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Will China's Brand of Stakeholder Capitalism Sustain Development in the Next 20 Years?

Ronald W. Anderson

Since 1978, China has developed strongly using a particular form of capitalism that has relied on close relations between private enterprise and the state, and the continuing presence of state-owned enterprises, both centrally and at local levels. This model has been criticised as being responsible for the rapid rise of debt since 2010, and more recently for the slowdown of growth. I assess the challenges to China's stated growth ambitions, emphasising the demographic factors that vary across regions. Using examples at the regional and local levels, I illustrate the workings of this system and highlight the challenges for adapting it to support China's growth ambitions for the coming decades. The conclusion is that China's public-sector development can no longer be financed principally through land sales, and Chinese savers will need to shift away from real estate and redirect their investments toward equities and other capital-market vehicles.

Journal of Economic Literature (JEL) codes: G3, H2, K4, P2

Keywords: state capitalism, debt overhang, infrastructure, local public finance, enterprise reform

1. Introduction

In this paper I consider a large question: is China's brand of capitalism capable of meeting the challenges of China's development strategy over the coming 10 to 20 years. Since 1978, China has developed strongly using a particular form of capitalism that relies on close relations between enterprises and the state. The enormous

* 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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growth of private enterprises accounts for much of the growth of Chinese GDP and real incomes. However, the state continues to assert its leadership role in guiding the growth process as evidenced by its continued use of 5-year plans to set quantitative targets for GDP growth and its reliance on state-owned enterprises to guide investment toward priority sectors.

The result of these policies has been sustained growth of production and incomes. Between 1977 and 2006 the average annual real growth rate was 9.8 per cent (based on the World Bank's measure of GDP expressed in constant 2015 USD), a result that is widely recognised to be an unprecedentedly strong growth record over three decades. However, with the onset of the financial crisis starting in 2007, China was confronted with a series of challenges to its continued growth. Following the 2007–2008 bank failures in the US and Europe, China responded with a massive fiscal stimulus that resulted in considerable domestic investment that supported China's continuing growth and mitigated the effects of the crisis world-wide. Subsequently, China has been confronted with continuing challenges in meeting its growth targets, which currently have been set at approximately 5 per cent for 2025. Issues that have preoccupied analysts are (1) the enormous growth since 2010 of debt issued by the non-financial enterprise sector[1], (2) the fact that authorities have adopted a series of policies that rely more on channelling investments through state-owned enterprises, which serves as a drag on innovation and technical progress[2], and (3) the fact that the hand of the state remains visible across a wide range of private firms both big and small[3]. In my own analyses of China's deleveraging policy, I argue that much of the debt growth can be traced to

[1] The risks posed by the very rapid growth of debt after 2010 were signalled by the *OECD* (*2013*) and the *IMF* (*2016*). Analyses by Chinese scholars traced the origins of this debt growth to the policy of fiscal stimulus the Chinese authorities adopted in 2008 to counteract the effects of the global financial crisis (*Bai et al. 2016*) and also to the emergence of Chinese shadow banking (*Chen et al. 2020*). Chinese authorities responded to these developments with a variety of measures starting in 2014, aimed at containing the growth of debt (*Wong 2018*). For an overview of how the structure of the credit bond markets has evolved since 2009, see *Chen and Anderson* (*2024*).

[2] Official discussions of China's economic development have consistently maintained that China is constructing socialism with Chinese characteristics. Even after the first wave of reforms of the state sector, which saw the number of industrial state-owned enterprises (SOE) drop from 127,600 in 1996 to 61,300 in 1999 (*Lardy 2014*), central authorities reaffirmed their commitment to state ownership and the 5-year plans that set investment priorities. However, analysts have had a hard time establishing an evidence-based case that would justify this. *Zhu* (*2012*) surveys contributions in growth accounting literature to assess the factors contributing to China's high growth rates. He finds that between 1978 and 1998, productivity growth was much higher in the non-state sector than in the state sector. Subsequently, following the reforms put in place in the late 1990s, there was a significant increase in state-sector productivity. However, by far the largest contributor to growth was labour mobility – specifically, the movement of a large part of the labour force out of the agriculture sector (and to a lesser extent the state sector) into the non-state sector engaged in non-agriculture activities, where the *level* of productivity was much higher than in the state sector. Also see *Lardy* (*2019*) and *Ljungqvist et al.* (*2015*).

[3] It should be noted that many analyses implicitly assume that the *purpose* of Chinese firms, both private and state-owned, is to maximise investor returns. They do not take seriously the idea that the interests of a broader group of stakeholders may also be served. Nor do they consider that some firms may actually be pursuing some form of public good provision or may be engaged in mitigating some public bad. In contrast, Dani Rodrik has argued that much of China's success in rapid growth and poverty reduction is attributable to being able to balance public and private interests. See *Rodrik* (*2020*).

financing infrastructure investments that carry public benefits as part of China's urbanisation strategy (*Anderson and Lu 2018, Anderson 2020*). I further show that, at the time the policy was announced, investors viewed the debt of both private firms and state-owned enterprises as carrying implicit state guarantees. Subsequently, between 2016 and 2018, it became increasingly clear that guarantees would be restricted to heritage infrastructure issues of state-owned entities, and this was reflected in the pricing of debt (see *Anderson 2020*).

To assess these challenges and the steps that authorities have taken to sustain high growth going forward, it is important to recall that the principle of decentralisation and self-reliance is deeply embedded in the Chinese system. It has given rise to a model of mixed public-private provision that exists with local variations throughout China. Regional authorities in China are responsible not only for organising public goods in the region, but also for finding the resources to support them. This principle was embedded in the Chinese system early in the market reform era, notably in the first experiments with Special Economic Zones (SEZ) in 1979–1980. In negotiating the creation of the Shenzhen SEZ, party leader Deng Xiaoping stated to Guangdong provincial leaders that "the party centre has no money. So, we will give you a policy that allows you to charge ahead and cut through your own difficult road." (*Vogel 2011*: p. 398). This gave the Guangdong authorities the freedom both to seek funding from overseas Chinese for new investments in the SEZ, and to sponsor enterprises that provide public services needed to support the incoming investments as well as support the growing population.

Subsequently this same principle has been deployed in rolling out economic reforms throughout China. This delegation between central and local powers in all spheres is described by *Xu* (*2011*) as a "regionally decentralised authoritarian" system. While Beijing has very strong powers to intervene in local implementation of policies, if it so chooses, in practice there are limits to its capacity to do so. This creates scope for local variations in the application of policies. In the area of industrial policy, this means that for activities where there are potentially big economies of scale, large firms (either state-owned or private) will be monitored, and possibly, regulated by organs of central government. For economic activities with a regional impact, comparable responsibilities will be assumed at the level of the province or large municipality. Similarly, county-level officials will bear some responsibility for the contributions to economic health and living conditions at the local level. This has led to close relations between public authorities and private business at every level of the Chinese system.

In my view, perhaps one of the most important characteristics that distinguishes China from other countries is the routine delegation of authority to the regional or local level, which in turn is counter-balanced by the centre's ability to give very clear guidance when it deems it necessary. One could argue that the centre exercising authority has become more frequent in the last ten years, and therefore it is more accurate to describe China's system as "state capitalism" rather than "stakeholder capitalism", as I have described it here. To get to the bottom of that debate would require a deeper discussion of comparative economic systems that is beyond the scope of this paper.[4]

While much power devolves to the regions in this system, the centre has still consistently taken responsibility for maintaining China's commitment to balanced growth, where benefits of development are widely distributed. In recent years this is reflected in the Party's commitment to "high quality growth", meaning growth that is sustainable economically, but also environmentally and socially. While central authorities can intervene actively through a variety of administrative means, one important tool, arguably the most potent, in affecting China's long-term development is the national system of residency registration. This is the so-called "hukou system", which indirectly shapes demographic trends throughout the entire country. Under this system, an individual is registered as a resident of a specific locality (either rural or urban), in most cases determined by the residency of the person's mother. In this way, it links the person's access to public services, such as education, healthcare and social benefits, to their place of registered residence. This system was introduced in the 1950s to control internal migration and allocate resources efficiently.

The effect of this system became visible in the years following the opening-up, starting in 1979–1980 as new Special Economic Zones began to take-off. The motivation of the first SEZs was to stimulate foreign investment and increase international trade, which would give rise to a process of export-led growth. This naturally created employment opportunities in coastal areas, which in turn attracted labour supply from rural areas and internal regions. However, the hukou system posed a significant obstacle that tended to restrain the flow of labour to regions with high demand. In the first instance, these contradictions of policy were resolved pragmatically. As word of opportunities in distant places reached the interior, workers set off for the coastal areas where they were housed in informal arrangements, and later in dormitories, as provided by employers or operated as new, private businesses. The new workers were not residents of the locality of the SEZ enterprise, and often their spouses, children and other family members

[4] Some useful contributions to the comparison of China's growth experience and economic structure can be found in other issues of this Review. See, in particular, *Csanádi* (*2017*), *Rippel* (*2017*), *Balogh* (*2017*) and *Komlóssy and Vargáné Körmendi* (*2019*).

remained in their place of legal residence where they had access to public services. Workers would return home at holidays carrying their savings and accessing any needed healthcare as best as they could.

Over time, the poor living conditions of newly arrived workers as well as the associated stress on their families became apparent, and authorities began to take steps to regularise the residential status and improve the provision of public goods in fast-growing regions. Again, the outcomes depended heavily on local initiatives and there was much regional variation. But overall, rapid economic growth has been shaped by demographic patterns in China, which in turn have themselves been shaped by the dramatic changes in the Chinese economy.

In *Section 2* I use Chinese demographic data at the provincial level to illustrate this interaction of demographic factors and economic development. And this, in turn, suggests how these factors will interact in the coming years based on some of the slow-moving characters of China's demographic profile. Then in *Section 3,* I use city-level data in one province, Guangdong, to discuss how demographic forces combined with local authorities' obligations for public good provision have interacted to produce some of the factors currently weighing on China's economic growth. This will suggest areas where central authorities might find ways to help local authorities avoid such problems going forward.

2. Regional demographic factors in China

I have already identified China's "hukou" residential registration system as one policy tool of the central authorities that has been important in shaping China's development path. A second important factor was China's "one-child" policy, which was introduced in 1980 and remained in place until it was relaxed in steps starting in 2014.[5] Otherwise, the main features of its development had things in common with many other countries: a country where initially most of the population is rural and is engaged in agricultural production with low levels of mechanisation and productivity. Development involves a flow of labour to urban areas to work in the manufacturing economy based on capital investments that promise high returns because of the availability of relatively cheap labour[6].

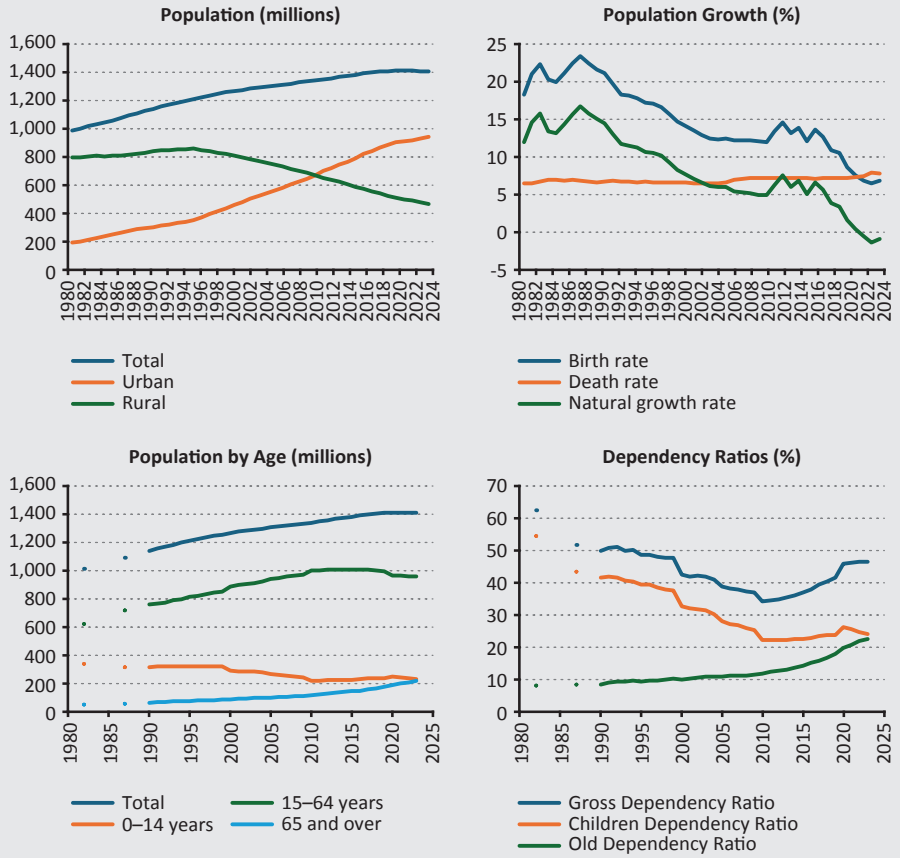
[5] Another dimension of the demographic forces at work in China is the overall aging of the population and its implications for savings, growth and the real rate of interest. These issues are discussed in *Pradhan and Goodhart* (*2024*). See also *Goodhart and Pradhan* (*2020*).
[6] See the classic growth theory set out in *Lewis* (*1954*). See also *Hirschman* (*1958*), *Lin and Shen* (2018) and *Wan and Zhang* (*2017*).

Figure 1 presents the evolution of Chinese demographics at the country level since 1980, based on statistics collected by the National Bureau of Statistics of China. The top left panel presents the population of China overall and broken down into rural and urban localities. In 1980 there was a total population of about 1 billion people, of whom 80 per cent were rural and 20 per cent were urban. Subsequently, the urban population grew strongly, as people were attracted by employment opportunities offered by new manufacturing companies opening in urban centres or in nearby rural localities that were transformed through urbanisation. The rural population continued to rise slowly into the 1990s, but then began to fall rapidly through a combination of low birth rates and emigration to urban areas. By 2010, half of China's population was rural and half was urban. At the end of 2024, the breakdown by residence was 67 per cent urban versus 33 per cent rural.

These broad patterns depict a rural exodus process that is the major feature of China's development in the last four decades, and is still ongoing. Labour was attracted by growth. This involved taking land out of rural areas that formerly had operated collectively in agricultural production, before selling off land rights for use in manufacturing and distribution in the first instance and then later for residential development and public services.

The increased need for public goods for newly arrived urban workers raised the question of how to pay for this social provision. Here, it was realised early on that the growth and prosperity of the newly urbanised areas would potentially lead to enormous imbalances if the tax rights in the new urban areas fell mainly to local authorities. In the face of this, the central authorities imposed a fiscal reform in 1994 that had local tax proceeds accrue to the central budget before being redirected by central authorities to regions all over China in line with priorities set out in the 5-year plans. Furthermore, regional authorities were constrained in their ability to borrow against the prospect of future revenues by prohibiting them from issuing local municipal bonds. However, the local authorities did retain the ability to use proceeds from land sales, and over time land sales became the single biggest asset in the balance sheets of regional governments (see *Anderson and Lu 2018*). The practice of land sales and distributing proceeds varies across regions, but in many cases, locally sponsored state-owned enterprises received proceeds from land sales as part of their capital base. Ultimately, these local SOEs were able to issue their own debt securities. Indeed, local SOEs' bond issues grew enormously as part of the fiscal stimulus launched in 2009, and account for much of the growth of non-financial debt through 2014 (see *Anderson 2020; Anderson and Lu 2018*).

Figure 1
National Level Demographics in China



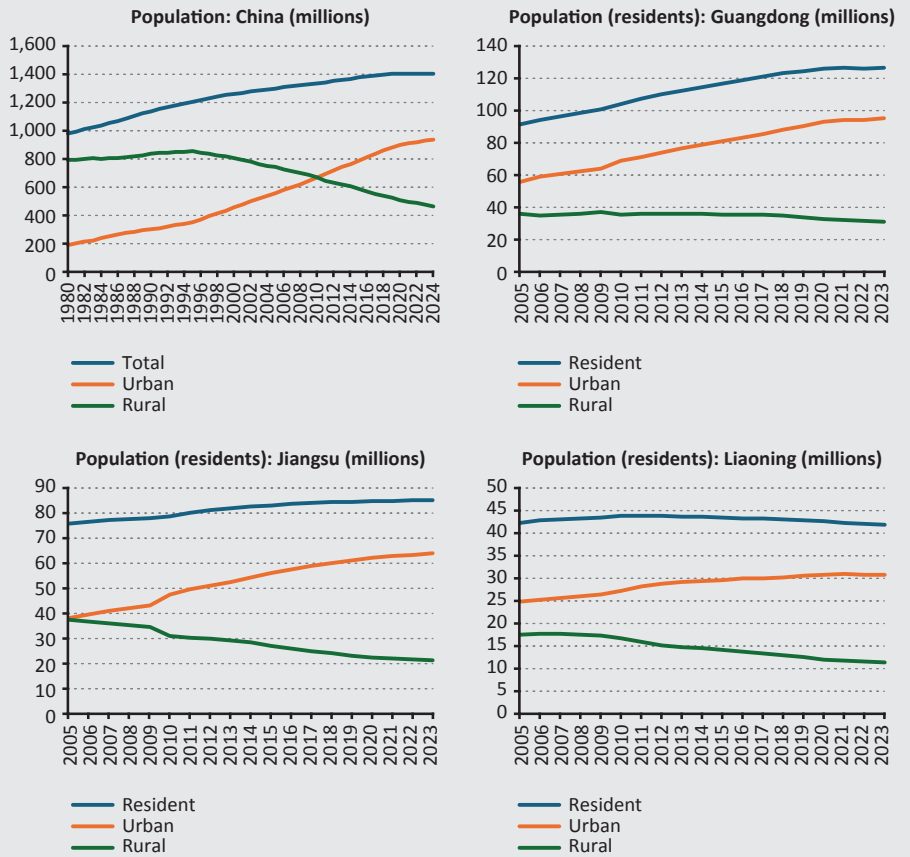
Sources: National Bureau of Statistics of China (https://www.stats.gov.cn/english/Statisticaldata/yearbook/)

The slowing of population growth triggered by the one-child policy in 1980 became visible only with a long lag. This is seen in the top-right panel of *Figure 1,* which depicts the birth rate, death rate and natural growth rate of population annually. From 1980, China's natural birth rate hit its peak in 1987. It subsequently fell smoothly until 2011, by which time the 1985–1990 generation reached peak child-bearing age, increasing the birth rate somewhat for about 5 years. This nicely illustrates the long-term predictability of demographic forces. Another way to depict these factors is seen in the age composition of the population, which is shown in the bottom-left panel of *Figure 1*. This shows the steady rise of the population 65 and older, and the simultaneous slow decline of the population aged 0–14 years.

Overall, China's total population hit its maximum level in 2020, and it has been declining very gradually since. However, the composition of the population has changed dramatically since 1980. This is seen in the bottom-right segment of *Figure 1*, which reports the dependency ratio. The child dependency ratio is the ratio of the population aged 0–14 to the total population. Old-age dependency is the ratio of those 65 or older to the total. And the overall dependency rate is the 0–14s and 65s and older divided by the total population. China's overall dependency ratio has been rising sharply since 2010. Even more striking is the change in the composition of the dependency ratio. In the past, the child dependency ratio was much higher than the old-age dependency rate. The two rates are currently at the same level, and in the future the elderly ratio will become dominant. The implications for social service provision are palpable and dramatic. In the 1980s and 1990s the major need was for education and child-care. In the future, the needs for elderly care and medical care will dominate.

In light of China's characteristic delegation of responsibilities to regional and local authorities, it is clear that many of the consequences of the demographic forces we have described are felt most acutely at the local level. Furthermore, given the nature of China's export-led growth surge, a considerable variation of demographics across regions should be expected. To illustrate this, I compare the demographics of three provinces that were all strongly affected by the growth of manufacturing since 1980, but whose development paths differ in important ways. These are Guangdong, Jiangsu and Liaoning. Guangdong province, whose capital Guangzhou (Canton) is located in south China and includes the Pearl River Delta, has been a trading hub since the 19th century. Jiangsu province is in central-east China, with many important cities in the region of the lower Yangtze River. Its capital is Nanjing. Liaoning is in northeast China, with important transport links to Russia and Korea and port access to the East China Sea. Its capital is Shenyang.

Figure 2
Population trends

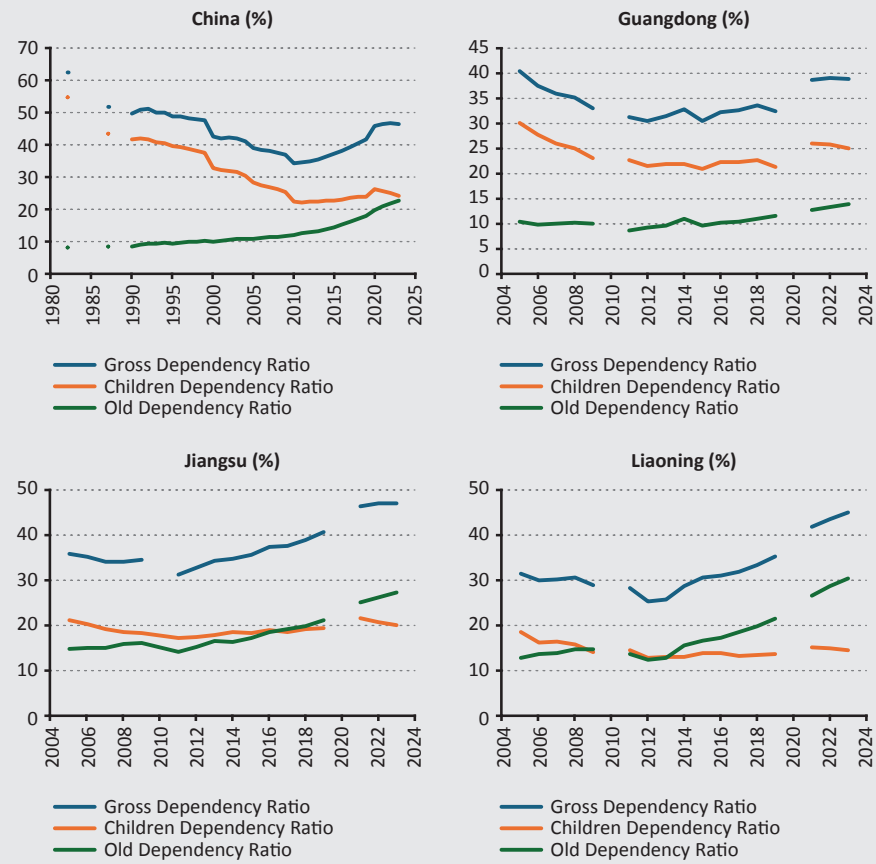


Source: National Bureau of Statistics of China (https://www.stats.gov.cn/english/Statisticaldata/yearbook/)

Figure 2 reports the total, urban and rural populations based on official residency (hukou) each year in each of these provinces between 2005 and 2023. For comparison, I include resident population statistics for China as a whole. We see there have been significant differences in demographic experiences across the three selected provinces. Between 2005 and 2023 overall, China's population grew by 8 per cent, Guangdong's grew by 38 per cent, Jiangsu's by 12.4 per cent, while Liaoning lost 1 per cent of its total population. Guangdong's large increase in population was driven by significant growth in the urban population, whereas its rural population declined by 13 per cent, which is well below the 38 per cent shrinkage of the rural population for China as a whole. The implication is that most

of the newcomers[7] to urban Guangdong came from other provinces. In contrast, since 1990 the overall population has grown moderately in Jiangsu (12 per cent) and not at all in Liaoning. However, there has been rapid growth in the urban population (67 per cent in Jiangsu and 24 per cent in Liaoning), while at the same time a huge rural exodus (–43 per cent in Jiangsu and –33 per cent in Liaoning). This suggests that the authorities in these two regions were faced with the task of reorienting public good provision away from rural areas towards newly developed urban areas.

Figure 3
Dependency rates



Sources: National Bureau of Statistics of China (https://www.stats.gov.cn/english/Statisticaldata/yearbook/)

[7] new registered residents

These regional differences can be seen from a different perspective by looking at dependency rates in these regions. This is depicted in *Figure 3* using data obtained from surveys of registered residents available in the selected provinces since 2005. In Guangdong province, the overall dependency rate declined during the period of its rapid growth from 2005 to 2015. Most of the dependency rate over the reporting period was concentrated in youth dependency, implying a need for schooling and other services to prepare the young for entering the workforce. By contrast, the overall dependency ratios have risen sharply in Jiangsu and Liaoning, driven by old-age dependency rising sharply to 24 per cent in Jiangsu and 31 per cent in Liaoning by 2023. The implication is that the authorities in those two regions have been faced with a need for increased public provision in urban health care, a major change from what was needed in the past.

3. Examples of Development Strategies at the Local Level

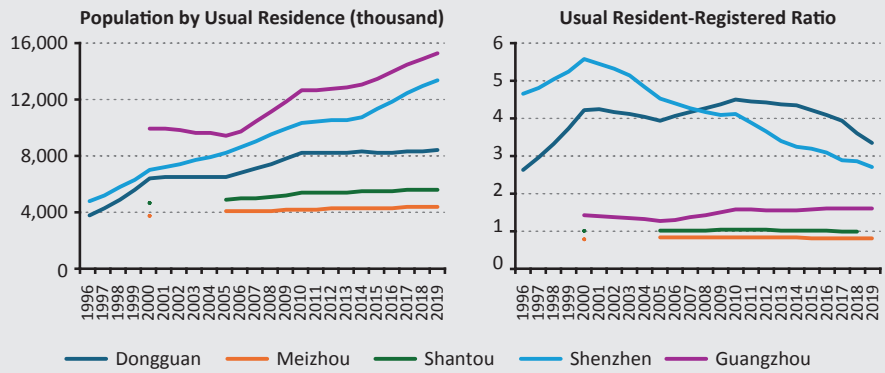
I have emphasised that both delegating public good provision and finding the means to finance it have led to a variety of solutions at the local level in China. To illustrate this more clearly in this section, I will focus on examples taken from five localities in Guangdong Province, a part of China I have visited often over the last 30 years, including extended visits in the last 8 years. These include Guangzhou, the long-standing provincial capital, and Shenzhen, the immediate neighbour of Hong Kong and the initial SEZ as described above. I include two other areas designated as SEZs at about the same time as Shenzhen. These are Dongguan, a large district adjacent to both Shenzhen and Guangzhou, and Shantou, a coastal port about 400 km east of Guangzhou. Finally, I include Meizhou, a historic city and district in the steep hills inland from Shantou. It was one of the homelands of the Hakka Diaspora found worldwide.

Figure 4 presents information about the evolution of the population in these five localities in a way that gives some insight into Chinese urbanisation patterns in the market reform era. The left panel of *Figure 4* reports the total number of people "usually resident" in each city. This includes both residents, people with hukou in that locality, and other people who have hukou elsewhere but are working and usually residing in the locality. The right-hand panel of *Figure 4* reports the ratio of the number of persons "usually resident" (with and without hukou there) to the number of registered residents in the locale.

If you recall, under China's household registration system, upon birth a child is registered in the locale where his or her parents are registered residents. Normally, this was meant to compel them to live and work in that locality in order to have public benefits such as school and medical care. However, after 1980, as certain locales began to prosper, many people left the rural areas to seek job opportunities

in cities. Once in a job they would find housing under informal arrangements or in dormitories provided by their workplace. While this practice was tolerated, the workers did not have the same rights as registered residents. As the numbers of such 'temporary' workers grew in some areas, local authorities began collecting statistics on the numbers of people normally residing in the locality.

Figure 4
Population characteristics



Sources: CEIC (https://www.ceicdata.com/en)

Thus, in 1996 for example, Shenzhen had a population of 4.8 million based on usual residence. At the same time, it had a usual resident/registered resident ratio of 4.67, implying a registered resident population of 1.03 million. This reflected the enormous influx of newcomers to Shenzhen in the first 16 years of its development as a SEZ. Subsequently, Shenzhen's usual resident population grew strongly so that by 2019 it had a population of more than 13 million. Between 1996 and 2000, the usual/registered ratio rose steadily, reflecting a continuing predominance of new workers engaged on a temporary basis. Subsequently, the usual/registered ratio fell steadily and stood at less than 3 in 2019. This tells us that many of the recent arrivals in Shenzhen have been drawn based on employment that qualified people for registered residence status, and allowed them to have their families settle in Shenzhen as well. These dry numbers suggest something about the stunningly fast transformation of Shenzhen from being an underdeveloped rural community to a boom-town living off light manufacturing, and then later emerging as a world-class tech centre.

Figure 4 shows that Dongguan, Shenzhen's neighbour to the north and also an SEZ, experienced an even sharper increase in population between 1996 and 2000, dominated by an influx of temporary workers. Between 2000 and 2005 the usually resident population remained stable. This period saw the closure of many factories that had lost a competitive advantage to other areas of China or other countries. The population has subsequently grown slowly in a process of industrial renewal with a changing mix of products, but it is still dominated by workers with temporary status.

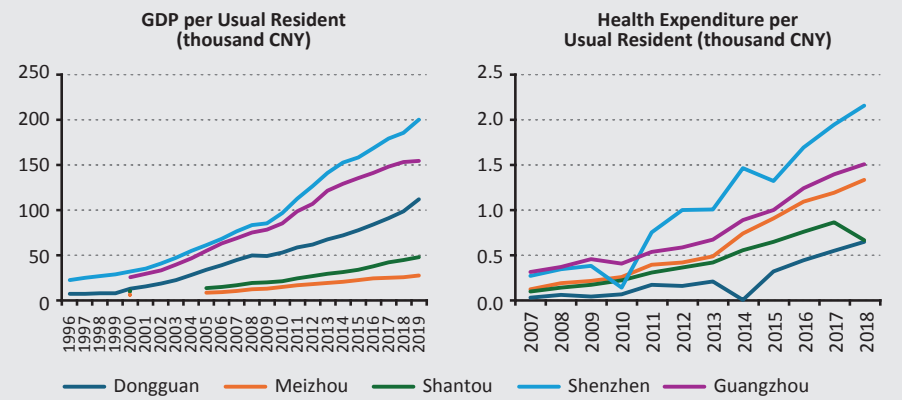
In Guangzhou, the resident population rose strongly from 9.9 million in 2000 to 15.3 million in 2019. Over the same period, the ratio of resident population to registered population rose modestly from 1.42 to 1.6. This reflects the fact that as the capital of the province it has been able to benefit from the rapid development of the surrounding region, including Dongguan and Shenzhen, but also Foshan, Zhuhai and other localities on the western side of the Pearl River Delta.

From *Figure 4* we also see that Shantou and Meizhou have not seen anything like the rapid population growth of Shenzhen, Dongguan or even Guangzhou. Shantou grew from a resident population of 5 million in 2005 to 5.7 million in 2019. Over the same period Meizhou went from 4.1 million to 4.8 million. During this time their ratios of usual residents to registered residents were static at around 1.0. This suggests a process of gradual evolution rather than radical change, even for Shantou, despite its 4 decades of experience as a SEZ.

These population growth patterns seem quite understandable if one considers how the localities are connected. Shenzhen and Dongguan have long had sea access to Hong Kong, Macao and other countries, and also to other areas throughout the Pearl River Delta. At the beginning of the market reform era there was already a railroad link between Guangzhou and Hong Kong (Kowloon) that had stops in Shenzhen and Dongguan. Thus, with the introduction of the SEZs there was already a skeletal transportation network and a great many possible and relatively cheap extensions of that network that could produce a wide variety of agglomeration economies. In contrast, Meizhou and Shantou were hampered by poor transport links either to the Pearl River Delta in the west or Xiamen and Zhejiang Province to the east. These transport links have improved only gradually. In 1996 there was no direct train from Guangzhou to Shantou. By 2008 a direct train service was in place with an overnight train ride taking 7 hours. The Shenzhen-Shantou high-speed rail link came in 2013 and has reduced travel time to about 2 hours. The Guangzhou-Shantou high-speed line is still under construction, and is scheduled for completion in late 2025. Once finished, it will reduce travel time to about 90 minutes.

Figure 5 gives some additional insight into social and economic development in these five cities. The left panel gives the GDP in the locality per usual resident of the locality. By this measure, the burgeoning prosperity of Shenzhen stands out. In 2000, twenty years after it took to its "own difficult road" as set out by Deng Xiaoping, it had more than equalled Guangzhou, long the most prosperous city in southern mainland China. By 2019 this gap had widened. GDP per usual resident was 200,400 CNY (29,000 USD) in Shenzhen versus 154,400 CNY (22,286 USD) in Guangzhou. The evolution of per capita GDP in Dongguan reveals the boom-bust-renewal pattern suggested by the population figures. In Meizhou and Shantou, this measure is consistent with the moderately increased prosperity in line with the scenario suggested by the slower growth of their resident populations.

Figure 5
GDP and Health Expenditure per usual resident



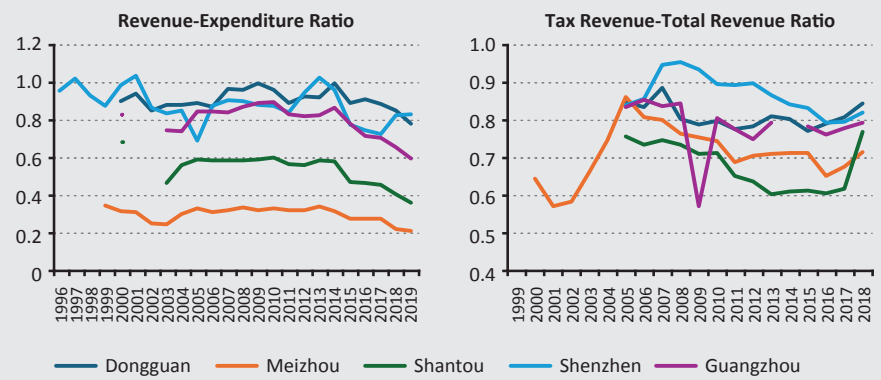
Source: CEIC (https://www.ceicdata.com/en)

The right-hand panel of *Figure 5* reports the total expenditure on health and family planning in public facilities in the locality per usual resident in the locality. We see that this measure of socio-economic development has tended to increase with rising GDP, but not in lockstep. It is particularly interesting that, by this measure of public health provision, Meizhou attains a status close to Guangzhou, the provincial capital that boasts a large number of excellent hospitals and specialised health facilities. By comparison Shantou, and particularly Dongguan, lag behind.

I think these patterns well reflect the consequences of China's system of regional self-reliance. Health authorities in a prefecture-level city in China fund expenditures through a combination of (a) contributions from the municipal budget or higher-level (provincial or national) budgets under specific programmes, (b) fees for services provided to patients paid by insurers (based on household registration, employment

or private insurance) plus patient co-payments, and (c) from sales of medicines and other health products in shops embedded in public facilities. Thus the relatively high level of health expenditures in Meizhou may be a consequence of high demand for health services by the local population reflecting demographic characteristics (e.g. a relatively older population) as well as income levels. However, it may also reflect the fact that Meizhou is the main city servicing a wider region that includes many isolated rural communities. It would be the nearest and most convenient place to seek medical assistance for any relatively complicated medical condition. Finally, since citizens are free to seek their medical assistance where they like, high demand may reflect a good reputation. Thus, there is an element of competition at work. Staff of a medical facility may seek excellence as a matter of pride. But they may also appreciate the financial benefits that a strong flow of co-payments brings. These same considerations suggest why, in *Figure 5*, Dongguan appears to lag behind the other cities in terms of local health expenditures. It may be that some its healthcare needs are best served in nearby Guangzhou or Shenzhen. Also, the many recent arrivals without household status in Dongguan may also find it preferable (due to cost, waiting time or familiarity) to seek health services when they return home to visit their families. For example, when a Meizhou native working in Dongguan worker falls ill, he may well return home for an operation where post-operative care is cheaper, and where he has family members for support.

Figure 6
Revenue-expenditure ratios



Sources: CEIC (https://www.ceicdata.com/en)

Figure 6 sheds light on the ways in which slow-growers like Meizhou, and to a lesser extent Shantou, stand apart from their fast-growing neighbours in the Pearl River Delta. The left panel reports the ratio of municipal public revenues to total municipal public expenditures. In 2019 this ratio stood at 0.2 in Meizhou and 0.37 in Shantou[8]. This compares to 0.83 in Shenzhen, 0.78 in Dongguan and 0.59 in Guangzhou. In the right-hand panel, we see that the ratios of tax revenues to total municipal revenues are similar in all 5 localities. Thus, there seems to be a general structural difference that results in a higher level of local public good provision in Meizhou and Shantou. One possible explanation is that some of these services are being funded either through commercial activities generating payments earned directly by the entity providing the service (fees for health, education, etc.) or from subsidiaries or other branches of the same entity providing the public service.

Unfortunately, it is not easy to use publicly reported data to understand which of any contributing factors account for the proportion of public services paid for off-budget. As discussed by *Wong* (*2018*), weaknesses in China's reporting systems result in inconsistencies across jurisdictions and over time. In particular, it is not clear that all the relevant entities are identified and are required to report using the appropriate accounting framework. This was recognised in the 2014 Budget Law that called for the introduction of a new government financial reporting system to collect comprehensive information on government revenues including extra-budgetary and earmarked levies, land sales, remittances from SOEs and receipts from various pensions and social insurance schemes (*Wong 2018*: pp. 276–277). However, progress on implementing this has been slow. In part, this reflects the difficulty of identifying the relevant reporting entity and in classifying them correctly as either a public service or a commercial entity. For example, a city may sponsor many SOEs organised as a large group with many subsidiaries, some of which providing public goods and others purely commercial. It may be that profits from commercial activities are used to fund some of the expenditures of the public service entities, but that these transfers are not included among the public revenues.

Proponents of enterprise reform in China have long embraced the principle that public and private provision should be unbundled by clearly identifying an enterprise as either a commercial or a public service. Furthermore, since about 2000, one of the objectives of enterprise reform has been to "securitise" SOEs with a commercial purpose by structuring them as either limited liability companies or joint stock companies. However, this agenda has never been pushed consistently across all regions. In a comparative study of enterprise reform, *Lu* (*2018*) reports that as of 2014 in Guangdong Province there was a relatively low level of securitisation

[8] The money needed could come from any of the sources indicated above in (a), (b) and (c). Note that this includes payments made by non-residents for health services they receive in the localities (Meizhou or Shantou).

among local SOEs: as of 2012, only 21 per cent of total local SOE assets were in listed firms, compared to the target of 60 per cent set in the 12th Five Year Plan. In her assessment, many SOEs in Guangdong were sprawling conglomerates without clear core competencies.

Some insight into this issue can be gained by using information available on SOEs issuing enterprise bonds listed on either the Shanghai or Shenzhen stock exchanges that were used to fund infrastructure projects. The Shantou Investment and Financing Group Company, an AA-rated local SOE, issued a 1.8 billion CNY enterprise bond in March 2014 to fund municipal construction projects in Shantou. As reported by Wind Financial Services[9], it describes itself as active in financing "investment industry, agriculture and traffic, municipal facilities, real estate industry, ... import and export, ..., implementing the Municipal party committee and the city's decision-making, land reserve development, ... engineering advisory service, flowers cultivation, plant cultivation, technology study, development and operation." This seems to align well with the characterisation of lacking a clear core competency. It is certainly consistent with the view that some public good provision in Shantou may be financed through internal resource flows within this broad publicly owned group.

The case of Shenzhen Metro Group (SZMG) gives a different impression. It is an AAA-rated local SOE that issued two enterprise bonds in 2013 and 2014 for a total of 8 billion CNY. It is described in Wind as a firm concentrated in "construction, operating, development and comprehensive utilisation of subway and light-rail traffic projects". Its core activities are described on its website (in Chinese and in English) as the construction and operation of Shenzhen's rail transit lines, which had a total length of 210 kilometres in 2016. However, in addition, it undertakes a variety of commercial activities that are treated as integral to the metro developments, including commercial and residential property development, advertising and station commerce. In fact, real estate development accounts for a large share of its profits, which in 2019 stood at 11.7 billion CNY as compared to revenues of 21 billion CNY from metro operations. Its owner, the Shenzhen Municipal Government, contributes capital mainly in the form of land use rights. Costs of development are funded by retained earnings and debt, which is reimbursed largely through proceeds from commercial and residential real estate.

However, SZMG is not just a big real estate developer. It also represents the interests of Shenzhen in transportation planning and coordination activities at the provincial and national level. It cites its active involvement in targeted social services, including the provision of free transit for elderly residents and the construction of 22,000 units of affordable housing. Finally, it states that "Shenzhen Metro Group Co., Ltd. emphatically advocates and creates the enterprise culture

[9] https://www.wind.com.cn/

with the core value of 'mutual undertaking of responsibilities, mutual creation of values, and mutual sharing of achievements'", dedicated to the creation of a learning-oriented enterprise with a spirit of strict discipline and humanistic management, a harmonious and balanced "iron sole". While this mission statement uses enthusiastic language that exceeds the current norm in the West, it is in fact reminiscent of the statements of purpose used by many of the prominent cooperative enterprises developed in Europe in the early 20th century, some of which are still deeply embedded in important sectors such as insurance and banking.

4. Conclusion

To close this exploration of the operations of Chinese-style stakeholder firms, I now return to the question presented at the outset, which I reformulate as follows: Do the struggles of local governments for resources drive reform of local SOEs? And, if so, how does this affect the provision of public versus private goods? There is some evidence that China's deleveraging policy since 2014 is indirectly placing pressures on local governments to reform their SOEs. As detailed in *Anderson* (*2020*), the main elements of this policy are (a) prohibiting local governments from making open-ended debt guarantees or from committing proceeds from future land sales for that purpose, (b) channelling general-purpose local government borrowing through municipal bond issues by provinces or provincial-level cities, and (c) channelling public funding for capital investment projects through partnership projects (PPP[10]), where a local SOE joins with an outside partner (a private company or another SOE) that contributes their management expertise in infrastructure plus financial capital for about 20 per cent of the project cost, with the remaining 80 per cent funded by debt, often from a domestic policy bank. Following the Directive of the State Council in 2014 setting out this programme, it became clear that the policy was being reinforced by the National Development and Reform Commission, which reduced the flow of new approvals for enterprise bond issuances that had formerly been a major funding channel for local governments' infrastructure projects. Furthermore, during 2016 and 2017, repeated statements from the Ministry of Finance and the State Council emphasised the limited scope of government guarantees. At the same time there were highly publicised cancellations of several major PPP projects plus associated disciplinary actions against local government personnel for violating PPP guidelines.

[10] public–private partnership

All of this has had the effect of reducing local governments' ability to move resources freely among government departments and their associated SOEs. City and county governments must make their cases to provinces to gain access to resources, and the provinces need to convince Beijing that their allocations are coherent and effective. During 2018 and 2019, it became clear that local governments were feeling the effects of this regime when some highly indebted municipalities encountered major difficulties in rolling over infrastructure debts that were falling due[11]. More recently, in the wake of the trade disputes with the US and the Covid-19 pandemic, the central authorities dialled back somewhat on the deleveraging campaign. For example, they have allowed "special-purpose" municipal bonds to be used to recapitalise local publicly owned commercial banks, and have abolished a rating metric of "local public finance quality", which penalised localities with a low proportion of total expenditures funded through local taxes. However, despite these stop-gap measures, the pressure is on local governments to confine their commercial ventures to those that contribute resources rather than drain them, and to channel these resources to public services that are needed by local people.

The challenges to China's development model have been focused on the real estate sector since 2020, and particularly since the high-profile defaults of *Evergrande* (*2021*) and *Country Garden* (*2023*)[12]. Through 2024 most of the significant defaults have been confined to private enterprises and have taken place in the offshore market, especially Hong Kong. Some pressures have come to bear on public-sector finance, as evidenced by delays in payments of some short-term commercial paper issued by so-called local government funding vehicles. Most recently, the central government authorities have taken steps to contain these pressures by making capital infusions into several of the largest state-owned commercial banks and by targeting a central fiscal deficit in 2025 of 4 per cent of GDP. In so doing, they have tacitly recognised that China's future public-sector development can no longer be financed principally through land sales, and that Chinese savers will need to shift away from real estate and redirect their investments toward equities and other capital-market vehicles.

[11] See e.g., *The Local Government Debt Crisis that Just Won't Go Away*. Caixin, 10 April 2019. https://www.caixinglobal.com/2019-04-10/in-depth-the-local-government-debt-crisis-that-just-wont-go-away-part-1-101402567.html

[12] See *China Default Review 2024: Through Before the Third Wave*. S&P Global Ratings, 23 April 2024. https://www.spglobal.com/_assets/documents/ratings/research/101596523.pdf

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Geoeconomic Fragmentation in the Western Balkans

Tamás Ginter

Geoeconomic fragmentation has become one of the timeliest topics in international economics. This paper focuses on geoeconomic fragmentation in the Western Balkans by applying a descriptive analysis of trade flows with each of the region's major trading partners between 2010 and 2023. In addition to painting a detailed picture of the trading partner structures of the economies in the region, I examine whether geoeconomic fragmentation (growing trade within a geopolitical bloc) can be identified. I find that the Western Balkans trades predominantly with the EU and intraregionally. Trade patterns with Russia and China show mixed signs, and there are no clear signs of geoeconomic fragmentation. Thus, this paper supports the literature stating that so far in Central, Eastern and Southeastern Europe, geoeconomic fragmentation has rather been a possible policy narrative than an economic reality.

Journal of Economic Literature (JEL) codes: F4, F5, F6

Keywords: geoeconomic fragmentation, trade fragmentation, Western Balkans

1. Introduction

Geoeconomic fragmentation (i.e. a 'policy-driven reversal of global economic integration', *IMF 2023*, p. 91) has become one of the timeliest topics of international economic research during the past decade. The underlying causes are manifold: following the US-China trade war in the late 2010s, the polycrisis of the 2020s (including the Covid-19 pandemic, escalating geopolitical tensions as well as an energy crisis comparable with that of the 1970s) erupted. On the one hand, this polycrisis generated a need to restructure global value chains (GVCs) once the

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vulnerability of such had become evident after the numerous supply chain crises caused by pandemic-induced measures. This need to restructure value chains is described by the terms 'reshoring' and 'nearshoring', meaning the approximation of production and consumption, as well as shortening GVCs (see also *Aiyar – Ilyina 2023* and *Abeliansky et al. 2023*). On the other hand, the escalating geopolitical tensions of the 2020s (including military conflicts such as the wars in Ukraine and the Middle East as well as the emerging rivalry between the United States and China) resulted in a need to relocate production to and enhance trade with countries that are geopolitically aligned (described by the term 'friendshoring', *Maihold 2022*).

While geoeconomic fragmentation has emerged as a widely researched phenomenon in the past decade, relatively little focus has been directed towards its effects on the countries of the Western Balkans (WB).[1] This is all the more peculiar as the Western Balkans' geopolitical position can be considered rather unique on the European continent (see, for example, *Zarić – Budimir 2022*; *Hake – Radzyner 2019*). The six countries of the WB can be primarily characterised by a westward orientation, and significant steps have been made towards integration into the European Union, albeit the bloc's enlargement fatigue has resulted in a standstill and full-fledged integration into the European economy still seems a distant goal. In the meantime, global geopolitical actors have all expanded their influence in the Western Balkans (the United States by successful steps of NATO enlargement and China by launching the Belt and Road Initiative in the mid-2010s; see also *Barisitz 2024*). Furthermore, Russia has numerous historic, cultural and economic ties primarily with Slavic, orthodox WB nations, while regional geopolitical powers (such as Türkiye and certain Gulf states) are also exerting power via trade and investments (*Reményi – Csapó 2021*). Considering this unique position of the Western Balkans, the research of geoeconomic fragmentation in the region is particularly relevant and timely.

This paper thus aims to analyse geoeconomic fragmentation in the Western Balkans using trade data as a proxy. It is structured as follows: *Section 2* includes a literature review (focusing on the phenomenon of geoeconomic fragmentation as well as the relevant research on the Central, Eastern and Southeastern European region). *Section 3* and *Section 4* present the research methodology and results (on a country level as well as on a regional level), respectively. *Section 5* concludes.

[1] Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia and Serbia. The designation 'Kosovo' is used without prejudice to positions on status and in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.

2. Literature review

2.1. Geoeconomic fragmentation: definitions and consequences

2.1.1. Definitions and a brief historical overview

Definitions of (geoeconomic) fragmentation vary to a certain extent. *IMF* (*2023*) defines geoeconomic fragmentation as a 'policy-driven reversal of global economic integration' (p. 91), reflecting on the fact that fragmentation is initiated by political and economic agents, rather than being a spontaneous shift in the global economy caused by exogenous factors. A similar, but more detailed, definition stems from *Gopinath et al.* (*2024*), who define fragmentation as 'policy-induced changes in the sources and destinations of cross-border flows, often guided by strategic considerations, such as national and economic security, sovereignty, autonomy, which may or may not be associated with a decline in world trade relative to GDP' (p. 1). *Campos et al.* (*2023*) consider the emergence of aligned blocs within the global economy as a prerequisite for fragmentation that eventually limits (trade and capital) flows between the respective blocs. The underlying causes of this (policy-driven) geoeconomic fragmentation include changes in trade policy (and the rise of protectionist policies in particular) as well as a reshuffling of the global geopolitical order (including the emerging need for strategic autonomy; *Baur et al. 2023*).

The term 'fragmentation' is often linked with the concepts of 'reshoring' and 'friendshoring', which are defined as 'strategies to move production processes to trusted countries with aligned political preferences, to make supply chains more resilient and less vulnerable to geopolitical tensions' (*IMF 2023*, p. 91). Similarly, *Norring* (*2024*) categorises geoeconomic fragmentation as a component of deglobalisation, where fragmentation (i.e. 'economic activity concentrating within blocs' (p. 4)) is 'driven by geopolitics' (*ibid*). No clear definition of these blocs is, however, available, and delving into the geopolitical background of the formation of blocs would exceed the scope of this paper. Common categorisations predominantly use three bloc models (the United States and the European Union, Russia and China, the rest of the world; *Gopinath et al. 2024* or similarly, East, West and Neutral; *Campos et al. 2023*).

Research related to economic disintegration and the reconfiguration of global supply chains in accordance with geopolitical motives has gained significant importance over the past decade. The literature (see, for example, *Kaaresvirta et al. 2023* or *Norring 2024*) typically refers to the trade war between the United States and China as a starting point of global fragmentation, but signs of economic disintegration were already seen during the aftermath of the Great Financial Crisis (*Halmai 2023*). Other major milestones causing a need for policies supporting fragmentation

include the Covid-19 pandemic (primarily incentivising nearshoring) and the war in Ukraine (primarily incentivising friendshoring; *Blanga-Gubbay – Rubínová 2023*). Fragmentation is transmitted through a variety of channels, including foreign direct investment, cross-border migration and international trade (*Aiyar – Ilyina 2023*). The analyses in this paper focus on the latter as trade has been extensively used as a proxy for measuring geoeconomic fragmentation (see, for example, *Hakobyan et al. 2023; Alvarez et al. 2023*; etc.).[2]

2.1.2. Effects of geoeconomic fragmentation

While geoeconomic fragmentation has become a widely researched phenomenon, its extent is highly debated in the literature. *Gopinath et al.* (*2024*) corroborate the emergence of fragmentation since the 2022 start of the full-scale war in Ukraine: trade flows between geopolitically distant blocs have declined relative to trade among aligned countries. Nevertheless, so far fragmentation has proceeded at a relatively slow pace. These findings are supported by *Bosone et al.* (*2024*), whose EU-wide analysis concludes that when it comes to EU imports, evidence for nearshoring and friendshoring trends is limited. *Kaaresvirta et al.* (*2023*) found that despite the ever-intensifying discourse on deglobalisation, little evidence supports geoeconomic fragmentation on a global level. While trade and FDI flows between the United States and China have diminished since the start of the trade war between the two superpowers, the data do not support the emergence of other economic blocs. Furthermore, emerging regions (including Central and Eastern Europe) have seen growing patterns in trade and foreign direct investment since the start of the polycrisis of the 2020s. The latter findings are supported by *Ginter – Tischler* (*2024*) on a regional level: trade patterns in the Visegrád countries also do not show signs of fragmentation.

The effects of geoeconomic fragmentation are hard to model, and thus estimations vary substantially (*Norring 2024*). *Campos et al.* (*2023*) estimate that in the case of a global order with three blocs (West, East and Neutral), international trade would be reduced to one half in the most extreme scenarios and cause average welfare losses of 3.4 per cent. Losses would be more severe in the Eastern bloc. *Javorcik et al.* (*2023*) estimated the economic effects of friendshoring (i.e. reconfiguring trade flows by predominantly trading with countries that share similar values). They found that friendshoring may cause losses of up to 4.7 per cent of GDP, but the losses for countries in emerging Europe are estimated to be lower. Furthermore, *Javorcik et al.* state that not even emerging European countries would profit from friendshoring (through the relocation of production sites), although non-aligned status would help in minimising the losses caused by the restructuring of global value chains. Similarly, *Aiyar – Ohnsorge* (*2024*) state that while costly for most actors, fragmentation can

[2] FDI-related fragmentation in the Western Balkans is examined by *Ginter – Hildebrandt* (*2024*), for a review, refer to *Section 2.2*.

create opportunities for jurisdictions fostering free trade agreements, and thus acting as 'connector countries'; emerging Europe being considered as one of these regions.

2.2. Geoeconomic fragmentation in the Western Balkans

As referred to in *Section 1*, despite the Western Balkans' peculiar geopolitical position, little focus has been directed to geoeconomic fragmentation concerning the region. *Kaloyanchev et al.* (*2018*) painted a very detailed picture of the trade structure and main trading partners of the Western Balkans, albeit their data do not include recent developments induced by the polycrisis. According to *Kaloyanchev et al.,* as of 2018 the most important trading partner of the region was the European Union, with intraregional trade (i.e. trade within WB countries) ranking second; the former was declining, while the latter was rather stable. Looking at trade among the six WB countries, geographical proximity does not play a major role: it is rather linguistic and cultural proximity as well as the deconstruction of trade barriers that enhances intraregional trade. Trade with major non-Western geopolitical actors, i.e. 'Russia, China and Türkiye is less pronounced and is systematically skewed towards imports from them' (*ibid, p. 1*).

Ginter – Hildebrandt (*2024*) researched geoeconomic fragmentation in the Western Balkans by examining major geopolitical actors' share in foreign direct investment stock (FDI) in the respective WB countries between 2010 and 2023. They found that while the EU has been the major investor in the region, its share in FDI stocks has declined over time, while China, and to a lesser extent certain Gulf states, have emerged as investors. US investment activity has been limited and so has that of Russia. (Russian investments, however, still play a substantial role in Bosnia and Herzegovina). Furthermore, there have been signs of regional integration, with WB countries becoming investors themselves in fellow WB countries. Thus, foreign direct investment does not show a pattern of fragmentation in the Western Balkans. On the contrary, the region's investor structure has become diversified across geopolitical blocs. *Jovanović et al.* (*2024*) used micro-level data to identify nearshoring trends in the Western Balkans. They found that such trends are occurring in WB countries, and, that the region is a beneficiary of global nearshoring trends with production being moved to the Western Balkans (from Asia, in particular). Furthermore, they state that it is not only European companies moving production facilities to the region, but also certain Asian manufacturers which are aiming to ensure their proximity to European markets by their presence in the Western Balkans.

2.3. Research questions

Based on the reviewed literature, I posed the following research questions:

- Has the change in the global geopolitical landscape been reflected in the Western Balkans' trade flows?
- Has the Western Balkans been subject to geoeconomic fragmentation in the light of the global need for GVC rearrangements?
- Are there country-specific characteristics of geoeconomic fragmentation in the Western Balkans?

3. Methods

The goal of this paper is thus to identify any signs of potential geoeconomic fragmentation in the Western Balkans by analysing trade linkages with major trading partners and other, global and regional geopolitical actors. While fragmentation as a concept covers more than merely trade, similarly to a body of literature (*Hakobyan et al. 2023; Alvarez et al. 2023*; etc.), I use trade data as a proxy for measuring fragmentation (the limitations thereof can be found in *Section 5*). Based on the literature review, I consider geoeconomic fragmentation present if intra-bloc trade grows and trade outside the respective geopolitical bloc declines.

Before examining the trading partner structure of the Western Balkans, I first provide an overall assessment of the role of foreign trade in the Western Balkans. I used data from the World Bank[3] on the respective trade-to-GDP ratios for the WB countries. Then, I drew on the IMF's DOTS[4] database and analysed the shares of trade flows by respective trading partners for each WB country. This allows for a country-level understanding of the various structures. In order to gain a more long-term understanding of major trade trends in the WB countries, I used a dataset ranging between 2010 and 2022 (for imports) or 2023 (for exports). Exports and imports were treated separately in the analysis. Eight distinct trading partners and partner groups were identified as relevant for the analysis (based either on their global geopolitical influence and/or the significant trade share in some or all WB countries):

[3] https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS?locations=AL-MK-XK-RS-BA-ME. Downloaded: 29 October 2024.
[4] Direction of Trade Statistics. https://data.imf.org/?sk=9d6028d4-f14a-464c-a2f2-59b2cd424b85. Downloaded: 29 October 2024.

- the European Union,
- the United States,
- Switzerland,
- the United Kingdom,
- Türkiye,
- the remaining five Western Balkans countries,[5]
- Russia, and
- China.

Altogether, the share of these eight trading partners and partner groups covers at least 85 per cent of total exports and imports of all the WB countries in focus, and in most cases their sum even exceeds 90 per cent, thus covering all major trading partners of the region. I provide a descriptive analysis of the share of trade flows by partner countries and groups between 2010 and 2023 (or 2022). By doing so, I provide a detailed picture of the trade structures and trade integration of the WB countries.

In order to measure geoeconomic fragmentation, I identified (the three) global geopolitical blocs based on the relevant literature. Based on all major categorisations of blocs (*Gopinath et al. 2024* as well as *Campos et al. 2023*), the EU and the US are undoubtedly representatives of the Western bloc; this paper categorises Switzerland and the UK as part of the Western alliance as well (see also *Campos et al. 2023*). Conversely, Russia and China are part of the Eastern bloc. In this analysis, I consider Türkiye as well as the rest of the world to be unaligned (the latter in accordance with *Gopinath's* categorisation). Furthermore, I treat the region itself separately, due to the region's historical intertwinement as well as the very peculiar bundle of interests present in the region. The comparison of the respective blocs' shares in each WB country's trade allows to determine whether signs of geoeconomic fragmentation are emerging.

[5] For example, if Albania is the country in focus, the remaining five Western Balkans countries (hereinafter abbreviated as WB5) consist of Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia and Serbia.

4. Results

4.1. Role of international trade in the Western Balkans

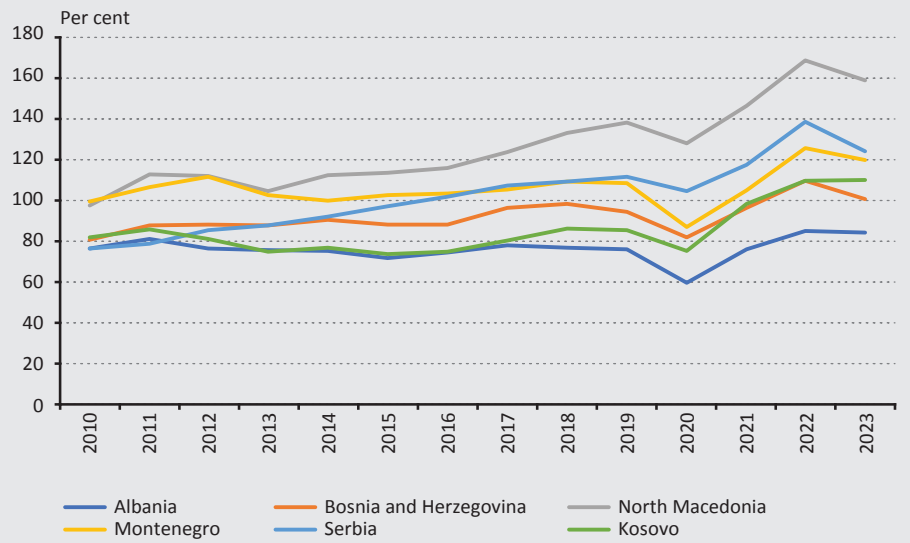
In this analysis, I first assess the overall role of trade in the WB countries. Trade-to-GDP ratios in these countries (as depicted in *Figure 1*) tend to be lower than those of the smaller Central, Eastern and Southeastern European (CESEE) EU member states (i.e. the Czech Republic, Hungary, Slovakia and Slovenia) and comparable with those of the larger ones (i.e. Romania or Poland; cf. World Bank data).[6] This primarily reflects the relatively small internal markets of the WB countries as well as the lack of beneficial effects of EU integration.

In terms of trade openness, as of 2023 North Macedonia (159.1 per cent) and Serbia (124.3 per cent) had the highest trade-to-GDP ratios. The least open economy in the WB is Albania (84.5 per cent). In the timeframe 2010 to 2023, trade openness trends varied among WB countries. Serbia, and even more notably North Macedonia, recorded strong growth in their trade-to-GDP ratios. Other WB countries' trade trends were more characterised by stagnation throughout the 2010s. These results align with the narrative on slowed-down globalisation (slowbalisation) after the GFC (see also *Halmai 2023*).

Trade-to-GDP ratios were significantly affected by global economic developments. The Covid-19 pandemic and the related measures caused a sharp setback in trade activities in 2020, followed by a rapid recovery, with 2022 trade-to-GDP ratios vastly exceeding pre-Covid levels in all six countries. (These results show much similarity to those of *Ginter – Tischler* (*2024*), who analysed trade-to-GDP ratios in the Visegrád countries for the same timeframe, implying that these metrics developed very similarly across the broader CESEE region). As far as data are available, this recovery might have been temporary, as 2023 came with another setback in all countries, also in connection with external crises. This setback happened irrespectively of the sanctions related to the Russian-Ukrainian conflict; countries refraining from sanctions were also affected (see also *Stanicek – Caprile 2023*).

[6] https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS. Downloaded: 29 October 2024.

Figure 1
Trade-to-GDP ratios in the Western Balkan countries between 2010 and 2023



Source: World Bank

4.2. Country profiles

In this section, I present the developments in the shares of the respective trading partners by each country in focus (for a detailed depiction, refer to *Figure 2*).

4.2.1. Albania

As is widely common in the region, Albania's most important trading partner is the European Union. The EU's share is particularly dominant in the case of exports, exceeding 70 per cent over the entire timeframe analysed and remaining more or less constant over time. This is less the case with imports that can be characterised by a shrinking trend throughout the past decade, with the EU's share reaching an all-time low of 51.5 per cent by 2022 (vs. 68.5 per cent in 2010). This setback can be considered atypical compared to other WB jurisdictions. Albania's major trading partner within the EU is – due to its geographic and historical proximity – Italy, which accounts for more than one half of Albania's trade with the EU. Exports to other WB countries (especially Kosovo) showed a rising trend from 2010 on, reaching an all-time high of 18.8 per cent by 2023, indicating deepening regional integration. Imports from the WB5 are markedly lower and comparable with those from China (between 6–9 per cent during the timeframe analysed). Exports to Türkiye shrunk markedly in the past decade, while Turkish imports have grown, however, making Türkiye the second biggest import partner of Albania by 2023 (at 12.0 per cent of total imports). Trade with other major geopolitical actors (such as the United States

and Russia as well as imports to China) is limited to negligible (maximum 2.5 per cent of total trade).

4.2.2. Bosnia and Herzegovina

In the 2010–2023 timeframe, the EU's share in Bosnian trade has always markedly exceeded 50 per cent (oscillating at around 60 per cent of total imports and 70 per cent of total exports). Contrary to other WB countries, the share of trade with the EU has not shrunk in the past decade (and on the export side it has even shown moderate growth). In addition to major EU economies (and Germany and Italy, in particular), trade is intensive with the former Yugoslav EU countries (Croatia and Slovenia). A notable and constant share of Bosnian exports (14–20 per cent) flow to the other WB5 economies (especially Serbia and to a lesser extent Montenegro). As for imports, WB5 countries (strongly dominated by Serbia) are the second biggest source after the EU, with a constant, albeit smaller share (10–13 per cent). In terms of imports, China and Türkiye also doubled their shares between 2010 and 2022 (reaching 8.1 and 5.8 per cent, respectively); Russian imports contracted significantly in this timeframe (from 8.4 per cent in 2010 to 2.3 per cent in 2022).

4.2.3. Kosovo

Kosovo is the least dependent on the EU out of the sample in focus. Imports from the EU account for a stable 40–45 per cent, while exports to the EU declined by one third between 2010 (45.2 per cent) and 2023 (32.3 per cent). On the other hand, the share of trade with the remaining five countries of the Western Balkans is outstandingly high. WB5 countries' share (particularly that of Albania and North Macedonia) in exports grew from 22.6 per cent in 2010 to an impressive 39.8 per cent in 2023; with imports (particularly from Serbia and North Macedonia), however, Kosovo experienced a decreasing share (34.4 per cent in 2010 vs. 17.7 per cent in 2022). Geographic proximity indeed plays a role in Kosovo's intra-WB trade (thus confuting the findings of *Kaloyanchev et al. 2018*). Furthermore, the United States' share in foreign trade is the largest in the case of Kosovo: in 2023, 12.3 per cent of Kosovan exports were directed to the US (this is a relatively new phenomenon: until 2019 the share of the US in Kosovan exports was negligible). On the import side, Türkiye is a notable player with a share of 14.9 per cent in 2022 (a share that has doubled in 12 years). The Russian share is negligible, and trade with China is much skewed towards imports and maintains a constant share.

4.2.4. Montenegro

The share of EU trade in Montenegro is lower compared to most other WB countries; major EU trading partners include Germany, Italy and Slovenia. The share of EU imports fluctuated around 45 per cent, while the share of exports narrowed in the early 2010s and has since stabilised around 30–35 per cent. Similar to Kosovo,

intra-WB trade accounts for a remarkably high share in Montenegrin trade, with exports growing (38.1 per cent in 2010 vs. 48.0 per cent in 2023) and imports shrinking (36.5 per cent in 2010 vs. 26.1 per cent in 2022). There is trade with all WB5 countries, with Serbia as the largest partner. The share of imports from China ranges around 10 per cent (exports to China do not play a major role), while other partners' share is moderate.

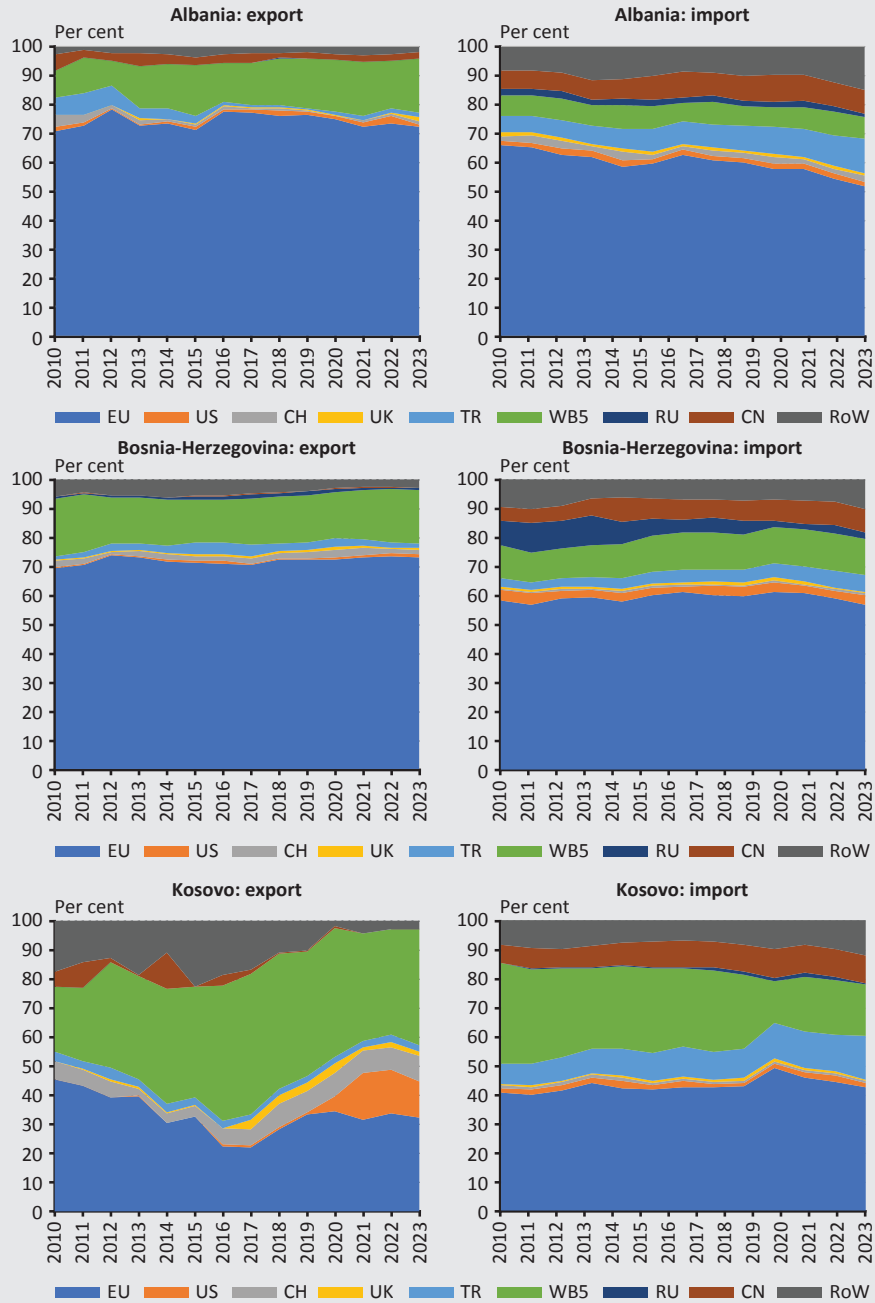
4.2.5. North Macedonia

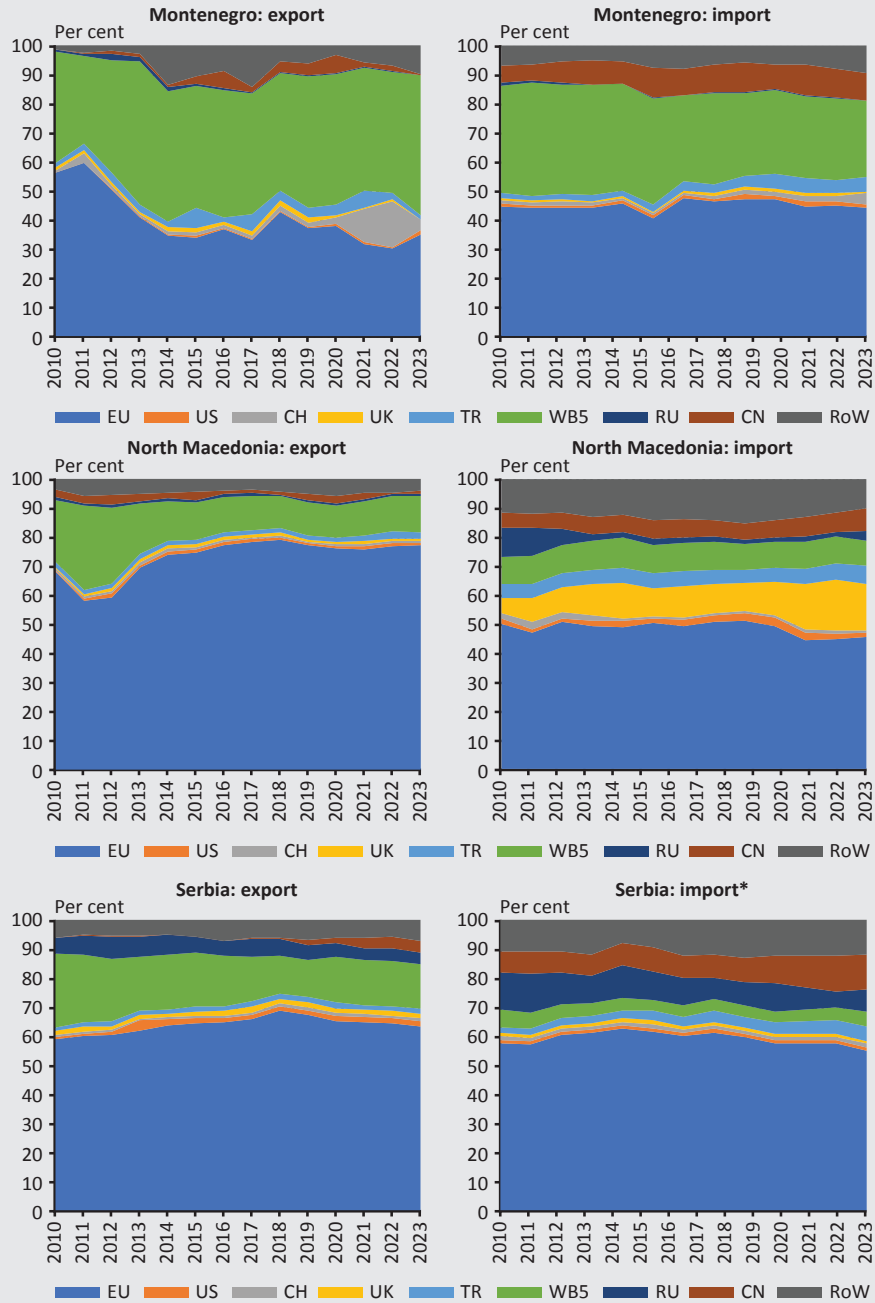
In contrast to several of its WB counterparts, the EU's share in North Macedonian exports has grown markedly over the past decade (from 68.0 per cent in 2010 to 77.3 per cent in 2023), making the country highly integrated into European value chains. However, the EU's share of imports has fallen slightly (50.0 per cent in 2010 vs. 45.5 per cent in 2022). The growing share of EU exports went hand in hand with lower intra-WB exports; along with Albania, North Macedonia is the least integrated into trade with the remaining five WB countries (12.0 per cent of exports and 8.6 per cent of imports in 2022). While these two groups of entities cover approximately nine tenths of North Macedonian exports, the structure of imports is somewhat more diverse. The share of Chinese and Turkish imports has grown to a moderate extent over the past decade (reaching 8.8 and 6.3 per cent in 2022, respectively). Furthermore, Russian imports have declined to a remarkable degree, dropping by approximately two thirds between 2010 (10.1 per cent) and 2022 (3.5 per cent; this decline was not related to the war in Ukraine and had already taken place in the first half of the 2010s). Furthermore, the United Kingdom plays a more than remarkable role in North Macedonian imports, with a share of above 10 per cent (a share that has grown markedly over the past decade).

4.2.6. Serbia

EU and intra-WB trade account for four fifths of Serbian exports, with the former showing moderate growth (58.9 per cent in 2010 vs. 63.2 per cent in 2023), while the latter shows a downward trend (25.5 per cent in 2010 vs. 15.3 per cent in 2023). The Serbian import structure is more diverse. While the EU is Serbia's main source of imports, its share has fallen moderately (from 57.3 per cent in 2010 to 54.9 per cent in 2022), and other, major geopolitical actors also play a role in Serbian imports. Chinese and Turkish imports expanded remarkably between 2010 and 2022 (rising from 7.2 per cent to 12.1 per cent, and from 1.9 per cent to 5.2 per cent, respectively), but Russian imports tapered off in this period (from 12.9 per cent to 7.5 per cent). The share of imports from other WB countries is low compared to other subjects in the sample (varying between 3.7 and 5.9 per cent). Thus, Serbia – which is the biggest economy of the WB countries – is the most globally oriented country as well. While Serbian imports have not become significantly more diversified, a restructuring of non-Western imports has taken place along with the geopolitical shifts of the past decade.

Figure 2
Country profiles: trade by partner





*Note: RoW: Rest of the World. * Data of the IMF regarding Serbian imports in 2020 was inaccurate, thus, data for 2020 imports are extrapolated.*

Source: IMF (2024)

4.3. Overall assessments of trade integration and geopolitics in the Western Balkans

After having presented the country profiles, in this section I discuss the overall results and trends regarding trade structures for the entirety of the Western Balkans. Three major results can be derived from the data.

First, the size of the respective economies appears to determine the trade orientation of a given country to a certain extent. The smallest countries (i.e. Kosovo and Montenegro) are the most integrated regionally (i.e. have the highest share of trade with the remaining five WB countries). Besides market size, this phenomenon can be explained by historical factors, as well: these two countries were the last to declare independence from Serbia (Montenegro in 2006 and Kosovo in 2008). Conversely, larger economies tend to be more diversified, as well as more open to trade with non-Western partners.

Second, despite growing concerns regarding WB foreign policy turning all the more eastward, the European Union is the main trading partner for all of the WB countries. (The only exception is Kosovo, where, by the 2020s, intra-WB exports exceed EU exports. Nevertheless, the share of Western partners, i.e. the European Union and the United States combined exceeds that of the WB5.) Despite the declining share of trade with the EU in some cases, the European Union has not ceased to be the main trading partner, and, in some cases has even gained in share of trade (these results align with those of *Ginter – Hildebrandt* (*2024*) where the respective shares in FDI stock show a similar structure). The second major partner group for all of the countries in focus consist of the remaining five countries of the Western Balkans themselves. Thus, trade in the WB countries is primarily characterised by regional integration: on the one hand, into EU value chains, and, on the other hand, on a more local level.

Third, in line with the EU's share in trade as well as the important role of intraregional trade, trade between other global geopolitical players (i.e. the United States, China and Russia) and the WB countries is limited and skewed toward the imports side. Imports from China are significant in all of the countries' trade portfolios; other than that, trade with global geopolitical powers does not play a major role. Certain alliances, however, are reflected in trade flows, such as growing Kosovan exports to the United States, and the moderate, yet persistent trade between Russia and both Serbia and Bosnia and Herzegovina. In addition, geographic proximity plays a greater role than global geopolitical power: nearby Türkiye is a major source of imports for (primarily Southern) WB countries. These findings largely support those of *Kaloyanchev et al.* (*2018*).

4.4. Overall assessments of geoeconomic fragmentation in the Western Balkans

In order to assess the geoeconomic fragmentation of the Western Balkans countries, I calculated the differentials between the respective shares of a trading partner (or partner group). These differentials (calculated from the two temporal endpoints of the sample, i.e. 2010 and 2022 or 2023, respectively, depending on data availability) are depicted in *Tables 1* and *2*. The tables also separate the different – and allegedly emerging – geopolitical blocs (West, consisting of the EU, the US, Switzerland and the UK; East, consisting of Russia and China; and Neutral, consisting of Türkiye and the rest of the world. The WB5 is not clustered in any of the three blocs due to itself being the subject of the analysis).

As for exports, WB countries' alignment with the Western bloc (and trade with its members) has remained unchanged. Some outliers exist in both positive as well as negative terms. While the smallest countries (having declared independence only in the 2000s, i.e. Kosovo and Montenegro) have registered a significant drop in the share of EU trade, the remaining four countries' exports to the EU have grown. The extent of this growth is most notable in North Macedonia and Serbia. Other major Western partners' shares have remained constant in the past decade, along with remarkable growth in Kosovan exports to the US. Regarding exports to the Eastern bloc, there are no clear signs of fragmentation. Exports to Russia have always been negligible (and have not grown either); Chinese exports have either shrunk (Albania, Kosovo) or grown (Serbia) to a smaller extent. Exports to the Neutral bloc have tended to decline. Intra-WB integration shows a mixed picture: exports have grown remarkably for Albania, Kosovo and Montenegro, while contracting remarkably in the case of North Macedonia and Serbia (see *Table 1* for more details).

Regarding imports, the overall picture is similar, yet certain differences apply. Western imports have remained roughly constant in the past twelve years (with Albania being a notable outlier having registered a sharp drop in EU imports). On the other hand, imports from the Eastern bloc have changed notably. WB countries that used to trade extensively with Russia (primarily the Slavic ones, Bosnia and Herzegovina, North Macedonia, and Serbia) have registered significant drops in imports from Russia. This has not been a result of 2022 sanctions in the aftermath of the escalation of the war in Ukraine, but rather a gradual downward trend since 2010. However, imports from China have grown in all WB countries over the past twelve years (most notably in Serbia). Thus, mixed conclusions can be drawn regarding import fragmentation and decoupling from the notable Eastern geopolitical actors. In the Neutral bloc, it is Türkiye from which imports have grown notably. As for imports, the share of the WB has remained unchanged, and, for the two smallest countries (Kosovo and Montenegro), it has fallen significantly.

Table 1

Heat map: percentage point change of the respective export partners' shares between 2010 and 2023

Exports	Albania	Bosnia and Herzegovina	Kosovo	Montenegro	North Macedonia	Serbia
European Union	1.50	3.61	–13.12	–21.25	9.27	4.32
United States	–0.46	0.96	12.28	1.30	0.13	1.09
Switzerland	–3.24	–0.68	2.78	3.01	0.35	0.25
United Kingdom	1.37	0.03	1.14	1.14	0.13	–0.08
Russia	0.02	0.07	0.00	–0.50	–0.34	–1.59
China	–3.29	0.11	–4.84	0.32	–1.61	3.88
Türkiye	–4.34	0.42	–0.80	–0.19	0.52	1.04
Rest of the World	–1.04	–3.19	–14.68	8.50	0.54	1.28
WB5	9.47	–1.32	17.23	9.94	–9.00	–10.19

Source: author calculations based on IMF data

Table 2

Heat map: percentage point change of the respective import partners' shares between 2010 and 2022

Import	Albania	Bosnia and Herzegovina	Kosovo	Montenegro	North Macedonia	Serbia
European Union	–14.26	–1.43	2.09	–0.39	–4.53	–2.49
United States	–0.18	–0.11	–0.37	0.10	–0.45	–0.33
Switzerland	0.78	–0.10	–0.26	2.65	–0.76	0.26
United Kingdom	–0.70	–0.19	–0.09	–0.16	10.63	–0.33
Russia	–1.07	–6.13	0.36	–0.99	–6.68	–5.40
China	1.74	3.46	3.44	3.61	2.52	4.92
Türkiye	6.32	3.17	7.96	3.03	1.57	3.24
Rest of the World	6.72	0.58	3.61	2.57	–1.51	1.01
WB5	0.64	0.75	–16.74	–10.43	–0.80	–0.88

Source: author calculations based on IMF data

To summarise, based on trade data, no clear signs of geoeconomic fragmentation can be seen in the Western Balkans: while the region has minimised trade ties with Russia, trade with China has grown notably. Also, intra-bloc trade (i.e. trade with major Western partners) has not grown significantly. In general, major trading partners have remained the same (i.e. the European Union and fellow WB countries), determined by geographic proximity, and cultural, historic and economic linkages (very similar trends persist for FDI in the WB, see *Ginter – Hildebrandt 2024*).

5. Conclusions

In this paper, I presented an analysis on trade data of the Western Balkan countries between 2010 and 2023. I found that the structure of the WB countries' trading partners has been relatively stable in the past thirteen years. The main trading partner of the region has been the European Union (albeit showing a somewhat shrinking share in certain cases). Intraregional trade plays a significant role as well. Trade with the United States is limited, while trade with major non-Western geopolitical entities (Russia, and especially China and Türkiye) primarily occurs on the imports' side, their share being smaller than that of the EU and the WB5. Trade with Russia has dropped off significantly in the past decade, its share being taken over by China and Türkiye. WB countries' trade has been thus organised by regional (WB-level and EU-level) integration rather than by the interest of global geopolitical actors. I also found that little evidence supports fragmentation in the Western Balkans: trade with the Western bloc has remained stable (has neither grown, nor shrunk), while the Eastern bloc results are mixed (lower trade with Russia, but Chinese imports growing significantly).

This paper generally supports findings on geoeconomic fragmentation (for example, *Kaaresvirta et al. 2023; Ginter – Tischler 2024; Ginter – Hildebrandt 2024*): hitherto moderate to no signs of fragmentation are seen in emerging Europe – including the Western Balkans. The reasons behind this are manifold. As the phenomenon of geoeconomic fragmentation is relatively new, economies need time to align. It is however not an economic necessity to reshape value chains according to a new geopolitical reality: as stated above, fragmentation is primarily driven by policy. Thus, it is not necessarily the case that small, open economies on the European semi-periphery share the needs for fragmentation of global geopolitical players. This is especially true if we accept the supposition of *Javorcik et al.* (*2023*) that, for emerging regions, it might be beneficial to conduct non-aligned (trade) policy. Furthermore, WB countries (along with the entirety of Central, Eastern and Southeastern Europe) may be beneficiaries of reshoring and friendshoring tendencies due to relative geopolitical alignment and geographic proximity to GVC sections with high value added – even if their trade policy is not completely aligned.

With these results, I hope to have contributed to the literature on geoeconomic fragmentation, including a yet unexamined region in the analysis. By doing so, I painted a detailed picture on the structure of the respective WB countries trading partners, providing a temporal prolongation for the sample *of Kaloyanchev et al*. (*2018*). Furthermore, I provided a descriptive analysis on the (potential) geoeconomic fragmentation of the six WB countries. Among the limitations of the study, it is important to emphasise that trade was the only factor in respect of which I analysed geoeconomic fragmentation. While trade may be a good proxy for measuring fragmentation, other cross-border flows (e.g. FDI or migration) also come into play. While geopolitical aspects of FDI in the Western Balkans have recently been covered by *Ginter – Hildebrandt* (*2024*), it would be beneficial for future research to focus on other variables proxying fragmentation. Furthermore, future research should tackle other factors that influence trade flows (such as free trade agreements or the progress of EU integration). Last but not least, as stated above, geoeconomic fragmentation is a relatively new phenomenon. Thus, a temporal extension of the sample and renewed study in the future could provide further insights.

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Latest Trends in the Use of Artificial Intelligence in the Banking Sector

Gergely Lülök – Zoltán Sebestyén

The study examines the latest trends in the application of artificial intelligence (AI) in the banking sector, with a focus on bank failure prediction, risk management and customer relationship optimisation. The research is based on a systematic literature search of relevant publications in the Scopus and Web of Science databases, using the PRISMA methodology for source selection and analysis. The results show that Unsupervised Learning Models dominate in bankruptcy prediction and risk analysis, while Natural Language Processing and Deep Learning techniques are mainly focused on improving customer relationships and increasing bank efficiency. The research shows that AI is playing an increasingly important role in banking decision-making, but that the different application areas face different regulatory and ethical challenges. The results underline the importance for financial institutions to improve the transparency and interpretability of AI and to develop adaptive regulatory frameworks to balance innovation and security.

Journal of Economic Literature (JEL) codes: C10, G21, O33

Keywords: artificial intelligence, banking sector, financial services, trend analysis

1. Introduction

Artificial intelligence is playing an increasingly important role in the banking sector, revolutionising the areas of credit scoring, risk analysis and transaction processing. The use of AI-based systems enables automated decision-making, more accurate forecasting of financial risks and the development of improved fraud detection mechanisms. Financial institutions are increasingly taking advantage of the opportunities offered by Machine Learning and data science to help improve the efficiency of the sector.

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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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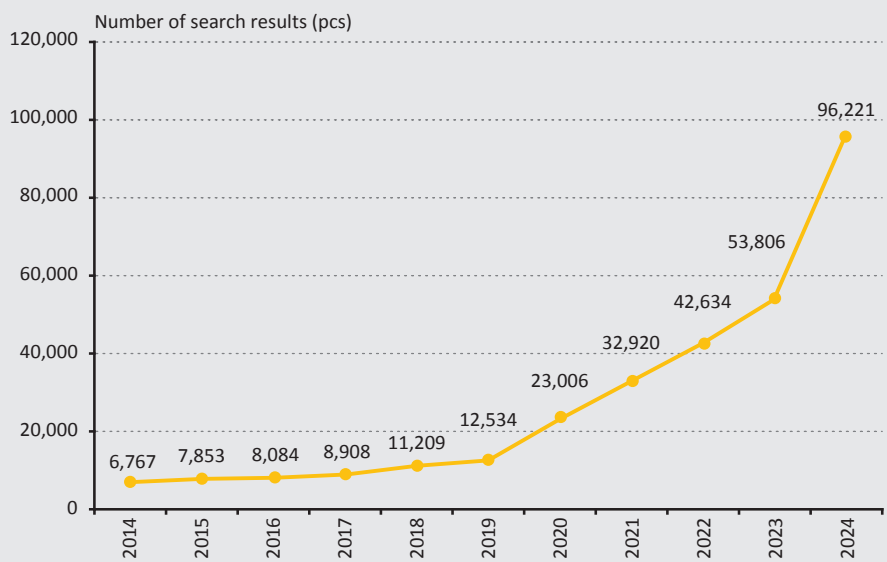
This study is a systematic literature review (SLR) that examines the state of the literature on applications of artificial intelligence in the banking sector. The aim of the research is not to collect new empirical data, but rather to map the international literature according to the PRISMA methodology and to analyse it from the point of view of content, technology and citation. In our research, we systematically review which AI technologies are applied in the financial sector, in which target areas and within which methodological framework, with a special focus on bank failure prediction, risk management and customer relationship development. The aim of the study is to provide a structured summary of the scientific results and to identify the most relevant research trends, thus contributing to the systematic organisation and comparability of the financial AI applications.

Scientific interest and research activity in artificial intelligence has grown significantly over the last decade. *Figure 1* shows that the number of search results for keywords such as "Artificial intelligence" + "finance industry", "Artificial intelligence" + "banking sector", "Artificial intelligence" + "credit scoring", "Machine learning" + "finance", and "Machine learning" + "transaction" is steadily increasing. The figure is based on search results from Google Scholar, Web of Science (WoS) and Scopus, reflecting the state of scientific literature on AI and its applications in the banking sector in the period between 2014 and 2024.

Figure 1
Search trends for artificial intelligence in the financial and banking sector (2014–2024)



Source: Edited based on Google Scholar, Web of Science and Scopus

In the period between 2014 and 2019, the figure shows a moderate increase in interest in AI and its financial applications, with a few thousand hits per year. The first significant jump is seen in 2020, when the number of hits exceeded 23,000. Thereafter, further growth is shown, probably linked to the wider adoption of AI-based financial models and increased digitalisation in banking. Search results increased steadily between 2021 and 2023, before a dramatic jump in 2024. The number of hits in 2024 nearly doubled, compared to the previous year, to more than 96,000. This suggests that AI applications in the banking sector became a real priority in 2023–2024. It is important to note that there is typically a 1–2-year lag (publication delay) between the spread of practical applications of AI and the number of scientific publications on the topic, and thus the search data reflect the scientific coverage of earlier waves of innovation.

Based on search data, the study of the relationship between AI and the financial sector is currently steadily growing. Banks and financial institutions are increasingly using AI-based models for loan approvals, anti-money laundering and personalised financial advice. Trends show that AI is not only emerging as a supplementary technology in the banking systems, but is also becoming a key strategic tool, significantly transforming the way the sector operates and its competitiveness.

Several international studies have examined the applications of AI in banking, with a particular focus on improving customer relationships, risk management and forecasting models. Based on the literature presented in detail in *Section 3*, we can say that these studies have typically focused on a specific sub-area and used different methodological approaches. By contrast, the aim of our study is to provide a comprehensive, systematic analysis that categorises the banking applications of AI thematically and assesses their scientific weight, based on quantitative indicators (citation rate, technology-based distribution). We used the PRISMA methodology to ensure the transparency and reliability of our scientific research. The novelty of the study lies in the combination of a methodology applied to such a wide range of articles with high scientific impact metrics and a multidimensional analytical framework.

In our research, we seek answers to the following research questions and hypotheses, among others:

[Q*1*]: Which artificial intelligence models dominate bank failure prediction and risk management, and why are they the most effective?

[*H1*]: Unsupervised Learning-based solutions dominate in bank failure prediction and risk management, as these models can efficiently identify ambiguous financial patterns and anomalies.

[Q*2*]: How does AI contribute to improving customer relationships?

[*H2*]: Customer relationship optimisation relies primarily on Natural Language Processing and Deep Learning techniques, as these methods can efficiently analyse customer preferences and automate interactions.

[Q*3*]: Which artificial intelligence models are most helpful in improving bank performance and operational efficiency?

[*H3*]: Semi Supervised Learning and Deep Learning techniques play a key role in improving bank performance and efficiency, by helping to automate and optimise the operational processes.

2. Research trends and applications of artificial intelligence in the banking sector – a review of the literature

The rise of artificial intelligence in banking services presents many opportunities and challenges. For customers and financial institutions alike, adoption analysis is key, as the effective integration of AI-based systems can increase operational efficiency and user satisfaction.

The following studies examine *AI Adoption* from various approaches, highlighting the role of technological, psychological and organisational factors.

Research in the field of *Natural Language Processing* has shown that cognitive and emotional factors have a significant impact on AI adoption. Examining the relationship between customer experience and risk attitudes, *Cintamür* (*2024*) found that social influence and emotional motivations encourage adoption, while technology-related anxiety and risk aversion hinder adoption. In relation to mobile banking, *Lee and Chen* (*2022*) showed that intelligence and human characteristics can enhance trust, but can also increase perceived costs.

The application of *Machine Learning* in banking processes is the focus of several studies. *Ikhsan et al.* (*2025)* confirmed in the Indonesian banking sector that AI adoption is driven by perceived ease of use and usefulness, while perceived risk is a barrier. Examining bank managers' knowledge of AI, *Mogaji and Nguyen* (*2021*) highlighted that the regulatory environment and organisational coordination play a key role in AI integration. *Mostafa* (*2009*) has shown that in Arab banks the acceptance of AI-based systems is related to the accuracy of performance evaluation. The more reliable an AI system's evaluation is, the greater the internal organisation's trust in it. A study by *Khaled Alarfaj and Shahzadi* (*2025*), using Deep Learning methods, demonstrated that technological efficiency – in this case, bank fraud detection – also contributes to the adoption of AI, by increasing the financial institutions' sense of security and systemic trust in new technologies.

In the field of *Cognitive Computing*, *Norzelan et al.* (*2024*) analysed the adoption of AI by managers in finance and accounting departments, with a particular focus on the shared services sector. Their results show that perceived usefulness and technical skills are the most important determinants of adoption, while social pressure and a supportive environment are less important.

Taken together, these studies highlight that the adoption of AI in the banking sector is a complex process, shaped by technological characteristics, customer experience and organisational structure. On the consumer side, trust, ease of use and social norms are key, while for the financial institutions, integration challenges and regulatory requirements are the main obstacles.

Improving banking performance and operational efficiency is a key objective for the financial sector, supported by the increasingly effective use of AI. The various methods of *Machine Learning* offer the potential to optimise business models, reduce operating expenses and increase profitability, as the following studies demonstrate. *Bolívar et al.* (*2023*), *González-González et al.* (*2022*) and *Bonaparte* (*2024*) showed that AI-based analytics improve the efficiency of bank business models and increase profitability. Similarly, *Chishti et al.* (*2024*) concluded that a combination of AI and green finance can stabilise business cycles in the long run, reducing financial volatility. In line with this, *Fraisse and Laporte* (*2022*) used Deep Learning models to achieve more accurate capital adequacy forecasts, which can contribute to reducing the banks' regulatory capital requirements. Similar results were obtained by *González-Carrasco et al.* (*2019*), who improved data integration and the accuracy of business decision-making by automating the identification of correlations between banking transactions. *López Lázaro et al.* (*2018*) also demonstrated the efficiency-enhancing role of AI when applied to optimise cash logistics, achieving a 14-per cent cost reduction. In line with this, *Met et al.* (*2023*) found that Auto Machine Learning-based predictions improve the performance evaluation and goal-setting of bank branches. Finally, *Moffo* (*2024*) used Machine Learning models in the field of bank stress testing to achieve more accurate forecasts, which can help design more efficient capital adequacy strategies. The above research clearly demonstrates that the widespread adoption of Machine Learning can lead to significant efficiency gains in all areas of the banking operations, supporting long-term competitiveness.

The further *development of strategic decision-making* is also increasingly relying on artificial intelligence to support financial analysis, forecasting and business strategy development. The following research papers all rely on *Machine Learning* to improve decision-making.

Lu et al. (*2024*) pointed out that AI-based models provide more accurate predictions for analysing the effects of changes in the financial structure than traditional

economic models. Similarly, *Ma et al.* (*2025*) showed that sustainable finance has a more significant influence on the fintech market than on AI shares, a key factor in financial strategic decision-making. *Qian et al.* (*2024*) investigated how political uncertainty affects bank lending and the companies' investment decisions, and used Machine Learning models to identify the key influencing factors. Consistent with these, *Tang and Li* (*2023*) demonstrated the accuracy of Deep Learning models in prediction tasks that can help business decision-makers. *Xie et al.* (*2023*) investigated the interpretability of Machine Learning models in bank telemarketing, showing that these tools can help to reach target audiences more accurately and increase the effectiveness of campaigns. *Klein and Walther* (*2024*) investigated financial applications that improve the transparency of AI models in risk management, lending decisions and regulatory compliance.

Natural Language Processing also plays a key role in supporting strategic financial decisions, in particular by analysing textual data. *Katsafados et al.* (*2024*) used Machine Learning-based text analysis to predict bank mergers, showing that the language used by corporate executives can be a reliable indicator of merger intentions. *Sun et al. (2024*) investigated the impact of regulatory changes in the Chinese shadow banking system, using Natural Language Processing and text analysis, which they found to significantly affect bank lending strategies. These studies have shown that Natural Language Processing is an effective tool to support banking regulation and market decision-making.

Artificial intelligence is also playing an increasingly important role in *predicting bank failures*, which is crucial for financial stability. The following studies have all used *Machine Learning* methods to estimate the probability of bankruptcy more accurately. *Gogas et al.* (*2018*) developed a model using Support Vector Machines that separated solvent and failing banks with 99.22-per cent accuracy, outperforming traditional statistical methods. Similarly, *Hu et al.* (*2025*) applied the Random Forest algorithm to predict the failure of US banks, highlighting the importance of capital adequacy ratios for prediction accuracy.

Lagasio et al. (*2022*) were the first to use Graph Neural Networks to investigate the failure risk of euro area banks, showing that market competition affects the probability of failure. In line with this, *Le and Viviani* (*2018*) demonstrated that Artificial Neural Networks provide more accurate bankruptcy predictions than logistic regression, thus helping regulatory decision-making. *Petropoulos et al.* (*2020*) confirmed the effectiveness of the Random Forest method, which showed reliable performance in estimating the probability of failure for both US and European banks. *Asmar and Tuqan* (*2024*) and *Durongkadej et al.* (*2024*) demonstrated that Machine Learning models are effective in identifying threats to digital banks and significantly reduce the risk of failure. These results clearly show

that the use of Machine Learning significantly increases the accuracy of bank failure prediction, contributing to the stability of the financial system.

AI is playing an increasingly important role in the *management of banking risks*, enabling more accurate forecasting and better decision-making. The following research papers are based on *Machine Learning* models. *Alonso-Robisco and Carbó* (*2022*) and *Hussein Sayed et al.* (*2024*) found that Machine Learning models provide more accurate predictions, thereby reducing regulatory capital requirements. *Kruppa et al.* (*2013*) and *Lin et al.* (*2025*) demonstrated the benefits of Machine Learning models in predicting consumer and car loan risks using the Random Forest and XGBoost methods. *Mercadier et al.* (*2025*) and *Heß and Damásio* (*2025*) developed a new AI-based approach to identify the global banking system risks, while *Wang et al.* (*2024*) and *Uddin et al.* (*2023*) did the same from the perspective of the impact of banking digitalisation. *Shahbazi and Byun* (*2022*) also developed a similar solution, but for reducing risks in the cryptocurrency markets. *Sugozu et al.* (*2025*) analysed the credit risk of the Turkish banking system and showed that Islamic banks have higher risk exposure, especially in competitive situations, while *Zhou et al.* (*2019*) presented an IoT-based (Internet of Things) financial risk management system that enables faster and more accurate forecasts through parallel calculations.

The only study using *Natural Language Processing* is the work of *Thi Nguyen et al.* (*2024*), which examined the risk analysis of bank capital adequacy ratios and stress tests.

Artificial intelligence is playing an increasingly important role in the *development of banking customer relationships*, supporting the personalisation of offers, and increasing customer satisfaction and the efficiency of financial advice. The use of *Machine Learning* allows for more accurate modelling and prediction of customer preferences. *Bockel-Rickermann et al.* (*2025*) investigated the use of Causal Machine Learning in the optimisation of mortgage loan offers, while *Singh et al.* (*2024*) studied prediction models developed for predicting customer loss, highlighting the effectiveness of the XGBoost and Random Forest methods. Similarly, *Omoge et al.* (*2022*) demonstrated that AI-based Customer Relationship Management (CRM) systems increase customer satisfaction and loyalty, although technological outages may limit their effectiveness. *Northey et al.* (*2022*) showed in their research that consumers trust human advisors more than AI-based robo-advisors, especially for major investment decisions. Deep Learning models are also prominent in predicting customer satisfaction, with *Zeinalizadeh et al.* (*2015*) using neural networks to investigate the main determinants of customer satisfaction.

Natural Language Processing also plays a key role in analysing customer opinions and improving the automated customer service system. *Hentzen et al.* (*2021*)

investigated the impact of Natural Language Processing-based Content Extraction on customer engagement, while *Königstorfer and Thalmann* (*2020*) used Sentiment Analysis to analyse customer experiences of AI-based services. The results show that Natural Language Processing is effective in understanding bank interactions, thereby improving the customer experience and optimising marketing strategies.

Our analysis was based exclusively on international academic publications in Q1 journals, with the aim of providing a comprehensive picture of the latest trends in the application of artificial intelligence in finance. Hungarian studies were not included in our analysis, as we wanted to provide an internationally oriented, scientifically authoritative literature review.

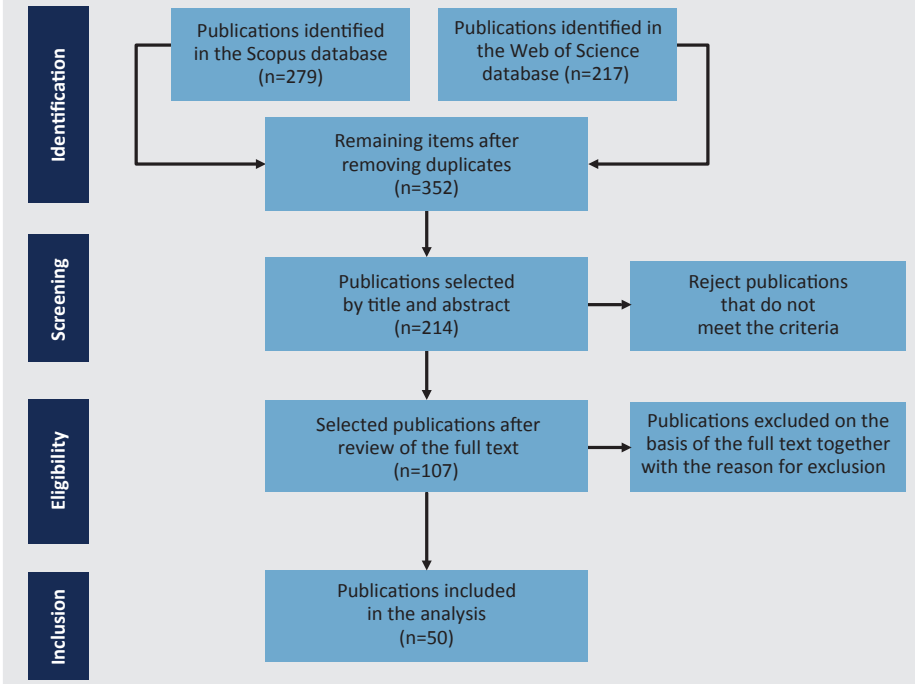
At the same time, it is important to stress that there is growing interest among Hungarian researchers in the application of AI in the financial sector. *Domokos and Sajtos* (*2024*) looked at the key areas of AI use in banking, such as risk management and customer relationship automation, highlighting regulatory issues. *Rajka and Pollák* (*2024*) analysed the application of the XGBoost algorithm in credit risk modelling, showing its predictive advantages. *Bagó* (*2023*) examined the role of Machine Learning and Big Data in banking digitisation. *Prisznyák* (*2022*) gave a detailed presentation on AI-enabled customer service solutions and banking *robotisation*. *Harkácsi and Szegfű* (*2021*) described the relationship between compliance assurance and AI. *Boncz and Szabó* (*2022*) and *Zsinkó* (*2025*) analysed the impact of artificial intelligence on the labour market, while *Benedek and Nagy* (*2023*) showed that AI-based methods for identifying motor insurance fraud are currently less cost-effective than traditional statistical-econometric tools. These studies clearly show that the Hungarian academic discourse is also actively dealing with the financial aspects of AI, which further strengthens the relevance and the niche character of our research, as we go beyond focused case studies and systematically review the whole range of international AI applications in the banking sector.

3. Research methodology

Our research looked at the role of AI in the banking sector, with a particular focus on the types of solutions most commonly used. To this end, we conducted a systematic literature search, collecting the relevant scientific publications from the Scopus and WoS databases.

We used the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (*PRISMA*) *methodology* for our research, which ensures the transparency and reproducibility of the literature review. The analysis consisted of four main steps: *identification, screening, compliance and inclusion.* The process is shown in *Figure 2.*

Figure 2
Mapping of the relevant publications using the PRISMA method



In the identification phase, we applied a predefined search strategy using keywords such as "*Artificial Intelligence*", "*Machine Learning*", "*Finance*", "*Banking*", "*Credit Scoring*" and similar keywords. As a result, 279 relevant publications were identified in Scopus and 217 in the Web of Science database, and thus a total of 496 studies were included in our initial analysis.

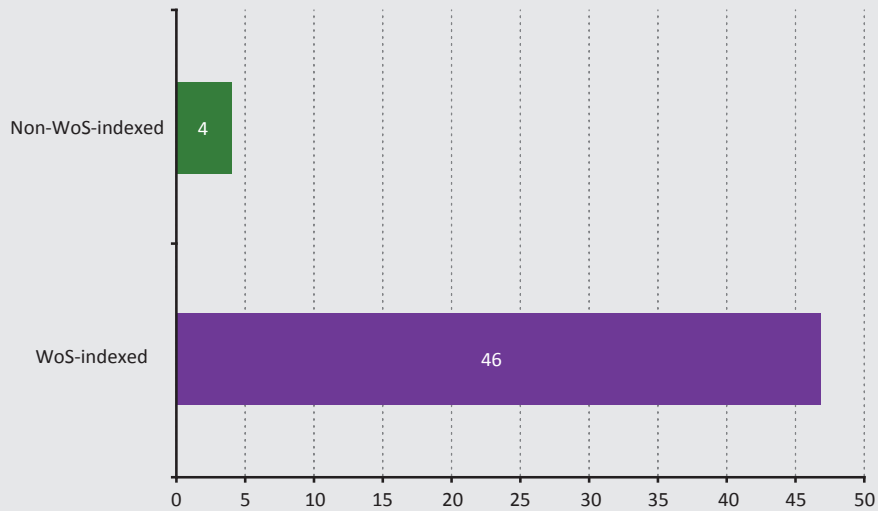
The first step in the *screening phase* was to remove duplicate studies, leaving 352 individual publications. This was followed by a review of the titles and abstracts, to exclude studies that were not closely related to the study of the financial applications of AI. As a result of this step, 214 publications remained in the analysis, while 138 were excluded because they did not meet the analysis criteria.

In the *compliance phase*, we carried out a further screening, which involved the analysis of the full text of the publications. During this process, we assessed the research questions, methodology, databases and relevance of the publications. As a result of the analysis, we finally retained 107 publications and excluded 31 studies, because they did not contain sufficient empirical data or did not directly address the specific cases of AI use.

The final screening in the *inclusion phase* was to identify the most relevant and highest quality studies. To do this, we took into account the impact factor, citation rates and the scientific importance of the publications. Finally, 50 studies were selected for detailed analysis and were categorised thematically according to the different financial applications of AI.

Figure 3 shows the distribution of the selected publications by WoS indexation. Of the 50 studies examined, 46 are included in the WoS database, while 4 are not WoS-indexed. This means that 92 per cent of the studies in the sample come from WoS-indexed sources, while the share of non-WoS-indexed publications is only 8 per cent.

Figure 3
Distribution of the publications by WoS indexation



	WoS-indexed	Non-WoS-indexed
Item number	46	4
Percentage distribution	92%	8%

The high WoS indexation indicates that the majority of the studies included in the analysis were published in peer-reviewed journals, which ensures the reliability and scientific credibility of our literature review. The low ratio of non-WoS-indexed publications indicates that the research relies primarily on internationally recognised sources, minimising the influence of potentially less well-established or lower quality studies on the results.

Table 1 provides the definitions of the artificial intelligence methods used in the research, with their Hungarian and English forms, to facilitate a clear understanding and consistent use of each technique in the study.

Table 1
Artificial intelligence methods and their definitions

AI method	Brief description of the method
Cognitive Computing	AI systems that provide data processing capabilities that mimic human thinking, such as Natural Language Processing, and help solve complex problems via decision support and pattern recognition.
Content Extraction	A Natural Language Processing technique that extracts relevant information from unstructured textual data, such as key indicators from financial reports or relevant legal terms from contracts.
Deep Learning	A specialised branch of Machine Learning that uses Deep Neural Networks to analyse large amounts of data and recognise complex patterns, for example in image recognition, speech recognition and financial forecasting.
Dimensionality Reduction	A Machine Learning technique that reduces the number of variables while retaining the essential characteristics of the data, for example in financial models or customer grouping, to increase the efficiency of data analysis.
Information Retrieval	A Natural Language Processing technique that can extract relevant documents, data or key information from large data sets, for example to search financial reports, legal texts or customer archives.
Machine Learning	An AI method that can learn from data samples and make predictions without the need for explicit programming, for example in credit risk analysis or customer behaviour prediction.
Natural Language Processing	An AI technology that enables computers to interpret, process and generate human language, for example in chatbots, financial report analysis or sentiment analysis of customer reviews.
Question Answering	A Natural Language Processing technique that enables AI to provide accurate and relevant answers to human questions based on structured or unstructured data, for example in customer service chatbots or financial report analysis.
Reinforcement Learning	A Machine Learning method in which an algorithm optimises its decisions based on experimentation and feedback, using a reward system, for example in algorithmic trading or robotics applications.
Semi Supervised Learning	A Machine Learning method that learns by combining small amounts of labelled data with large amounts of unlabelled data, for example in fraud detection or credit risk analysis, where fully labelled data sets are not always available.
Sentiment Analysis	A Natural Language Processing technique that analyses and classifies the emotional content of textual data into positive, negative or neutral categories, for example to assess the emotional sentiment of customer reviews, market news or financial reports.
Text Generation	A Natural Language Processing technique capable of automatically generating human-language text, such as summarising financial reports, generating chatbot responses or producing marketing content.
Topic Modelling	A Natural Language Processing technique used to automatically detect major themes and patterns in large text data sets, for example to categorise financial reports, customer reviews or market analysis.
Unsupervised Learning	A Machine Learning method that searches for patterns and structures in unlabelled data, for example in customer segmentation or anomaly detection in the financial sector.

Source: Based on Khosravi et al. (2023)

4. Quantitative analysis of the application of artificial intelligence techniques

Table 2 shows the quality, distribution and relevance of the sources of the literature reviewed, which indicates that the research is based on a solid scientific foundation. All sources are from Q1 journals that ensure a high level of peer review and recognised research results.

Table 2
Rating of the sources of the literature reviewed and citations

Journal	Rating	H-index	Number of citations
Borsa Istanbul Review	Q1	42	1
Computers and Industrial Engineering	Q1	161	1
Data Science and Management	Q1	13	1
Decision Support Systems	Q1	180	1
Digital Business	Q1	13	1
Ecological Informatics	Q1	77	1
Engineering Applications of Artificial Intelligence	Q1	137	1
European Journal of Operational Research	Q1	305	2
Expert Systems with Applications	Q1	271	3
Finance Research Letters	Q1	101	4
Heliyon	Q1	88	1
IEEE Access	Q1	242	6
Information Sciences	Q1	227	2
International Journal of Bank Marketing	Q1	104	7
International Journal of Cognitive Computing in Engineering	Q1	16	1
International Journal of Forecasting	Q1	119	2
International Journal of Information Management Data Insights	Q1	34	1
International Review of Economics & Finance	Q1	78	1
International Review of Financial analysis	Q1	91	3
Journal of Banking & Finance	Q1	197	1
Journal of Behavioural and Experimental Finance	Q1	39	1
Journal of Financial Stability	Q1	73	1
Pacific-Basin Finance Journal	Q1	75	3
Research in International Business and Finance	Q1	73	2
Technological Forecasting and Social Change	Q1	179	2

Among the journals surveyed, there are several journals with high H-index scores, such as the European Journal of Operational Research (H-index: 305), Expert Systems with Applications (H-index: 271) and IEEE Access (H-index: 242). These journals are leaders in the fields of artificial intelligence, data processing and decision support. Journals focusing on the financial and banking sector, such as the Journal of Banking & Finance (H-index: 197) and Finance Research Letters (H-index: 101) are also publishing platforms with a significant impact.

Based on the thematic distribution of the resources, the analysis of financial applications of AI reflects a multidisciplinary approach. In particular, journals such as the International Journal of Bank Marketing (7 articles), IEEE Access (6 articles) and Finance Research Letters (4 articles) frequently discuss the relationship between AI and the banking sector. The use of data analysis and Machine Learning is supported by publications in the Expert Systems with Applications and the Engineering Applications of Artificial Intelligence journals. The International Journal of Forecasting and the Journal of Financial Stability play a prominent role in financial stability and forecasting.

Overall, the literature reviewed covers a wide range of disciplines, including AI-based decision making, banking risk analysis, customer relationship management and economic forecasting. This ensures that our study provides a comprehensive assessment of the artificial intelligence trends in the financial and banking sector.

Research on AI applications in finance and banking has accelerated significantly in recent years, as shown by the distribution of citations by year (*Table 3*).

Table 3
Distribution of cited studies by year

Year	Number of cited studies
2009	1
2013	1
2015	1
2018	3
2019	2
2020	2
2021	2
2022	8
2023	5
2024	16
2025, until March	9

Between 2009 and 2021, interest in the area showed a gradual but moderate increase, with the first significant jump in 2018. Publication activity increased from 2022 onwards, reaching a peak in 2024 (16 citations), matching the dramatic surge in search hits during this period. This trend suggests that AI in the banking sector will become a truly central research topic, with recent studies increasingly shaping the technological evolution of the sector. The increasing use of AI-based models by banks and financial institutions for credit assessment, anti-money laundering and customer relationship development indicates that AI is becoming a key strategic factor in the financial sector, rather than just a support tool.

Table 4 presents the different applications of AI in the banking sector, based on the distribution of AI categories and subcategories, as well as on the citation data. In the quantitative analysis of the application of AI in the banking sector, literature searches were conducted using English keywords, and thus in order to present the results consistently and accurately, the AI categories and methods are also presented in English. This ensures clear terminological consistency and allows the comparison of the results with international research.

The field of AI adoption is dominated by Machine Learning and Natural Language Processing techniques, with Semi Supervised Learning (372 citations) and Unsupervised Learning (191 citations) playing a prominent role. Deep Learning and Question Answering systems are less cited areas, but remain important in the study of AI adoption.

Improving bank performance and operational efficiency is mainly based on Unsupervised Learning models (85 citations, 5 references), while Deep Learning (37 citations) and Dimensionality Reduction (5 citations) are also significant. Text Generation models play a smaller but relevant role (11 citations, 2 references).

Unsupervised Learning models dominate in the field of bank failure prediction (502 citations, 4 references), indicating their importance in predicting financial stability. Supervised Learning and Deep Learning received fewer citations (20 for Supervised Learning, 0 for Deep Learning), but remain relevant areas.

In risk management, Unsupervised Learning (317 citations) and Deep Learning (126 citations) are of paramount importance, as they provide accurate predictions. Reinforcement Learning (51 citations) plays a role in risk modelling, while Information Retrieval solutions are less prominent (3 citations, 1 reference).

The development of strategic decision-making is mainly supported by Unsupervised Learning (11 and 3 citations, respectively, in several references), while Deep Learning (6 citations) and Dimensionality Reduction (2 citations) are also mentioned. Topic Modelling techniques show low citation rates (0 citations).

Table 4
Distribution of AI applications in the banking sector

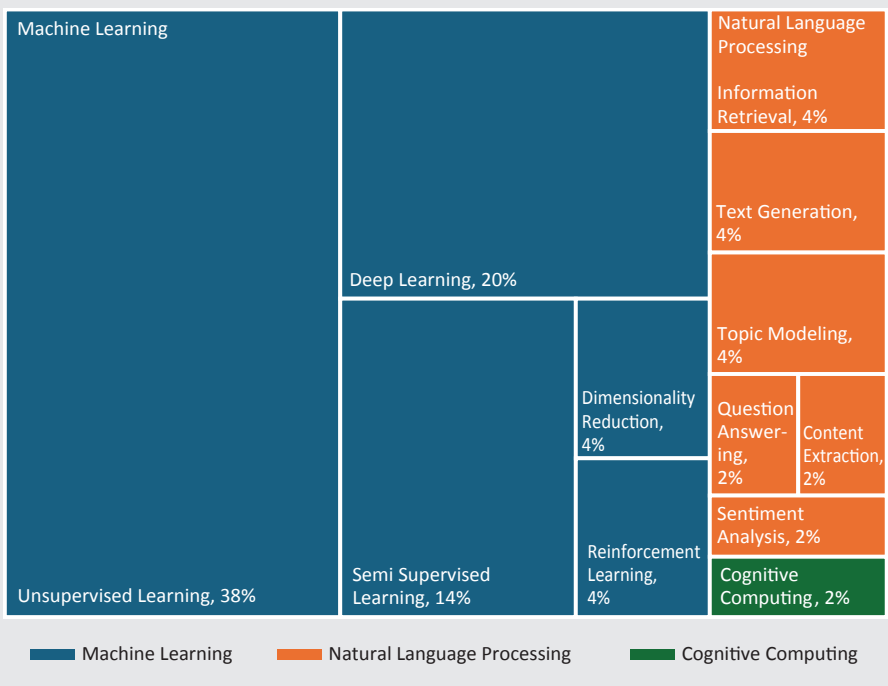
Area	AI category	AI subcategory	Citations	Number of cited studies
AI adoption	Cognitive Computing	–	45	1
	Machine Learning	Deep Learning	0	1
		Semi Supervised Learning	372	2
		Unsupervised Learning	191	1
	Natural Language Processing	Question Answering	7	1
		Topic Modelling	168	1
Improving bank performance and operational efficiency	Machine Learning	Deep Learning	37	1
		Dimensionality Reduction	5	1
		Semi Supervised Learning	63	1
		Unsupervised Learning	85	5
	Natural Language Processing	Text Generation	11	2
Bank failure prediction	Machine Learning	Deep Learning	20	2
		Semi Supervised Learning	0	1
		Unsupervised Learning	502	4
Risk management	Machine Learning	Deep Learning	126	3
		Reinforcement Learning	51	1
		Semi Supervised Learning	71	2
		Unsupervised Learning	317	4
	Natural Language Processing	Information Retrieval	3	1
Developing strategic decision-making	Machine Learning	Unsupervised Learning	11	1
		Deep Learning	6	1
		Dimensionality Reduction	2	1
		Unsupervised Learning	3	3
	Natural Language Processing	Information Retrieval	20	1
		Topic Modelling	0	1
Developing customer relationships	Machine Learning	Deep Learning	151	2
		Reinforcement Learning	74	1
		Semi Supervised Learning	40	1
		Unsupervised Learning	0	1
	Natural Language Processing	Content Extraction	193	1
		Sentiment Analysis	314	1

Both Natural Language Processing and Machine Learning are key to improving customer relationships. Sentiment Analysis is highly cited (314 citations), while Deep Learning models (151 citations) also play a significant role. Content Extraction (193 citations) and Reinforcement Learning (74 citations) help automate and personalise customer relations.

The results are consistent with the growing role of AI applications in the financial and banking sector, where Unsupervised Learning, Deep Learning and Sentiment Analysis are of paramount importance in business applications.

Figure 4 shows the distribution of the different categories and subcategories of AI, based on the articles studied.

Figure 4
Distribution of the categories and subcategories of artificial intelligence



The most dominant method is Unsupervised Learning (38%), which is particularly important in bank failure prediction and risk management, where the analysis of large, unstructured data and the recognition of patterns are needed. The widespread use of Unsupervised Learning shows that this approach is the most common in predicting financial instability and managing credit risks.

This is followed by Deep Learning (20%), which is mainly used to improve customer relationships and increase banking efficiency, in particular in the optimisation of automated customer service systems and personalised financial offers. Semi Supervised Learning (14%) also has a significant role to play, mainly in testing the adoption of AI and improving bank performance, as it combines the benefits of Supervised and Unsupervised Learning, thus leading to more efficient decision support systems.

Of the Natural Language Processing techniques, the use of Information Retrieval (4%) stands out, which plays a significant role in supporting customer relationships and risk management. Topic Modelling (4%) and Text Generation (4%) are also important areas, especially in the analysis and automated reporting of bank text data. Although less prevalent, Sentiment Analysis (2%) and Content Extraction (2%) also contribute to customer experience analysis.

Reinforcement Learning (4%) is mainly used to improve financial advice and customer interaction systems, enabling optimised decision-making in a dynamic financial environment.

This analysis confirms that different forms of AI are used for different purposes in the banking sector. While Unsupervised Learning dominates in bankruptcy and risk prediction, Natural Language Processing methods are mostly used to optimise customer relationships and marketing. Deep Learning is mainly used in efficiency-enhancing applications such as automated customer service and financial advice, while Reinforcement Learning and Semi Supervised Learning contribute to the development of dynamic financial models.

5. Discussion

Our research can be characterised as unique in three ways:

1. by rigorously applying the PRISMA methodology, we provide a structured literature review of AI technologies in the banking sector, which has not been covered in such detail in previous studies;

2. the literature reviewed is quantitatively classified according to the main categories and subcategories of AI, and thus the novelty of the study is the combination of bibliometric analysis and trend-based AI classification;

3. we present impact factors based on citation data using tables and graphs, to draw specific conclusions on future research and application opportunities. All of these factors combined result in the practical usefulness and scientific relevance of our research.

In the following, we compare the results of the relevant studies with our own research, highlighting the key parallels and differences in the application of AI in the financial sector. We then analyse our own results in detail, and refer back to the hypotheses formulated in our research, assessing their confirmation or possible modification in light of the empirical data.

Mishra et al. (*2023*) studied the role of AI and machine learning in the banking sector, with a particular focus on risk management, fraud detection and customer relationship optimisation. Similar to our research, their results show that Unsupervised Learning dominates in the area of bankruptcy prediction and risk analysis, while Natural Language Processing and Deep Learning are tools for customer relationships and efficiency improvement. In addition, the study highlighted the financial integration of large language models and blockchain technology, which, in line with the results of our research, shows that different AI technologies serve different purposes within the financial sector.

Almubaydeen et al. (*2025*) investigated the role of AI in improving the quality of accounting information in banking, in particular through the use of expert systems and automatic learning. Their results confirm our research that Unsupervised Learning (38%) and Deep Learning (20%) play a key role in predicting bank failures, managing risk and improving customer relationships.

Furthermore, our research also showed that Natural Language Processing techniques (Sentiment Analysis, Information Retrieval) support the efficiency of data processing and the speed of financial decision-making, which is in line with the authors' findings.

In their study, *Al-Hawamdeh and AlShaer* (*2022*) investigated the impact of AI on banking innovation, highlighting the use of Fuzzy Logic Systems. Our research confirms that AI serves different purposes in different areas.

Unsupervised Learning is dominant in financial risk analysis and bankruptcy prediction, while Natural Language Processing and Deep Learning can be used to improve customer relationships and operational efficiency.

In addition, both studies emphasise the rapid evolution of AI and the need for institutions to continuously adapt to technological changes, which our research supports by examining the different regulatory and innovation challenges of AI.

Taken together, the results of these four studies and our own research show that the application of AI in banking is bringing significant changes in the areas of risk analysis, customer relationships and decision-making. Unsupervised Learning dominates in the areas of bankruptcy modelling and risk analysis, while Natural Language Processing and Deep Learning focus on improving customer service and

banking efficiency. Regulatory and ethical issues are central to all of the research papers reviewed, demonstrating that the transparency and compliance of financial AI solutions is key to the further development of the sector.

The results of our research show that AI is playing an increasingly important role in the banking sector, especially in key areas such as bank failure prediction, risk management, customer relationship development and strategic decision support. In the course of the study, the most dominant AI technologies belonged to the categories of Machine Learning and Natural Language Processing, particularly through Unsupervised Learning, Deep Learning, and Sentiment Analysis methods.

The results clearly support hypothesis [*H1*] that Unsupervised Learning-based solutions dominate bank failure prediction and risk management. The citation data show that this method has the highest literature support (502 citations in bank failure prediction and 317 citations in risk management), suggesting that these models are effective in identifying ambiguous financial patterns and anomalies. By contrast, Deep Learning and Semi Supervised Learning are less dominant in this field, suggesting that although these technologies can provide accurate predictions, Unsupervised Learning methods are more effective for independent pattern recognition.

Consistent with hypothesis [*H2*], the results show that the optimisation of customer relationships relies on Natural Language Processing and Deep Learning techniques. Natural Language Processing and Sentiment Analysis solutions showed a very high citation rate (314 citations), indicating that customer communication and market preference analysis are key factors in bank marketing and customer service strategies. The high number of citations for the use of Deep Learning (151 citations) also confirms the growing role of automated customer service systems and personalised offers in the financial sector.

Our research also supports hypothesis [*H3*] that Semi Supervised Learning and Deep Learning techniques play an important role in improving bank performance and operational efficiency. The citation data show that Semi Supervised Learning (63 citations) and Unsupervised Learning (85 citations) methods contribute significantly to operational process optimisation and automated decision-making. These results also confirm that hybrid learning models in the banking sector – combining the benefits of Supervised and Unsupervised Learning – can be particularly effective in automating business processes.

One important finding of our research is that the use of AI in the banking sector has accelerated significantly in recent years, as the distribution of studies cited by year shows.

The number of AI-related publications has risen sharply from 2019 onwards, peaking in 2024, indicating that AI has become a strategic technology in the banking sector. Trends show that financial institutions are increasingly relying on Machine Learning and Natural Language Processing to optimise business decision-making, risk management and customer relationships.

The results of the research highlight that the deepening integration of AI into the banking sector's operations not only helps to increase efficiency and optimise risk management, but also provides a long-term strategic advantage for the financial institutions.

The dominance of Unsupervised Learning in predicting bankruptcy and risk analysis, and the key role of Natural Language Processing and Deep Learning in improving customer relationships, suggest that AI applications are becoming more targeted and increasingly sophisticated.

Improving the interpretability and transparency of AI, especially for Unsupervised Learning models where decision-making processes are difficult to reverse engineer, could be a priority for future research. In addition, the dynamic evolution of the regulatory environment warrants further research on the ethical and legal issues of AI, in particular in the areas of automated decision-making and the personalisation of financial services.

Expected trends in technological development include the increased integration of large language models and generative AI systems in the financial sector, which could open up new opportunities for automating customer services and data-driven decision-making. The combined use of AI and blockchain technology is also a promising area that can contribute to increasing the security and transparency of financial transactions.

Ultimately, the development of artificial intelligence will not only transform current financial processes, but will also become a key factor in the future competitiveness of the banking sector. Accordingly, future research should pay more attention not only to technological innovations, but also to the risks and regulatory challenges they entail.

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Sustainability and Climate Risk Analysis of Gold as a Central Bank Reserve Asset

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Gold is a precious metal with several functions: it has been widely used in jewellery for thousands of years, and, as it serves as a store of value and has other special financial properties, it is also used as an investment asset. Gold also plays a prominent role in central bank reserves, primarily as a safe-haven asset and diversifier. Climate change may have negative social and economic consequences, such as intensifying geopolitical tensions and rising inflation, which may increase demand for safe-haven assets, including gold. Considering the role gold plays in central bank reserves, it is important to understand its climate risk profile as well. In this paper, we assess the physical and transition risks of gold investments. The main message of our analysis is that gold as a final product is practically indestructible and therefore its physical risk exposure is negligible, but its transition risk profile cannot be clearly determined.

Journal of Economic Literature (JEL) codes: Q51, Q54, G32, E58

Keywords: sustainability, climate risks, gold, gold reserve, central bank investments

1. Introduction

Exploring and understanding climate risks is a prerequisite for the green transition. The transparency of central banks is an important consideration also when climate risks are measured. As independent public institutions, central banks should assess the climate risks in their balance sheet because of the potential losses. Additionally, they can support the development of best practices in measuring climate risks and may also shape the climate awareness of market participants (*Kolozsi et al. 2022*).

* 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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Accordingly, in recent years several central banks have emphasised the importance of the green transition and have made efforts to understand and disclose the climate risk exposure of their own operations and financial assets. The environmental sustainability and climate risk aspects of conventional financial investments (shares, bonds) are now widely discussed in climate-related financial disclosure reports published by central banks (e.g. *MNB 2024*). However, gold as a separate investment asset class has not been discussed so far, even though gold plays a prominent role in central bank reserves.

Awareness of environmental sustainability and other ESG (Environment, Social and Governance) issues is increasing on the gold market as well, as reflected in various market initiatives and the rising number of related analyses. When exploring climate change related risks, we must differentiate between physical gold as an investment and the gold industry. While participants in the gold market are closely interconnected as far as market effects are concerned, climate change processes may have different impacts on companies at different stages of the supply chain.

The carbon footprint of gold mining has been estimated in various studies, including *Ulrich et al.* (*2020*). The World Gold Council (WGC), the international trade association of the gold industry, has also published analyses of the connection between gold and climate change, the adaptation and decarbonisation options of companies involved in gold mining (*WGC 2018, 2019a, 2021a*) and the economic and social impact of WGC member companies (*WGC 2021b*). Various approaches have been used in the literature to analyse the environmental impact of gold mining. Both regional (*Chen et al. 2018*) and global mining data (*Mudd 2007*) have been researched. The carbon intensity of gold mining is analysed in comparison to other metals in some studies (see *Nuss – Eckelmann 2014*) and from the aspects of the extraction process in other papers (*Norgate – Haque 2012*). In addition to carbon intensity data, *Ulrich et al.* (*2022*) also analysed the impact of the introduction of a global carbon tax.

Our paper aims to contribute to the literature by integrating gold investments into the existing framework of central bank climate risk analyses as a separate asset class. We seek to answer the question how the environmental sustainability aspects of investment gold can be explored in the context of central banks' FX reserves. As the significance of climate risk considerations is increasing in the financial sector as well, it has become necessary to examine this precious metal, which has been popular for thousands of years, in terms of the new aspects that have emerged in the evolving investment environment. Gold as a special commodity has several unique properties that make the analytical approaches used for conventional

financial assets difficult to apply. Methodological challenges and the need to meet the new expectations of investors make the focus issue of the paper very topical.

In the first part of the paper, the interpretation context, i.e. the historical role of gold in financial markets, is described. This is followed by the analysis of how the emissions impact of gold investments can be compared to the profile of other financial products, and what risks lie, with respect to existing gold investments, in the economic and social processes expected to be triggered by climate change.

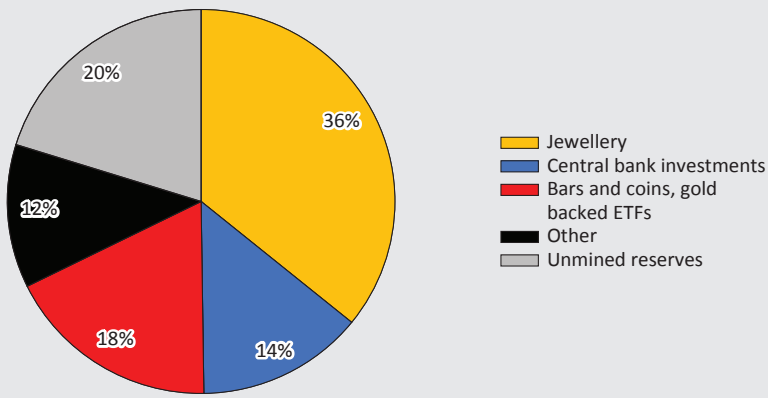
2. Gold as an investment asset

2.1. The role of gold in financial markets

Historically, gold has been among the most sought-after precious metals, a symbol of purity and nobility. Gold has several functions: it has been widely used in jewellery for thousands of years, and it is also used in modern industry. In addition, it serves as a store of value and is thus an investment asset (*Bánfi – Hagelmayer 1989*).

According to current estimates, approximately 216,265 tonnes of gold has been mined over the course of history, and about two-thirds of that has been extracted since 1950. Underground reserves are estimated at 54,770 tonnes (*Figure 1*).

Figure 1
Distribution of stock of gold (end of 2024)

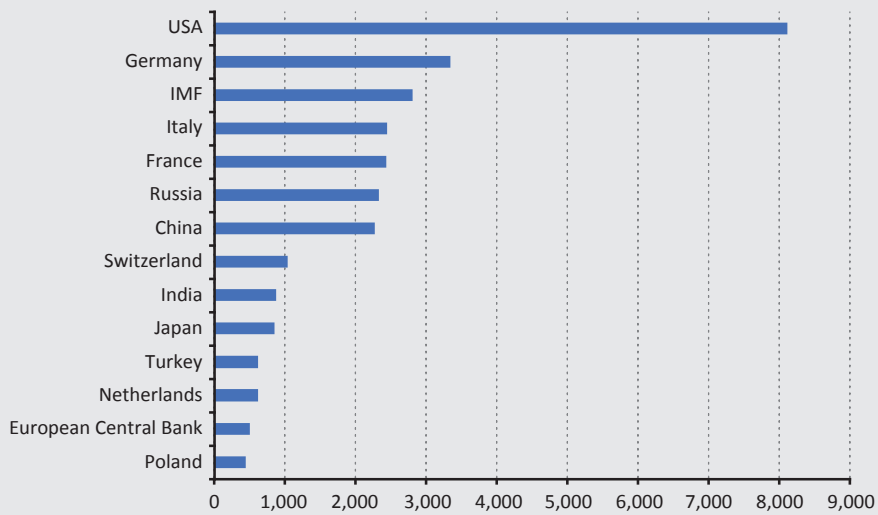


Source: Compiled from data by WGC (https://www.gold.org/goldhub/data/how-much-gold)

Throughout history, gold has been a central element in financial systems: it was first used as commodity money (*Bánfi 2022a*) and then in the 19th and 20th centuries countries around the world tied the value of their currencies to gold under the gold standard system (*Lőrincné Istvánffy 2004; Bánfi 2022b*). After World War II, until the collapse of the Bretton Woods system in 1971, the tying of the US dollar to gold was at the centre of the financial system: parties to the agreement guaranteed that their currencies would be pegged to the US dollar, and a fixed-rate conversion between USD and gold was also agreed (*Hagelmayer et al. 1975*).

While gold's significance in the operation of financial systems has decreased in recent decades, it still plays a prominent role (*Banai et al. 2021b*). This is clear from the exposure of central banks to gold, as after the US dollar and the euro, gold is the third most important reserve element, amounting to about one-fifth of global reserves. Despite the collapse of the Bretton Woods system, several countries still hold significant amounts of gold, with the USA, Germany and Italy having the three largest reserves (*Figure 2*).

Figure 2
Largest official gold reserves (tonnes, end of 2024)



Source: Compiled from data by World Official Gold Holdings and International Financial Statistics

Not immediately after Bretton Woods but in the 1990s, central banks' approach to gold in developed countries changed significantly, leading to a moderate decrease in gold reserves (*Palotai – Veres 2020*). Central banks with substantial gold reserves wanted to diversify away from gold without jeopardising the value of their existing portfolios. Relevant agreements were made on these issues, and the Central Bank Gold Agreement (CBGA) was signed in 1999 and then renewed three times. The role of gold was less prominent in reserves than it was in the Bretton Woods system.

This trend came to an end with the global financial-economic crisis in 2008: developed countries practically stopped selling gold, while emerging countries started to buy more, which led to a general increase in gold reserves. The low-return environment of the 2010s, i.e. the decrease in the opportunity cost of holding gold, and the increasing significance of the safe-haven function also played a role in this. This change in the trend is also shown by the fact that the CBGA was not renewed by the signatories when it expired in 2019 (*ECB 2019*), and more and more central banks are currently appearing on the gold market as buyers (*Ladányi – Paulik 2018*).

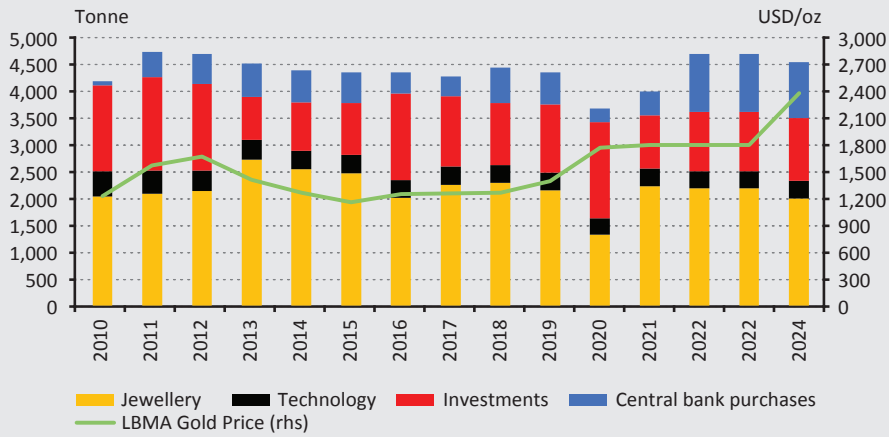
2.2. Special features of gold investments

Analysis of the dynamics of supply and demand on the gold market reveals the dual nature of gold: on the one hand, it is a commodity with physical demand and supply from mining (and recycling), while on the other it is also a financial-investment product where, in addition to buying and holding physical gold, derivative markets may also affect market conditions. The gold derivatives market is extensive, with a significant trading volume in both OTC and exchange-traded futures, but investors can also gain exposure though ETFs. The liquidity of the different markets is high. However, there may be a considerable price spread across markets.

Gold's prominent role is clear from the global volume of central bank gold reserves, which exceeds 36,000 tonnes,[1] as well as from the fact that recent purchases by central banks and other investors have accounted for nearly one-half of annual demand (*Figure 3*).

[1] Value exceeding USD 3,000 bn, at 2024 end-of-year prices

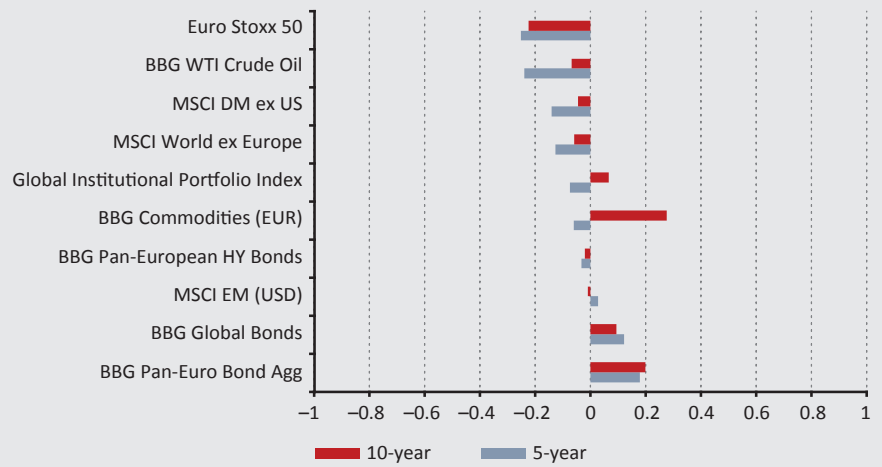
Figure 3
Breakdown of annual demand for gold and the price of gold



Source: Compiled from data by WGC (https://www.gold.org/goldhub/data/gold-demand-by-country)

The price of gold depends on a number of factors (*Asztalos – Asztalos 2011*). Historical experience shows that the co-movement of the prices of various investment assets increases as the uncertainty of the market intensifies. The weak correlation between gold and other asset indices (especially in turbulent times) substantiates the idea that gold can have a diversifying role in investment portfolios over the medium or long term (*Figure 4*).

Figure 4
Correlation between gold and other asset classes



Note: For the periods 31 December 2014 – 31 December 2024 and 31 December 2019 – 31 December 2024, based on monthly returns.

Source: Compiled from data by WGC (https://www.gold.org/goldhub/data/gold-correlation)

The safe-haven[2] status of gold has been explored in several empirical studies (e.g. *Bouoiyour et al. 2018*). Some of these analyse the connection between the price of gold and geopolitical risks (*Baur and Smales 2018; 2020*) or the price of gold and pressure on global supply chains (*Li et al. 2023*), while others (*Gosh et al. 2001; Beckmann – Czudaj 2012; Conlon et al. 2018*) point out that gold may also be useful as a hedge against unexpected inflation.

Overall, it can be established that gold investments have a number of special properties (*Arslanalp et al. 2023*): gold is an investment which is independent of the issuer and can be stored in any country,[3] which means it is a store of value with practically no credit risk; its price typically rises in times of market stress (flight-to-quality effect), which may be of particular importance from a central bank perspective in the event of an increase in both geopolitical and financial risks; depending on the investment horizon, it can help mitigate the negative effects of unexpected inflation. It is also important to note that the gold market is regulated, structured and deep,[4] and when necessary, physical gold can be converted to liquidity in other currencies through various swaps.[5]

Considering the events of the past 10–15 years (e.g. Lehman crisis, the European sovereign debt crisis, Brexit, Covid, Russia-Ukraine war), these properties may counterweigh the other financial and investment considerations that arise in relation to gold (e.g. no interest payment, relatively high price volatility compared to bond investments, potentially lower liquidity of physical gold) and explain the renewed interest of central banks. Fears of potential international sanctions and an intention to move away from the US dollar may have been among the factors considered by several larger countries when buying gold (*Alimukhamedov 2024*), while central banks in other countries (e.g. Hungary, Czechia, Poland) decided to increase their gold reserves considering strategic aspects and emphasising the positive features of gold (*Banai et al. 2021a; Veres 2024*).

[2] In the case of gold, the safe-haven feature is also reflected in the positive skewness of the returns, as opposed to the negative skewness of other assets (*Lucey et al. 2003*).
[3] No significant extra costs are incurred when it is stored in own existing vaults (used for other purposes as well, e.g. for storing cash).
[4] The average total daily trading volume of gold across various platforms (OTC, stock exchange, ETF) exceeded USD 162 bn in 2023, which is comparable to US T-bills (USD 161 bn) and the EUR/GBP market (USD 154 bn). (See https://www.gold.org/goldhub/data/gold-trading-volumes)
[5] Converting electronic gold to liquidity is easy through account movements. Liquidity is more limited when gold is stored or held physically, far from large financial centres.

3. Assessment of the climate risks of gold as a separate investment asset class

Investors increasingly combine conventional return-risk goals with other, non-financial aspects (*MNB 2023*), as reflected in the increasing interest in sustainable and responsible investments.[6] It should be noted that investor demand for gold and the weight and role of gold in a given portfolio are basically determined by strategic and financial aspects; central banks' demand is also primarily driven by the favourable properties of gold as a diversifier or safe-haven asset. However, it is important to realise that various climate scenarios (e.g. by NGFS) predict an increase in geopolitical tensions and inflation risks, disruptions to agricultural production, GDP declines and potential disruptions to the financial system (*NGFS 2024*). This means that climate-related considerations may affect investor decisions indirectly rather than directly, for example as tail risk events that spill over to the conventional analytical framework through various transmission channels.[7] Taking this into consideration along with gold investments' global scale and significant role in the reserve portfolios of central banks, it seems appropriate to try to understand the sustainability and climate risk aspects of gold.

With regard to conventional investment assets, based on the double materiality principle, climate risk analyses provide, on the one hand, assessments of the extent to which the operation of the issuer of a security (company or state) contributes to processes driving climate change (e.g. GHG emissions) and how and to what extent this is financed by investors (impact approach). On the other hand, such analyses also explore how the consequences of climate change (physical and transition risks) may, in turn, affect the issuers' operations and the value of their securities (risk approach).

This concept can be applied to gold as well, with the difference that climate risks may be assessed with two different approaches: gold can be considered as exposure to an industry, and companies in the value chain of the gold industry can be analysed (as for bonds and shares); however, it must be taken into consideration that gold is also a physical commodity.

[6] Sustainable and Responsible Investments (SRI)
[7] It should be noted that as global warming increases, the probability of events once considered extreme increases every year.

It is important to note that the assessment of environmental sustainability and climate risk aspects is not only relevant for central banks that intend to buy gold, but also for those that hold existing stocks, as the value of their investments is ultimately determined by the price of gold on the secondary market, which, through prevailing supply and demand conditions, may be affected by processes potentially triggered by climate change.

3.1. Assessment of physical risks

Physical risks arise from the increase in the severity and frequency of extreme weather events (e.g. extreme heat or cold, drought, tropical cyclones, coastal flooding, river flooding, forest fires, supercells, flash floods). In this category, it is not only the risk of losses due to the physical deterioration of assets and infrastructure that is considered, but also the breakdown of value chains, loss of biodiversity and the degradation of ecosystem services, which may have negative impacts on human health and well-being, and may spill over to the economic-financial system through transmission channels.

Physical gold is practically indestructible: it is not damaged even during (climate) disasters, which can be a positive feature compared to other investments – in specific companies – as physical risks may have a serious impact on the operation of such companies. Obviously, during a climate disaster, accessing, transporting and guarding gold may pose a challenge, but this is a problem of a completely different scale, time horizon and cost implications.

In the case of bond investments, physical risks are often analysed as supply-side shocks (e.g. a production facility is destroyed). According to this approach, in the case of gold the investor takes a position vis-à-vis an entire industry, not a specific company, which represents a significant difference compared to bond or equity investments; this is comparable to an ETF replicating a broad bond market index. Climate change may negatively affect certain participants involved in gold production, but the supply and demand shocks experienced, for example in the oil market, are considerably less likely to occur in the case of gold (*Fazekasné Szikra – Pivarcsi 2017*). This is basically because the geographical distribution of existing gold reserves is less concentrated (*Table 1*).

Table 1
Share of industrial gold mines in production

Annual production [tonne]	Share of gold mines (locations) (%)	Share of global production (%)
≥ 10	7	39
5 ≤ < 10	14	26
1 ≤ < 5	47	31
< 1	32	4

Note: The table shows the data of 622 industrial mines (2018–2021); mines producing gold as a by-product and small-scale producers are not represented.
Source: Compiled by Schütte (2023) based on data by S&P Global

In the case of gold, no region accounts for more than one-fifth of global production, which means more stable supply conditions, i.e. problems that may occur in some places do not necessarily lead to global supply shocks (*Figure 5*).

Figure 5
Geographical location of gold mines with the largest annual production volumes

Note: Mines with annual production exceeding 10 tonnes in at least one year between 2018 and 2021.
Source: Compiled by Schütte (2023) based on data by S&P Global

Another significant difference is that while a disruption in the operation of a specific company (due to the materialisation of physical risks) typically worsens the performance of the given company, industry or even the entire index, in the case of gold, extreme weather conditions may even lead to price increases due to the temporary decline in supply, which increases the value of existing investment positions.

Based on the above considerations, it can be concluded that the physical risk exposure of the gold reserves is relatively low compared to other forms of investment, and the realisation of risks may, in certain scenarios, even increase the value of the investment.

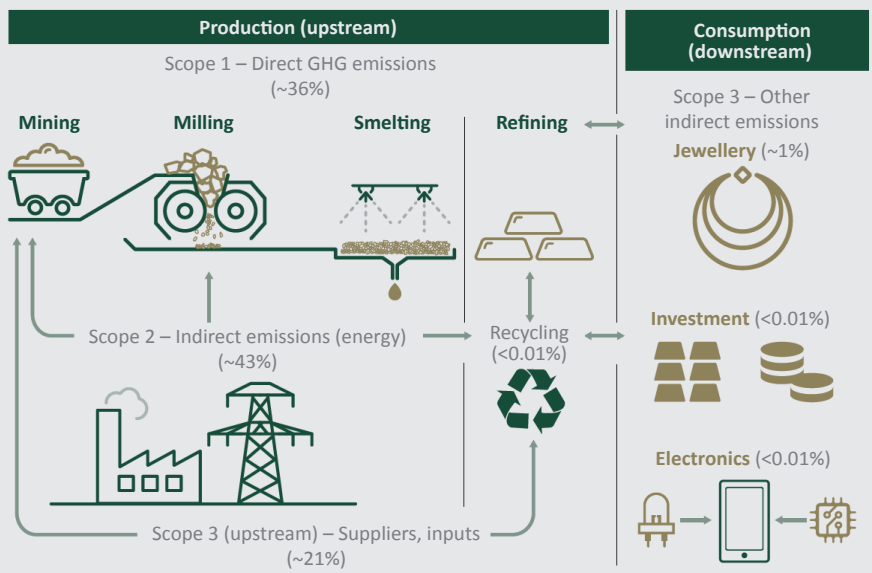
3.2. Assessment of transition risks

3.2.1. Emissions profile of the gold industry's value chain

Transition risks arise from the challenges of transitioning to a low-carbon and climate change resilient economy. Policy (e.g. more stringent emissions requirements, quotas, carbon tax, etc.), technological changes and rapid changes in consumer attitudes can all cause sudden changes in the price of financial instruments. As a consequence, credit and market risks may increase, and in certain scenarios, the resulting losses may spill over to the whole economic-financial system.

To understand transition risks, first the emissions profile of the gold industry's value chain must be explored. The production process has four main stages: mining, milling, smelting and refining (*Figure 6*).

Figure 6
Process and GHG emissions of the gold industry's value chain

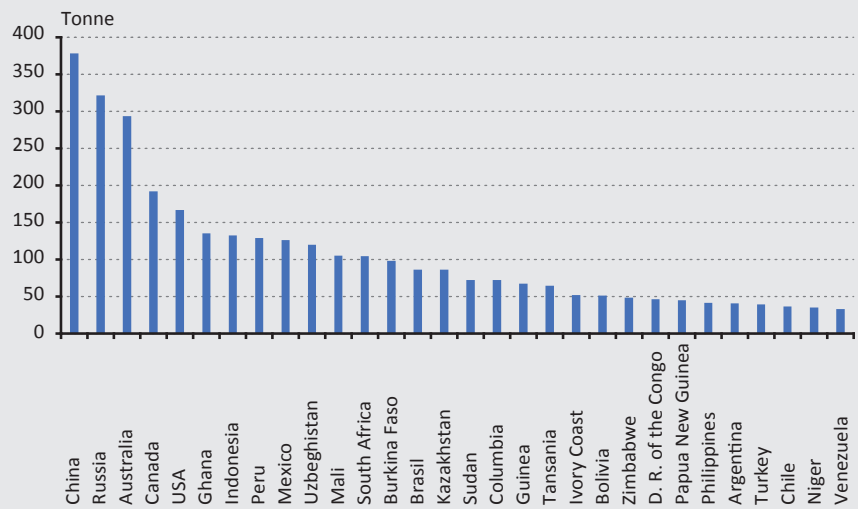


Source: WGC (2019a, p.11)

The annual emissions of the gold industry are estimated at approximately 120–130 million tonnes of CO_2e, which is only 0.25–0.3 per cent of the total global emissions, but is by no means negligible. The vast majority of production (approximately 80 per cent) comes primarily from gold mining companies using large-scale technology, most of which are listed companies, with a smaller proportion coming from small-scale mining. The emissions profiles of mines are highly heterogeneous and are determined by a number of factors (type and depth of mine, technology, grade of ore, etc.), but it is clear that the separation of gold from ore accounts for a large part of the value chain's energy demand, the vast majority of which is related to the use or on-site generation of electricity (*WGC 2019a*).

Considering that the energy mix of grid electricity varies by region, the gold's place of origin must be identified for the assessment of the emissions profile. Until 2006, South Africa was the largest gold producer globally. After 2007, production increased in other countries and decreased in South Africa,[8] and China became the top gold-producing country. In 2023, the countries with the largest gold production (China, Australia and Russia) accounted for approximately one-third of total global gold mining (*Figure 7*).

Figure 7
Production of the top 30 gold mining countries (2023)



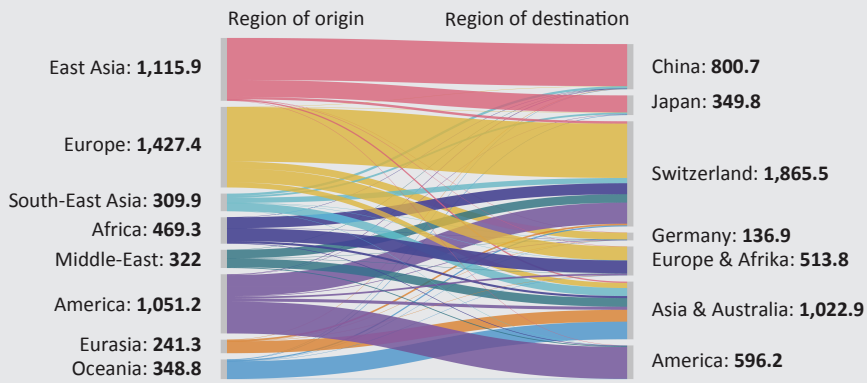
Source: Compiled from data by the WGC (https://www.gold.org/goldhub/data/gold-production-by-country)

[8] Mining in old mines is no longer profitable, as these are very deep and the concentration of gold in the ore is low.

Polluting energy sources still play a significant role in the energy mix of several top gold-producing countries,[9] whose future climate goals are not very ambitious.[10] This means the transition to carbon neutrality is a challenge for the gold industry as well, but it must be noted that – as opposed to other sectors (e.g. aviation, maritime transport) – the technological aspect of decarbonisation is relatively easy, for example with the installation of renewable energy sources. Accordingly, more and more of the largest participants in the industry are preparing medium-term decarbonisation plans (*WGC 2020*).

While most gold-related GHG emissions are generated during extraction, it is also clear that after it is mined, gold is transported across the globe, which also has an impact on the climate. Country of origin data from LBMA[11] provide an insight into the global physical flows of gold – from the country or region of origin, where the Good Delivery List (GDL) Refiners source their feedstock, to the country of destination, where the material is refined (*Figure 8*).

Figure 8
Global gold material flow (2022, tonne)



Source: Compiled from data by LBMA (https://www.lbma.org.uk/country-of-origin-data)

While there is an overlap between the countries producing and countries using the most gold (e.g. China), there are several destination countries with no gold production whatsoever (e.g. Germany, Switzerland, Japan). In this context, it should be noted that the share of recycled gold is high in practically every region (recycled gold amounts to approximately one-quarter of annual supply).

[9] https://www.iea.org/data-and-statistics
[10] https://climateactiontracker.org/countries
[11] The London Bullion Market Association (LBMA) is an international trade association operating the OTC wholesale market of gold and silver, accounting for approximately 50–60 per cent of the total OTC trading volume. LBMA sets strict standards for the purity, shape, size and quality of gold and silver bars on the market. It also administers the London Good Delivery list, a list of accredited refiners whose bars meet LBMA standards.

3.2.2. Emission of the gold industry in light of specific indicators

In order to understand the impact of gold as an investment product on climate change, and its climate risk exposure, it is first necessary to examine widely-used emissions intensity ratios, which, in the case of gold, may include the following:

- *tCO_2e/tonne of ore: emissions intensity of processed ore per tonne, which helps the assessment of the absolute change in GHG emissions in the case of mines with steady production. This, however, is not very useful for the comparison of mines unless they have the same nominal ore processing capacity.*
- *tCO_2e/tAu: specific GHG emissions of the final product, the best for the comparison of extraction companies or specific mines.*

Emissions estimates per tonne of gold vary widely in the literature (11,500–55,000 *tCO_2e/tAu*), mainly due to differences in the energy mix of the regional electricity grids. *Nuss – Eckelman* (*2014*) gathered data on the environmental impact of 63 industrial and precious metals and demonstrated that the environmental impact per kilogram is the highest for the platinum group and gold. *Haque – Norgate* (*2014*) estimated, among others, the GHG footprint of gold (38,100 *tCO_2e/tAu)*. *Ulrich et al.* (*2020*) used gold mining data from Australia to analyse the connection between the quality of gold ore and GHG emissions per ounce. In another study (*Ulrich et al. 2022*), they aggregated mine-specific GHG emissions and production data at the country level, allowing for the quantification of the effects of a potential global carbon tax. There is also additional research in the literature that addresses other environmental impacts of gold production. *Chen et al.* (*2018*) analysed the environmental impact of gold production in China through a life cycle assessment. *Norgate and Haque* (*2012*) found that the broadly defined environmental footprint of gold production (per tonne of gold produced) was several orders of magnitude greater than that for a number of other metals, largely due to the low grades of ore used for production. They estimated GHG intensity (18,000 *tCO_2e/tAu*) and other environmental impacts, including use of water per tonne (260,000 *tH_2O/tAu*) and remaining solid waste for non-refractory ore (1,270,000 *t/tAu*).

3.2.3. Environmental impacts from an investor's perspective

When analysing the environmental impact and climate risks of financial investments, it is necessary to examine the extent to which the investment contributes to financing emissions (see financed emissions, GHG Protocol – Scope 3 Standard), and the potential impacts of climate change processes on the value of investments. Investors finance GHG emissions involved in the activities of the issuer of a security through their ownership interest in the case of shares and as creditors in the case of bonds.

In international practice, there are several approaches for assessing the environmental impact (and climate risks) of conventional investments. According to the recommendations of the TCFD,[12] these include the carbon intensity ratio[13] calculated as the ratio of the annual GHG emissions resulting from the production and the corresponding annual revenue or the value added[14] generated by the given sector or company. The indicator shows how efficiently, from an environmental perspective, the issuer generates value added, and it is also used as a proxy for transition risks, for example as the basis for estimating how a potential carbon tax (or any other regulatory restriction affecting emissions-intensive activities) may directly impact the operations of a given company or industry. The advantage of this indicator is that it is relatively easy to calculate and does not require a complex methodological background. However, its disadvantage is that it relies mainly on historical data, i.e. it does not take into account possible future decarbonisation paths, nor does it provide answers as to how a given industry or company can adapt, for example, to what extent it can pass on the cost shock to other actors in the value chain.

The same logic may be applied to gold as well: calculated as the ratio of the annual value added of the gold market and total generated emissions, carbon intensity is approximately 400–600 *tCO_2e/million € value added.*[15] The question arises as to how this can be compared to other industries. Industry intensity ratios vary across and within countries. For example, in Hungary, 250, 470, 1,000, 2,140 and 7,130 *tCO_2e /million € value added* is generated in construction, manufacturing, transportation, agriculture and energy supply, respectively.[16] Based on this, it can be concluded that the carbon intensity of the gold industry is relatively favourable, primarily due to the high value of gold.

In addition to gold, central bank reserve portfolios mainly consist of sovereign bond exposures, and accordingly it is worth comparing these as well. For the first time in 2023, the eurozone central banks published their climate risk disclosures using a unified methodology. Among other data, they presented the weighted average carbon intensity of their portfolios, which varied between 150 and 350 *tCO_2e/million € GDP* (see *Marczis – Karácsony 2024*).[17]

The indicators for gold and bond portfolios are of similar magnitude, but attention should be drawn to a difference in methodology that calls for the use of an

[12] Task Force on Climate-related Financial Disclosures
[13] Weighted average carbon intensity (WACI). The indicator quantifies the average carbon intensity of portfolios, weighted with the share of the assets in them. For more on this indicator, see *Marczis – Karácsony* (*2024*).
[14] Either Enterprise Value Including Cash or market capitalisation; in the case of sovereign bonds, annual GDP.
[15] The exact value is highly affected by the gold price used, e.g. end-of-year price or annual average price.
[16] Eurostat Air Emission Accounts, 2023
[17] The basis of calculation is somewhat different for corporate and sovereign WACI (earnings, GDP, value added), which might lead to a slight distortion, but does not affect the interpretation context.

alternative approach: shares and bonds finance the current and future operations (and related emissions) of companies, and therefore the corresponding WACI represents continuous, annualised emissions and value added, which are meant to be used as a basis of comparison for those investing in the shares and bonds of companies in the gold industry. On the other hand, in the case of physical gold investments, the gold bars purchased only had a GHG impact once (during production), and no significant recurring emissions arise as they are held. The question is if and how the emissions aspects of physical gold can be integrated into the interpretation framework used for bonds and shares.

Some (*Baur – Oll 2017*; *WGC 2018*) suggest that, instead of intensity ratios (e.g. WACI), the focus should be on total carbon emissions (TCE). For companies, annual nominal GHG emissions (tonnes of CO_2e) can be determined, and where applicable, it can also be established how much tree planting or annual carbon credit purchases are required to offset this. The amount of GHG emissions generated during production can also be estimated for physical gold (approximately 11,500–55,000 tCO_2e for 1 tonne of gold). Given that gold generates a one-time emission, in the case of offsetting, it is necessary to determine the period over which such compensation is to be provided.[18] *Baur – Oll* (*2017*) examine how the climate impact of a gold investment of USD 1 million compares to a similar investment in the S&P500 stock index. To ensure comparability, the one-time GHG emission of gold is divided by the expected holding period of the investment: the longer the time horizon over which the single GHG emission can be spread, the lower the annualised value of the indicator. In their analysis, they conclude that regarding the emissions impact of gold – depending on whether the minimum or maximum value of the estimated range is used – the "break-even point" is reached in 4 to 9 years, meaning that in this approach the climate impact of gold is more favourable in the life cycle assessment if the investment period is long enough.

When conducting analyses related to gold, it is important to consider the position of the given investor: before making new investments, a number of ESG factors can be examined (screening), including the emissions impact of the purchase compared to other assets. However, in the case of existing portfolios, alternative questions need to be asked, as the environmental impact of previously purchased gold is a past condition. In its climate risk report, the German *Bundesbank* (*2024*) formulated the question of what the hypothetical annual carbon impact of its gold reserve would be if it had been produced today.[19]

[18] It is estimated that it takes 31–46 trees to absorb 1 tonne of CO_2e annually (see encon.eu), i.e. to offset the emission of 1 tonne of gold, approx. 250–1,774 trees need to be planted if the total impact were to be offset over the course of one year.
[19] Amounting to 3,353 tonnes, which was accumulated between 1950–1970 and has been held since then.

3.2.4. Transition risks from an investor's perspective

When analysing transition risks, it can generally be said that any regulatory changes introduced to promote the green transition have a negative impact on companies engaged in carbon-intensive activities, for example by making production more expensive, reducing profitability, making it more difficult to access funding and providing a competitive advantage to other companies with greener technologies. As a result, the value of an investor's shares or bonds usually decreases. However, in the case of gold, this interrelation is not clear-cut. It can be stated with certainty that there are no direct effects with regard to physical gold already held in the portfolios, and thus the direct effects of transition risks can be considered marginal.

Taking into account that the value of existing gold investments is also determined by the gold price, which is shaped by prevailing market supply and demand conditions, indirect effects may also play a significant role. However, estimating such indirect effects poses a number of challenges, as it is unclear how regulatory changes or consumer preferences may affect supply and demand. As shown above, as a result of the negative socio-economic processes triggered by climate change, on the one hand, demand for safe-haven assets may increase, but a scenario is also possible where more stringent regulations imposed on emissions-intensive industries are reflected in the cost of production, which – via the increase in prices – may even improve the position of investors who already have gold exposure. However, it is also possible that investors start preferring gold bars that were mined according to more stringent environmental rules,[20] which may have a negative impact on the price of gold.

It is important to note that a significant number of central banks hold their gold reserve in physical form. In addition to these challenges, the climate impacts of gold derivatives are even more difficult to identify, as these are not necessarily linked to physical gold.

4. Environmental sustainability and ESG in the context of gold

Gold mining may involve both positive and negative externalities. Effects are positive if a certain activity contributes to the well-being of local communities as well, for example gold mining creates jobs and the company contributes to the financing of local schools and healthcare institutions. It is important to note, however, that various ESG risks may be associated with gold mining,[21] mostly linked to topics such as water management, natural capital, waste management, air pollution and social risks.

[20] Some gold ETFs already take this into consideration (see *Alimukhamedov 2024*).
[21] Mostly in the case of small-scale mines accounting for 20 per cent of global production

4.1. Industry standards

Although gold investments by central banks are fundamentally driven by strategic and financial factors, due to the increasing importance of environmental, social and sustainability considerations in the attitudes of investors (e.g. UN Principles for Responsible Investment) and consumers, players in the global gold market are giving more and more weight to the aspects of responsible sourcing and use.

This was one of the factors that motivated WGC and LBMA to issue the gold industry's *Declaration of Responsibility and Sustainability Principles.*[22] Signatories set ten key sustainability goals, which include aligning with responsible sourcing standards, supporting the advancement of the UN Sustainable Development Goals,[23] and stepping up against climate change and committing to reporting. They also agreed to report their progress in the implementation of these principles in a transparent manner. Additional standards were developed for the various stages of the value chain: for mining, it is the World Gold Council's *Responsible Gold Mining Principles,*[24] which applies to all members of WGC,[25] and for refining companies, it is LBMA's *Responsible Gold Guidance.*[26] In 2021, WGC member companies made a commitment to regularly report on their progress in decreasing their climate risks and environmental impact, in line with TCFD recommendations. LBMA's Responsible Sourcing programme is mandatory for every refining company with LGD certification. Adherence to the audited process demonstrates compliance with responsibility and sustainability criteria to market operators.[27]

It should be noted that the EU regulation on minerals originating from conflict-affected and high-risk areas (EU 2017/821[28]) came into force on 1 January 2021, laying down supply chain due diligence and disclosure obligations for importers of certain minerals and ores, including gold, in relation to suppliers.

It should also be noted that while mines using large-scale technologies account for the vast majority of production, it is small-scale mining that is the most prone to ESG risks. The Alliance for Responsible Mining was established to explore and mitigate these problems.[29]

[22] Gold Industry Declaration of Responsibility and Sustainability Principles (https://www.gold.org/gold-industry-declaration)
[23] Sustainable Development Goals (SDG)
[24] Responsible Gold Mining Principles (https://www.gold.org/industry-standards/responsible-gold-mining)
[25] Currently accounting for nearly 60 per cent of annual large-scale gold production.
[26] Responsible Sourcing Programme, Responsible Gold Guidance (https://www.lbma.org.uk/responsible-sourcing)
[27] Several central banks, including the Magyar Nemzeti Bank, only have gold bars with this certification.
[28] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02017R0821-20201119
[29] Alliance for Responsible Mining (https://www.responsiblemines.org/en/)

4.2. Responsible and sustainable investment opportunities

4.2.1. Certificates, attestations and trademarks

Responses to evolving consumer expectations are gradually appearing on the gold market as well, with products such as gold bars, coins and jewellery with various certifications that prove the origin and other ESG features of the gold, demonstrating to buyers that various sustainability criteria are met.

There are several such certifications: some include designation of origin and certify the point of origin of the gold, while others confirm that environmentally friendly production processes are in place. For example, the Carbon Trust Footprint Label[30] shows that the carbon footprint of the company manufacturing the product decreases every year, in line with a decarbonisation plan certified and regularly audited by the Carbon Trust, and the remaining emissions are offset according to the ISO 14067 standard.[31]

Some gold refining companies use various analytical tools to assess supply chain risks. For example, the Swiss refiner Metalor and the University of Lausanne developed the Geoforensic Passport approach that determines the origin of gold based on various chemical components (*Schütte 2023*).

The various certifications, such as credit ratings, typically incur additional costs for producers. *Gruber and Montemurro* (*2021*) examined what information market participants want to be disclosed and found that the designation of origin is extremely important: buyers are willing to pay a premium of up to 2 per cent for such certificates. There are certificates attesting compliance with more broadly interpreted ESG criteria, with a price premium of 1.7 to 10 per cent as compared to uncertified gold. These include certifications by *Fairmined,*[32] by *Fairtrade*[33] and by *Better Gold Initiative*, which cost 4,000–6,000 USD/kgAu, 2,000 USD/kgAu and 1,000 USD/kgAu, respectively (*Gruber – Montemurro 2021*). The price premium buyers are willing to pay for a "green version" of a given product depends on the supply and demand structure (*Azevedo et al. 2022*).

4.2.2. Alternative forms of investment

Baur et al. (*2020*) presented an interesting idea: the actual extraction of gold is not strictly necessary for investors to access the performance of the gold market, and thus they propose to leave gold in the ground, in its natural vault. The authors recommend investing in companies – as an alternative to investments involving

[30] https://www.carbontrust.com/en-eu/what-we-do/product-carbon-footprint-labelling/product-carbon-footprint-label
[31] International standard defining methodologies for measuring the carbon footprint of various products: https://www.iso.org/standard/71206.html
[32] https://fairmined.org/what-is-fairmined/
[33] https://www.fairtrade.org.uk/buying-fairtrade/gold/

actual mining – that identify and secure gold reserves, but do not extract them. They analyse their research question on portfolios consisting of Australian gold exploration companies, and conclude that – despite the uncertainties about the quantity and quality of gold in specific locations – this "green gold" is strongly correlated with the performance of conventional gold investments.

The study presented above is an intriguing thought experiment, but it must be noted that with this form of gold investment the benefits of investing in physical gold probably cannot be realised. These include independence from the issuer, the lack of credit risk and, most importantly, the certainty that the asset concerned can be physically stored on the territory of one's own country. The causal relationships behind the phenomena presented in the paper should also be explored further, as correlation may have a number of underlying factors.

5. Conclusion

An increasing number of central banks publish sustainability and climate risk analyses according to the recommendations of TCFD, focusing mostly on their investments in bonds and equities. Despite its significant role in central bank reserves, gold as a separate investment asset class has rarely been discussed in these reports, even though climate change can have negative socio-economic consequences that may increase the significance of safe-haven assets.

Investor demand for gold is mostly determined by strategic and financial considerations, but, taking the above aspects into account, the sustainability and climate risks of gold should also be explored. This kind of analysis is not only relevant for central banks that intend to buy gold, but also for those that hold gold reserves, as the value of their investments is determined by the price of gold on the secondary market, which, through supply and demand, may be affected by processes potentially triggered by climate change.

While best practice is emerging in existing climate risk analyses, there is still no widely accepted methodology for gold. Gold, like bonds and shares, is an investment asset, but there are significant differences between these products, which limits the comparability of their climate risks. It can be established that gold is practically indestructible: it will not be damaged even during (climate) disasters, and therefore its physical risk exposure is negligible.

In the case of gold, the focus should be on total emissions impacts instead of intensity ratios. For shares and bonds, WACI expresses continuous, annualised emissions and value added and determines the degree of transition risks from that. As opposed to this, gold bars purchased have a one-time GHG impact, and no significant emissions are involved in their holding. For the sake of comparability,

it would be useful to bring the emissions indicators used for gold closer to the concept applied to securities – for this purpose, the analysis of total emissions per investment value seems suitable. Some analyses suggest that the one-time emissions of gold investments can be divided by a hypothetical holding period, which means the longer the planned investment horizon, the more favourable the indicator as compared to other investments that keep generating new emissions.

With regard to transition risks, it should be noted that potential regulatory changes or evolving consumer preferences have no direct effect on physical gold already included in investment portfolios. Nonetheless, considering that the value of existing gold investments is determined by the price shaped by prevailing market supply and demand conditions, indirect impacts may also play a role. Further research is needed to explore this.

Currently available findings in the literature and examples seen in practice suggest that there is still no consensus about reporting on the climate risks of gold investments. However, as gold investments play a significant role in central bank reserves, and environmental sustainability-related financial disclosures are more and more widespread, an increasing demand for such reporting can be expected in the future.

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Robo Sapiens Bankerius: An Ideally Designed Humanoid Banking Service Robot?

Alexandra Prisznyák

Autonomous intelligent robots are playing an increasingly prominent role in the banking sector. The acceptance and perception of these robots as social actors depends on various factors. Through the process of anthropomorphisation, people attribute human-like characteristics, behavioural patterns or intentions to robots. This essay explores the anthropomorphisation of banking robots and examines the interactions between key robot features: social skills, functionality and appearance. It presents the theoretical concept of an ideally designed "Robo Sapiens Bankerius". A questionnaire-based survey involving 26 robots which focused on the evaluation of the anthropomorphic appearance of banking robots was conducted between 2023 and March 2025: it found that majority of respondents preferred less human-like robots. Age, gender, concerns and attitudes showed no significant correlation with the choice of robot. The analysis of the open-ended responses revealed trade-offs between robots' social capabilities, functionality, and appearance. These findings point to new directions for research and provide an opportunity to compare the results with international literature.

Journal of Economic Literature (JEL) codes: O3, G21, L62

Keywords: anthropomorphisation, humanoid banking service robots, human-robot interaction, dehumanisation

1. Introduction

The integration of autonomous, intelligent robots into the current civilisational and economic system may result in a paradigm shift (*Ivanov 2017*), facilitating the emergence of a society where humans and robots coexist (*Amelia et al. 2022*). This trend is particularly evident in companies undergoing digital transformation. As we move from the Industry 4.0 framework toward the Industry 5.0 ecosystem, robots are playing an increasingly prominent role through disruptive innovation

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(*IFR 2024*). Artificial intelligence (AI) and AI-based robots are also revolutionising the financial system. Banking customers are already experiencing the integration of physically embodied robots (*IFR 2016; Song – Kim 2022; Prisznyák 2023*) as well as software robots into banking processes (*Jung et al. 2018; Diener – Špaček 2021; Jovanović et al. 2019; Abraham et al. 2019; Prisznyák 2022, 2023, 2024*). Virtual robots, such as Erica (Bank of America), Amy (HSBC), Aida (Skandinaviska Enskilda Banken), Eno (Capital Bank), Ally Assist (Ally Bank), Haro and Dori (Hang Seng Bank), Ceba (Commonwealth Bank of Australia), Sia (State Bank of India), Eva (HDFC) and iPal (ICICI Bank), are employed in various front-, middle-, and back-office processes within banks. These robots perform tasks at varying levels of autonomy, contributing to the reallocation of employee time toward higher value-added processes and enhancing efficiency (*Richert et al. 2018; Damiano – Dumouchel 2018; Jovanović et al. 2019*). At the same time, humanoid robots such as NAO (Mitsubishi UFJ Financial Group), Pepper (HSBC, Mizuho Bank, Rabobank, Capital Bank of Jordan, Emirates NBD, Leumi Group, DSK Bank), Lakshmi (Citi Union Bank), Pari (Nepal SBI Bank), Sberbasha (Sberbank), Promobot (Sberbank), Link 237 (Banco Bradesco, Brazil) and OPBA (Nam A Bank) have been deployed in bank branches worldwide (*Prisznyák 2023*). As part of their robot integration strategies, major banking institutions – such as China Construction Bank and Bank of America – are rationalising their branch networks, placing greater emphasis on the development of robotic branches operated by intelligent robots without human tellers (*McLannahan 2017; Roxburgh 2018*).

The design of robots is becoming increasingly sophisticated, determined primarily by their appearance, functionality (*Baraka et al. 2020*) and social interaction capabilities (*Galanxhi – Nah 2007; Cornelius – Leidner 2021*). Human-centred robotics (social robotics) aims to develop artificial agents that possess human-like traits and capabilities (*Sarrica et al. 2019*). Due to the phenomenon of "robot labelling"[1] the term "robot" can refer to agents of different natures (physical and virtual) (*Prisznyák 2025*). Despite these varying forms, such agents are capable of displaying human-like physical and behavioural features – such as body structure, movement, facial expressions, gender traits and communication patterns – which significantly influence user perception and interaction (*Mara – Appel 2015; Złotowski et al. 2015b; Abel et al. 2024*). The social integration – and public perception – of these robots is significantly supported by their ability to respond to social stimuli originating from human counterparts (*Chang – Kim 2022; Wiese et al. 2017; Wykowska et al. 2016; Arora et al. 2024; Castro-González et al. 2016*). In other words, the social skills demonstrated by robots may make it possible for them

[1] The phenomenon of robot labeling encompasses various interpretations of the term "robot", including robotic process automation (RPA), artificial intelligence, machine learning (ML), deep learning, robotic assistants, intelligent chatbots, and physical robots (*Prisznyák 2025*). Thus, the term "robot" refers to both physical and digital forms, despite their fundamental differences in the technologies applied, their modes of operation, and their potential uses.

to be perceived as (social) living beings (*Breazeal 2003; Fong et al. 2003; Richert et al. 2018; Damiano – Dumouchel 2018; Gambino et al. 2020*).

Anthropomorphism is a cognitive response in which people attribute human-like characteristics to inanimate objects and living beings (*Duffy 2003; Złotowski et al. 2015a; Urquiza-Haas – Kotrschal 2015; Fischer 2021*). The impressions formed when perceiving robots with anthropomorphic features (*Mori 1970; Fink 2012; Burleigh et al. 2013; Dacey 2017; Appel et al. 2020*) can contribute to their acceptance by humans as social agents – that is, as socially active entities similar to humans (*Wiese et al. 2017*). However, anthropomorphisation does not automatically guarantee the successful outcome of human-robot interaction (HRI) (*Fox – Gambino 2021*). When designing robots, it is advisable to consider findings from psychological research on anthropomorphism. Incorporating these insights into the design of a robot's physical appearance helps foster trust, a sense of closeness, and acceptance toward robots – even among young children (*Heerink 2011; Breazeal et al. 2016; Blut et al. 2021; van Straten et al. 2023*). Nonetheless, striking the right balance between anthropomorphic and dehumanised[2] design elements remains a challenge.

Despite the increasing spread of intelligent robots, the literature focusing on the banking sector mainly addresses software robots (e.g. RPA, robotic assistants, robo-advisors), with only a few publications examining the appearance of embodied banking robots.[3] In their study of retail banking robot acceptance, *Amelia at al.* (*2022*) identified 16 dimensions (e.g. usefulness, social interactions, data privacy risks, prior experiences, among others) that influence users' acceptance of robots. *Prisznyák* (*2023*) examined the range of service robots used in bank branches, while *Prisznyák* (*2025*) addressed the operational risk management challenges related to the phenomenon of robot labelling. The current niche-focused essay aims to develop a theoretical foundation for the concept of an ideal banking service robot (Robo Sapiens Bankerius), based on a synthesis of the most important scientific theories on the anthropomorphisation of service robots (*Section 2*) and empirical findings based on primary research (*Sections 3–5*). The results of a questionnaire-based study conducted between 2023 and March 2025 (n=257) (*Section 4*) help identify the functional, appearance-related, social dimensions and moderators[4] that influence preferred robot characteristics, as well as the trade-offs between them (*Section 5*). Based on these findings, the study proposes a robot design aligned with the evolving ideal image (*Section 6*).

[2] Dehumanisation involves the minimisation of human-like or life-like characteristics.
[3] In this essay, we consider embodied banking robots as autonomous and adaptive machines that interact with, communicate with and provide services to clients of financial institutions.
[4] In this text, the term "moderator" refers to factors external to the robot that influence the perception of the robot's anthropomorphism. Such moderating factors may include the user's relationship to technology, cultural background, the social nature of the situation or the context of the interaction.

The following hypotheses are tested in this study:

- H1: Anthropomorphisation increases robot acceptance: the more human-like a robot is, the more favourable the impression it creates and the higher its acceptance level.
- H2: The preferred banking service robot has a human-like, playful appearance.
- H3: Age, gender and prior concerns or attitudes toward robots influence the preferred robot appearance.
- H4: Enhancing certain robot features does not necessarily increase acceptance or selection preference.

2. Anthropomorphisation of banking service robots

It is natural for humans to strive for order and understanding of natural phenomena, particularly in order to avoid unknown or inexplicable situations (*Gültekin 2022*). In doing so, people tend to attribute intentional attitudes to both living beings (humans, animals) and inanimate objects (*Duffy 2003; Złotowski et al. 2015; Gültekin 2022*). Humans are inclined to interpret the behaviour of other beings or systems as being driven by intentions – a tendency referred to by *Dennett* (*1971*) as the intentional stance, a cognitive strategy that operates even when the observed entity lacks actual consciousness. This is an inductive approach in which people assign human-like psychological states – such as desires, intentions and beliefs – as well as human traits to unfamiliar or inanimate objects, animals or other entities. These serve as reference points for interpreting the phenomenon or object (*Duffy 2003; Złotowski et al. 2015a, b; Spatola et al. 2022, 2023; Gültekin 2022*). Anthropomorphism functions as a fast, automatic cognitive mechanism (a heuristic) that can distort perception by responding to living and non-living things through human-pattern recognition (*Caporael – Heyes 1997; Dacey 2017; Fischer 2021*). As a result, objects that trigger anthropomorphisation – such as robots – can evoke either positive or negative human emotions (e.g. sympathy, empathy or aversion) (*Arora et al. 2024; Spatola et al. 2022*). Thus, anthropomorphism contributes to the formation of relationships between natural and artificial agents (*Breazeal et al. 2016*), or conversely, to the lack of social bonding (*Haslam 2022*).

Depending on the nature of the task, artificial humanoid agents may require physical embodiment. Their shapes and functions are often inspired by various living beings in order to increase their functional utility, positive perception and ultimately their acceptance (*Epley et al. 2007; Robertson 2017*). In interpretive

anthropomorphism, emotions and intentions are attributed to non-human agents (*Fisher 1991*). For example, a robot assistant located in a bank's customer zone that avoids the area where clients are already being served and conversing with human staff may give the impression that it is deliberately focusing only on waiting customers. By contrast, imaginary anthropomorphism involves endowing an imagined character with human-like behavioural and cognitive patterns (*Urquiza-Haas – Kotrschal 2015*). The range of human characteristics attributed to social robots is extremely broad (*Fox – Gambino 2021; Arora et al. 2024*). For instance, in the case of a humanoid robot capable of facial expressions, customers may be prone to assign human emotions and traits to the robot based on its facial expressions and apply behavioural expectations accordingly (*Wykowska et al. 2016; Spatola et al. 2023*). These attributed characteristics may include the perception of intention in the robot's actions, leading people to interpret its voice, emotional expressions and written communication as indicators of its supposed "mental" states. However, this can lead to misunderstandings regarding the robot's behaviour, thinking and emotional capacity (*Dacey 2017*).

Culture has a fundamental impact on anthropomorphism (*Epley et al. 2007; Spatola et al. 2022*). Individual cognitive processes are shaped by norms acquired from one's environment, upbringing and experiences, which influence both social behaviour towards anthropomorphised objects and the way those objects are perceived (*Epley et al. 2007*). The perception of anthropomorphic robots varies due to individual differences (*Spatola et al. 2023*), as the psychological effects of anthropomorphism differ depending on personality type (*Richert et al. 2018*). At the same time, this process also depends on the personal responses of observers (*Spatola et al. 2023*). Before we can map out the characteristics that trigger anthropomorphisation in the design of banking robots, we must first ask the question: *What is a robot?*

The term robot originally refers to a programmed machine or physical agent that can take various embodied forms, operates at a certain level of autonomy and is capable of sensing (through sensors or cameras) and manipulating its environment (*ISO 2021*). Beyond this technical definition of robots in robotics, it is difficult to precisely define what qualifies as a robot (*Robertson 2017*). The phenomenon of robot labelling (*Prisznyák 2025*) further complicates this classification. Nevertheless, an intelligent social robot[5] must be capable of communicating with any person it interacts with (*Richert et al. 2018*). The design of robots plays a key role in the successful creation and maintenance of human-robot interaction (*Fox – Gambino 2021; Arora et al. 2024*), as well as in their integration into everyday life (*Arora et al. 2024*). The integration of robots into social contexts is supported when

[5] Robots that reproduce human behaviour, follow cultural norms, participate in social interactions and perform useful tasks (*Sarrica et al. 2019; Asprino et al. 2022; ISO 2023*).

organisational robot-integration strategies take interdisciplinary robot design aspects into account (*Robertson 2017; Coeckelbergh 2022; Prisznyák 2023*).

The external design of humanoid robots is increasingly approximating the natural forms of the human body (*Sugiyama – Vincent 2013*). In bank branches, robots can display varying degrees of anthropomorphic appearance – such as humanoid, android, gynoid or geminoid[6] forms (*Phillips et al. 2018; Prisznyák 2023*) – and these can elicit different responses from individuals depending on their psychological state and social-cognitive mechanisms related to unfamiliar experiences (*Duffy 2003; Złotowski et al. 2015a; Gültekin 2022*).

3. Dimensions of perceiving robots as social agents

According to the Computers Are Social Actors (CASA) theory by Nass, Steuer and Siminoff, when robots are designed with characteristics resembling human appearance, users tend to attribute human traits to them and apply rules of human interaction in their communication with the robots (*Nass et al. 1994*; *Reeves – Nass 1996; Nass – Moon 2000; Song – Kim 2022; Chuah – Yu 2021*).

In their three-factor SEEK model (Sociality, Effectance, Elicited Agent Knowledge), *Epley et al.* (*2007*) explain anthropomorphism as being driven by the following: (1) social motivation – the desire for human connection; (2) effectance motivation – the need to understand and control one's environment; and (3) elicited agent knowledge – the extent to which people use their knowledge and experience to interpret and evaluate non-human entities. However, the extensive body of literature on anthropomorphism does not yet offer full consensus on which factors specifically lead to the attribution of human traits to robots (*Blut et al. 2021; De Graaf – Allouch 2013*). There is still a lack of systematic understanding of which elements – beyond physical appearance – contribute to the perception of robots as social beings (*Phillips et al. 2018; Cornelius – Leidner 2021*). To support the design of Robo Sapiens Bankerius, the following overview is structured around three major categories – functionality, social skills and physical appearance – and summarises key findings from the literature.

[6] Humanoid robots imitate natural intelligence through cognitive processes (decision-making, perception, reasoning, problem-solving ability) and establish relationships with humans through their anthropomorphic features (*Arora et al. 2024*). In order for a robot to be classified as humanoid, it must have a body structure similar to human body parts (e.g. head, arms, fingers, torso, legs, eyes, etc.) and exhibit behaviour similar to that of humans (*Robertson 2017; ISO 2021*). If it resembles a male in terms of gender, it is called an android, while if it exhibits female traits, it is referred to as a gynoid. Another category is the geminoid, which is a highly realistic humanoid robot that closely resembles a specific individual in appearance (*Robertson 2017*).

3.1. Functionality

In terms of functionality, the design of human-robot interactions and the programming of social values are key elements of robot design (*Deng et al. 2019*). In the course of interacting with intelligent robots, users expect robots to behave similarly to humans and to deliver products or services of comparable quality. According to *Kim – Lee* (*2014*), consumer satisfaction is influenced by the robot's physical attributes (appearance, design), responsiveness (movement, expressions) and system quality (stable performance). Based on a survey of 237 drivers in Hong Kong, *Lee et al.* (*2018*) concluded that ease of use, trust and the quality of the output product/service significantly increase users' willingness to adopt robots through perceived usefulness. Robot functions – such as providing information, advice and guidance – play a crucial role in shaping users' perceptions and emotional responses (*Cornelius – Leidner 2021*).

According to an experiment with 254 participants by *Sah and Peng* (*2015*), anthropomorphic appearance decreases the sharing of personal data, while anthropomorphic language increases it, as the latter suggests a more intimate relationship. Supporting this, based on 175 questionnaire responses, *Araujo* (*2018*) found that chatbots possessing human-like characteristics have a stronger influence on consumer attitudes, satisfaction and emotional attachment. However, the more users anthropomorphise the robot, the more negatively they respond to its errors (*Choi et al. 2021*). Errors occurring during human-robot interactions, such as navigation problems, violations of social norms or performance failures, significantly impact users' perceptions of robots. These errors can lead to distrust and rejection (*Tian – Oviatt 2021*; *Cameron et al. 2021*). For example, in 2021, Japanese SoftBank Robotics announced the discontinuation of Pepper's production (*Nussey 2021*). Recent research suggests that the relationship between a robot's reliability and functionality also depends on the relationship between the user and the organisation deploying the robot (*Cameron et al. 2023*). In the case of errors, robots capable of autonomously correcting problems receive more favourable reception than those that only apologise (*Cameron et al. 2021*).

3.2. Social skills

Robots can achieve social presence through behaviour programmed to comply with social norms, creating for the user a sense of being in the presence of others (*Biocca et al. 2003; Heerink et al. 2008; Damiano – Dumouchel 2018*). When a robot demonstrates politeness in its operation, responds adequately to social cues and context, and respects diversity, it can elicit positive social reactions from people (*Araujo 2018; Asprino et al. 2022*). Robots exhibiting intelligence characteristics of humans during communication interactions are often perceived as social actors

(*Kahn et al. 2006*). The usefulness, social abilities and human-like appearance of robots positively influence consumer attitudes and acceptance, increasing the likelihood of successful interactions (*Song – Kim 2022; Beer et al. 2014*). Social skills are crucial for the social integration of robots (*Sugiyama – Vincent 2013*). In an experiment involving 326 participants, *Cameron et al.* (*2021*) found that a robot's ability to apologise in the event of operational errors increases sympathy and the intention to use the robot. Social robots must be capable of understanding and to some degree reproducing human emotions such as happiness, anger and satisfaction (*Murphy et al. 2019*). Analysing the interactions of 48 participants with the AIBO robot, *Lee et al.* (*2006*) concluded that perceiving the robot as a social actor facilitated the formation of a relationship. Service robots use sensors and cameras to monitor human emotions and can respond to them if equipped with the necessary features (e.g. facial expressions, skin, eyes) (*Murphy et al. 2019*). However, the ability to perceive emotions can also evoke feelings of eeriness among users if the programmed emotional reproductions seem less human-like (*Appel et al. 2020; Sugiyama – Vincent 2013*). Social skills such as verbal and nonverbal communication, related responsiveness (speech, emotions, gestures) and the recognition of user intent also positively contribute to the acceptance of humanoid robots (*Tuomi et al. 2021*). Verbal communication can be effectively supported by nonverbal communication, such as expressing emotions like joy or anger, and movements like gestures, body language and facial expressions. Human characteristics such as confidence, warmth, trust (*Cornelius – Leidner 2021*), and intentionality (*Wiese et al. 2017*) play a significant role in the user's psychological state, during which users may perceive the robot as a natural actor in the communication process (*Lee 2004*). Based on online questionnaire responses from 161 participants, *Ruijten et al.* (*2019*) found that the perception of robots' human traits is related to either human or uniquely human characteristics. In other words, users tend to perceive humanoid robots with social skills as similar to kind, polite, helpful, attractive and humorous human beings. Consequently, they often attribute human emotions to them because, based on their perceived traits and programmed reactions, they feel that the robots care about them (*Song – Kim 2022*).

3.3. Physical appearance

The shape and appearance of robots are key factors in their design, as they significantly influence user acceptance (*Deng et al. 2019*). Physical characteristics such as body shape, materials, colour, weight and movement (facial expressions, locomotion) all play a role (*Breazeal 2003; Beer et al. 2014; Kim – Lee 2014*). *Breazeal's* (*2003*) experiment with the KISMET robot highlighted that if the robot demonstrates social skills, these play a key role not only in interactions but also in task performance, self-maintenance and learning. *Powers – Kiesler* (*2006*) found

that people are more likely to seek advice from humanoid robots. These robots are often considered more suitable for performing tasks and providing higher levels of service than more simple artificial companions (*Lu et al. 2021*). This is based on the fact that as the level of anthropomorphism increases, so does trust in the robot's competence (*Cameron et al. 2023*). This is related to the tendency of people to attribute higher intelligence to more lifelike humanoid robots with complex body structures (*Bartneck et al. 2009b; Stein – Ohler 2017*). In other words, as human-likeness increases, consumer expectations regarding the robot's capabilities also rise, but failure to meet these expectations can disrupt human-robot interaction (*Phillips et al. 2011*). Robots that exhibit human features – such as humanoid forms with heads, arms, legs, and eyes – can facilitate positive interactions and increase acceptance (*Breazeal 2003; Beer et al. 2014*). This is supported by the experiment of *Broadbent et al.* (*2013*) with 30 participants, which found that users preferred the Peoplebot healthcare robot featuring a human face over one without a face. Analysing 391 Instagram posts, *Chuah – Yu* (*2021*) showed that robots' emotional expressions (e.g. joy, surprise) positively influence how they are perceived. This confirms the assertion of *Lu et al.* (*2021*) that a robot's facial expressions – i.e. the imitation of human facial movements like happiness or surprise – significantly affect its perception. In a preliminary study involving 126 participants, *Brengman et al.* (*2021*) found that dynamically moving humanoid service robots generally elicit more interactions than stationary kiosks. Thus, the dynamic locomotion ability of humanoid robots contributes to their acceptance (*Piwek et al. 2014*).

It is a common assumption that overly human-like robots are better suited for tasks and can provide a higher level of service than more simple artificial counterparts (*Lu et al. 2021*). However, excessively anthropomorphic robot forms often cause discomfort, anxiety or concern among users (*Mori 1970; Fink 2012; Burleigh et al. 2013; Stein – Ohler 2017; Castro-González et al. 2016; Ferrari et al. 2016*). For example, in a questionnaire study with 92 participants, *Stein – Ohler* (*2017*) found that autonomous humanoid avatars were perceived as being less strange. *Ferrari et al.* (*2016*) conducted research with 51 participants, assessing images of robots to understand psychological barriers to their social introduction. The results showed that androids with the most human-like appearance evoked the greatest concern regarding potential harm to people. However, many studies have shown the opposite. For instance, based on a 32-participant experiment, *Bartneck et al.* (*2009a*) concluded that highly realistic robots do not necessarily trigger negative reactions. At the same time, perceiving robots as social agents has other consequences. *Malle et al.* (*2016*) found that consumers expect moral decision-making from robots possessing human traits. Regarding external appearance, if a robot exhibits gender cues (voice, name, clothing), users tend to interpret it

according to gender stereotypes (*Eyssel – Hegel 2012*). This is supported by the study of *Rese and Witthohn* (*2025*) involving 300 participants, which showed that a chatbot's gender influences user reactions (male chatbots were less liked when service recovery failed).

3.4. User-related factors

Users' sociodemographic characteristics, such as age (*Heerink 2011; Breazeal et al. 2016; Kamide et al. 2013; Blut et al. 2021; van Straten et al. 2023*), gender (*Heerink 2011; Kamide et al. 2013*), level of education, personality and prior experiences (*Heerink 2011*), as well as users' individual predispositions (*Blut et al. 2021*), sense of social connectedness (*Haslam 2022*) and cultural embedding (*Epley et al. 2007*), along with robot-related attributes such as human-like appearance, social skills and functionality (among many other factors), all influence the perception of robots (*Mori 1970; Burleigh et al. 2013; Breazeal et al. 2016; Blut et al. 2021*). *De Graaf – Allouch* (*2013*) point out that intention to use and attitudes toward robots are influenced by various consumer-related factors, for example, how adaptable the user is to innovative technologies, and the role of age in shaping social and psychological experiences with robots.

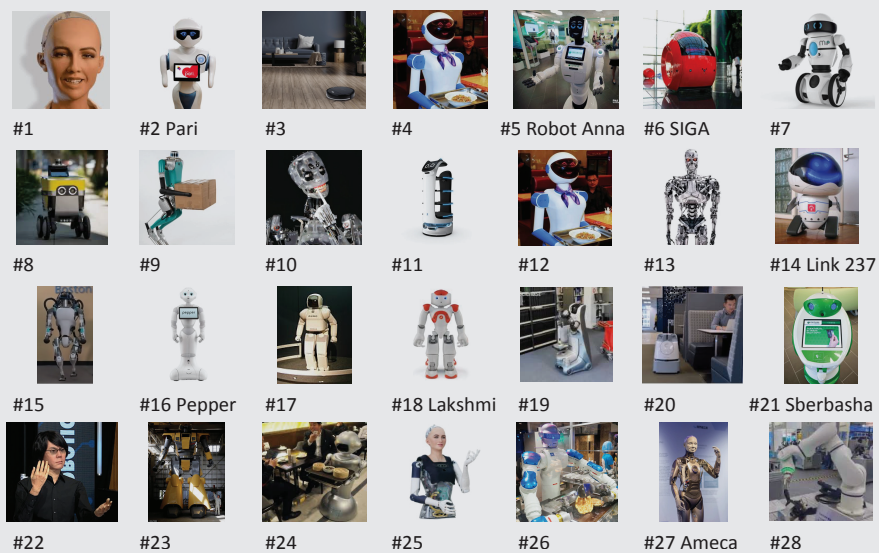
Prior negative experiences – whether imagined or real – and anxiety related to robots can negatively affect interaction and the development of trust (*Nomura et al. 2006*). People perceive anthropomorphic robot movements differently by gender: men are generally more sensitive to these movements, while women tend to attribute more human characteristics to robots' motions (*Abel et al. 2024*). Robot acceptance is assessed based on the ideal service concept, expectations regarding human frontline employees and self-service technologies. Robot functionality (usability, usefulness), the informative nature of human-robot interaction and relational factors (benevolence, satisfaction, understanding) all influence user decisions (*Stock – Merkle 2017*). Based on research with 116 participants, *Van Pinxteren et al.* (*2019*) found that comfort during service provision positively affects perceptions of human-robot interaction: at low comfort levels, robot social characteristics increase trust, while at high comfort levels, humanlike appearance enhances trust and acceptance.

4. Research design

4.1. Research method and data collection

In order to design the ideal banking service robot (Robo Sapiens Bankerius), I conducted a questionnaire survey[7] (via Google Forms) between 2023 and March 2025, completed by 257 respondents (see *Annex 1*). This study analyses the following topics from the questionnaire: perception of the robot (in terms of the dimensions of impression and human-likeness), choice among banking service robots and the reasons behind those choices. Respondents evaluated images of 26 robots based on 70 questions (two images were intentionally repeated[8], so a total of 28 robot images were assessed in two dimensions). Among the robots examined, seven are used worldwide in bank branches: SIGA (#6), Pepper (#16), Lakshmi (#18), Sberbasha (#21), Link 237 (#14), Pari (#2) and Robot Anna (#5) (*Figure 1*). In the course of the full examination, I analysed a total of 26 robots; however, the present analysis focuses exclusively on those used in bank branch environments. Since no highly human-like (humanoid) robot is currently in operation in such settings, I included the Ameca robot in the examination as a potential provider of banking services, in order to illustrate the spectrum and possible future applications.

Figure 1
Robots evaluated during the questionnaire (named in the empirical section)



Note: In addition to numbering, we have indicated the names of those used in the empirical section.

[7] Questions are summarised in *Annex 1*.
[8] The same image appeared for one of the robots, so the evaluation was influenced by the change in context (the robots before and after it). In the other case, one image showed only the human-like head, while the other also included the robot-like upper body.

Based on demographic data, the gender distribution of the respondents was nearly balanced (52 per cent female, 48 per cent male). Participants' ages ranged from 14 to 70 years, with an average age of 35 years and a standard deviation of 11 years (age group distribution is illustrated in *Annex 2*). All respondents had seen a robot in operation (via images or videos), while 69 per cent had personally encountered working robots. 49 per cent of respondents expressed concerns related to robots, while 44 per cent had positive impressions, 43 per cent had neutral impressions, and 13 per cent had negative impressions about robots.

4.2. Perceived human-likeness and impression of banking robots

The perception of the robots was examined in terms of human-like appearance and impression on a scale from 0 to 10, where 0 indicates a complete absence and 10 the maximum similarity or impression. Descriptive statistical information on the scores received by each robot can be found in *Annexes 3* and *4*. As highlighted above, this subsection presents the values of the banking robots used in the examination.

Based on the evaluation of the robots' human-like appearance, Pepper (#16) (M = 3.18) and Lakshmi (#18) (M = 3.04) received relatively favourable feedback, suggesting that their human-like appearance made a moderate impression. Robot Anna (#5) (M = 3.33), although possessing a more humanoid body, also scored moderately, indicating it did not stand out among the other robots. Link 237 (#14) (M = 1.57), Pari (#2) (M = 1.81), Sberbasha (#21) (M = 0.74), and SIGA (#6) (M = 0.28) received lower scores, indicating weak human-like appearance.

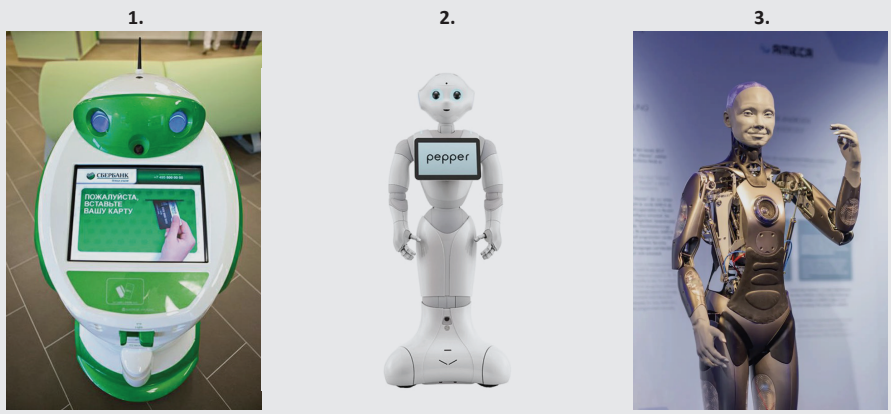
Regarding the perception of the robots' overall impression, Pari (#2) (M = 6.14) made an outstandingly good impression (receiving the highest score). It was followed by Link 237 (#14) (M = 5.82) and Lakshmi (#18) (M = 5.58), Robot Anna (#5) (M = 5.55) and Pepper (#16) (M = 5.23), all of which also received favourable feedback, indicating that their design elicited an above-average positive impression. Sberbasha (#21) (M = 5.75) and SIGA (#6) (M = 5.70) received lower, but still moderate, impression scores.

The data show no strong correlation between human-like appearance and impression scores, as for example, Link 237 (#14) received a low human-likeness score but a high impression score. Similarly, Lakshmi (#18) and Pari (#2) received high impression scores, despite not being notably human-like. This supports the view that impression perception depends on factors beyond human-like appearance. The above findings contradict hypothesis H1.

4.3. Preferred level of anthropomorphism: choice among banking robots

In selecting the preferred banking service robot, the aim was to determine whether respondents would rather interact with less anthropomorphic or more anthropomorphic robot clerks. Respondents chose their preferred future banking robot from three humanoid robots with different levels of human-likeness (from left to right in *Figure 2*: #21; #16; #27) and also provided open-ended explanations for their choices.

Figure 2
Ranking of preferred banking humanoid service robots based on choice results



The results of the choice among the three robots can be evaluated as follows: The green robot resembling a kiosk (#21) was the clear leader, being the most frequently chosen (n = 125). The Pepper robot (#16) was the second most popular choice (n = 94). Despite having the highest average human-likeness score (5.96), the Ameca robot (#27) was the least chosen service robot (with 55 selections). At the same time, 40 respondents did not want to interact with a robot at all. The results are detailed in *Annex 5*. This indicates that users prefer less humanoid forms. Based on these findings, hypothesis H2 is rejected.

5. Trade-offs between functionality, social abilities, appearance dimensions and moderators

To examine the relationships between moderator factors in the survey, namely: gender, age groups, attitude and concerns, and the choice of robot clerk, I conducted a Chi-square test in the Google Colab environment (Python 3; CPU). The p-values

for each test exceeded the 0.05 threshold (gender: 0.2707; age group: 0.2532; attitude: 0.0826; concerns: 0.5893). These results suggest there is no statistically significant association between the selected robot clerk and the examined variables. Therefore, hypothesis H3 is rejected.

The interpretive framework was established based on the analysis of open-ended responses supporting the selection of preferred banking service robot that includes three main perception dimensions (social skills, functionality, appearance) and three groups of moderators (robot-specific, user-related, environmental factors) (*Table 1*).

Table 1
Functionality, social skills, appearance dimensions and moderators

Dimensions of Robot Capabilities		
A. Social skills	**B. Functionality**	**C. Appearance**
A1. Level of communication A2. Likeability, persuasion, trust A3. Suggestion of robot existence/presence (living being, social agent) A4. Designed personality of the robot, friendliness	B1. Speed of service delivery B2. Natural language processing capability B3. Quality of task performance, reliability B4. Complexity of task performance B5. Level of autonomy B6. Robot intelligence (knowledge, learning, reasoning abilities and level) B7. Secondary, complementary robot functions B8. Ease of robot usability	C1. Human-like appearance – complexity of robot design C2. Friendly design C3. Robot components supporting communication (microphone, touchscreen, others) C4. Human-like facial expressions and expressiveness (facial expressions, others) C5. Human-like movement type and style C6. Robot gender
Moderators		
D. Robot moderators		
D1: Robot model: (a) new; (b) on the market for some time		
E. Customer moderators		
E1. Degree of control exercised by the user during the process E2. User perception of data security and protection E3. Openness to robot use (attitude, trust) E4: Religious beliefs E5: Application under compulsory circumstances (dependency, no other option) E6: Need for control and security E7: Personal disposition: trust in technology E8: Human information processing capacity and response speed E9: Experience with usage (manageability) E10: Previous experience with human agents		
F. Environmental (banking process) moderators		
F1. Complexity of the banking transaction the user must handle F2. Required skills for handling the banking transaction F3. Level of bank digitalisation: technologies used and robot replacement F4: Substitutability of the transaction service F5: Similar application and handling methods of technologies on the market		

Based on the robot capability dimensions and the identified relationships between them, the following trade-offs and conclusions are detailed below.

Perceived trade-offs and conclusions related to the social dimension:

- A1 – B1: Robots with intensive communication capabilities were often judged by respondents as socially advantageous, but several noted that these interactions could slow down the service process. This indicates that a high level of conversational ability may also pose a functional disadvantage if it results in decreased efficiency.
- A2 – C1: Surprisingly, responses showed that robots with less human-like appearances often elicited greater sympathy and trust. Overly anthropomorphic designs caused some users to feel discomfort, artificiality or even distrust, whereas simpler appearances allowed for clearer functional interpretation.
- A3 – C4: The use of human facial expressions and mimicry (eye contact, smiling) evoked ambivalent reactions: some participants saw these as strong signals of social presence, while others experienced fear, confusion or aversion.
- A4 – B3, B1: The friendliness of the robot's personality (open, helpful style) was viewed as an advantage by some respondents, while others stated that reliability and speed of service were more important to them. This suggests that social traits do not always add value.
- A4 – C4: Human-like facial movements, especially mimicry (e.g. smiling), increased acceptance and levels of trust. Robots with friendly facial expressions were more frequently described with positive attributes (kind, helpful) and judged as socially more competent by respondents.

Moderator effects related to the social dimension:

- A2 – E3: Some respondents showed greater openness toward more playful, less human-like robots. Such designs tend to generate fewer expectations for imitating human behaviour, thereby reducing the likelihood of rejection due to artificiality.
- A3 – E3 / E6 / E4: Anthropomorphic robot features suggesting social presence (eye contact, mimicry, body language) evoked feelings of comfort and trust in some users, while triggering suspicion of manipulation or hidden intentions in others. Correspondingly, those who perceived the robot as excessively "alive" reported decreased feelings of control and safety. Some respondents rejected robots as social beings for religious reasons.
- A4 – E10 / E3: Respondents with previous positive experiences interacting with human agents tended to show more trust toward robots with human-

like personalities as well. This indicates that experiences in human interactions significantly shape attitudes toward robots.

Trade-offs related to the functionality dimension:

- B1 – C1: For respondents prioritising robot speed and reliability, appearance played an insignificant role. Functionality and reliability mattered more than design, indicating their expectations were result-oriented.
- B2 – C3: Users with insufficient (functionality different from expected) natural language processing experiences expressed a stronger preference for touchscreen solutions. This shows that robot communication and interaction capabilities directly impact user experience: if the robot cannot reliably interpret speech or text, users tend to prefer intuitive, touch-based interfaces.
- B3 – C1: Those who valued robot accuracy and reliability most also considered appearance unimportant. Functionality remained the primary concern: efficiency, reliability, and speed were sufficient for visual characteristics to recede into the background.
- B4 – C1: Regarding complex, human-like robot bodies, respondents seeking advanced task execution capabilities tended to prefer more anthropomorphic robots. They felt physical appearance and sophisticated design were directly linked to the complexity of tasks the robot could perform. For them, more human-like robots signalled a higher level of task execution capability.
- B5 – C1: Human-like, complex robots may evoke a higher sense of autonomy among some respondents, as the robot appeared capable of making independent decisions, which increased trust and commitment toward the tasks performed by the robot.
- B6 – C1: According to some respondents, human-like robots suggested higher intelligence and better communication skills, which manifested in successful task execution and an increased perception of technological sophistication.
- B7 – B4: Some respondents felt that the lack of supplementary features (tablet, speaker, NLP) resulted in lower task complexity. Simpler robots offer less flexibility, which can be a disadvantage for more complex tasks.
- B8 – C1: Respondents often chose robots that were simpler and resembled already known, widespread technologies. This tendency reflects users' familiarity and attachment to familiar technological solutions, closely linked to easier usability and a shorter learning curve.

Moderator effects related to the functionality dimension:

- B3 – E10: Positive experience with a human agent may increase trust in robots, especially if robots perform tasks reliably, similarly to human agents.
- B4 – F2: According to respondents, those who are initially hesitant toward robots may still choose robot assistants for complex tasks, as task complexity can override initial rejection.
- B7 – E8: Robots equipped with displays were found useful by respondents who were given time to think, evaluate information and formulate responses. The visual support provided by such robots helped users in decision-making and task processing, reducing stress and allowing time for considered responses, which respondents believed would increase their trust and satisfaction toward the robot.
- B8 – F5: Respondents showed greater openness to robots similar to less complex, familiar banking systems, as their simpler design reduced technological anxiety and facilitated use.

Trade-offs related to the appearance dimension:

- C1 – B3: With a more complex appearance, respondents were more likely to perceive a higher task-performing capability (complex robot design = higher-level task performance). Thus, users associated the robot's physical appearance with its functionality.
- A2 – C1: A more complex robot appearance led to higher assumptions of customer manipulation. Some respondents felt that advanced, human-like robots were capable of manipulation, while simpler, cleaner-designed robots inspired more trust and better matched their expectations.
- A3 – C4: Anthropomorphic robots imitating human appearance elicited mixed reactions among respondents. While some experienced more natural interactions and perceived them as social beings, others felt low trust and discomfort. Thus, anthropomorphic appearance had a positive effect for those more easily connecting to human-like robots, but also caused negative reactions among those rejecting robots' human traits.
- C2 – A3: A friendly appearance strongly increased trust and reduced feelings of concern or hidden intent. Respondents felt that robots with friendly and kind appearances were more trustworthy and less likely to cause worry (e.g. in case of malfunction) than those with intimidating or neutral looks.
- C3 – C1: For anthropomorphic robots, some respondents found loud communication disruptive in certain situations. These users often preferred kiosk-

like, tablet-equipped robots because they were impersonal, less distracting and allowed for private transactions without burdensome personal interaction.

- C4 – C1: The presence of a human face/mimicry elicited varied responses among respondents. For some, the robot's facial expressions (such as smiling) generated higher trust and empathy, while for others, it caused a distinct sense of unease.
- C5 – C1: Users often perceived robots with simpler designs as safer and were more willing to choose them.

Moderator effects related to the appearance dimension:

- C1 – E2: For robots with less complex appearances, the sense of security related to data privacy decreased. Respondents perceived that simpler-looking robots provided less adequate protection of personal data.
- C1 – F4: A simpler robot appearance suggested that the robot primarily performed routine tasks, which may have created a feeling of reliability and ease of use.
- C1 – E10: Those who had previous negative experiences with humans tended to associate human intentions with human-like robots, which could increase feelings of distrust and rejection towards the new technology.
- C1 – E6: Some respondents had higher expectations for advanced robots with human-like features. If these robots malfunctioned (e.g. incorrect response/ reaction), it was interpreted not only as a technical problem, but also as a danger and a loss of control.
- C3 – E1: For robots equipped with touchscreens, respondents felt as if they had greater control over the process. When using such robots, they attributed more significance to their role in the transaction.
- C4 – E3: Robots capable of emotional expression (smiling, eye contact) increased emotional bonding and generated stronger emotional interactions between users and the robot. Respondents were more likely to respond positively to emotionally expressive robots because they appeared more human and friendly.
- C5 – E3: Robots with dynamic movement also increased the trust factor due to their human-like characteristics. The naturalness and smoothness of the movement contributed to respondents trusting the robot more, as dynamic movement was associated with higher intelligence and autonomy.
- C6 – E3: Robots with female characteristics appeared more trustworthy and empathetic to some. This resulted from the interplay between social dimensions and sensitivity to gender traits, where users associated female traits with qualities such as kindness, trust, and empathy.

6. Instructions for designing Robo Sapiens Bankerius

In designing the Robo Sapiens Bankerius service robot for bank branch applications in the near future, the following aspects should be considered: In terms of functionality, the robot must perform tasks quickly to effectively support in-branch banking services. To enhance usability, it is desirable for the robot to include auxiliary tools that support reliability and a sense of control, such as a tablet and a simple, user-friendly interface. During the initial phase of market adoption, it is advisable to avoid an overly human-like form. The robot should be friendly and align with the bank's ethical and AI codes. Dynamic movement capabilities and a toylike form featuring limbs and a face, along with communication skills, can increase trust and the perception of the robot as a social agent. When designing the robot, it should be taken into account that the research findings may require further validation. Moreover, the impact on acceptance and its determining factors may evolve over time during technological adaptation.

7. Conclusion

The ideally designed Robo Sapiens Bankerius banking service robot is a dynamic (not static) model capable of adapting over time to user needs and preferences. When designing the ideal robot, social skills, functionality and appearance must be taken into account to ensure the best possible user experience. Based on the evaluation of 28 robot images by 257 respondents, it can be concluded that the data do not support the relationship that the more human-like a robot is, the more favourable the impression it creates (rejection of Hypothesis H1). The majority of respondents preferred less human-like humanoid robots (rejection of Hypothesis H2). Furthermore, age, gender, concerns and attitude characteristics showed no significant correlation with the choice between robot service agents (rejection of Hypothesis H3). Analysis of the reasons behind the choice among robot service agents highlighted the trade-offs between the robots' social abilities, functionality and appearance features, as well as client/robot/environmental moderators (acceptance of Hypothesis H4). Validation of these findings can be realised in future research.

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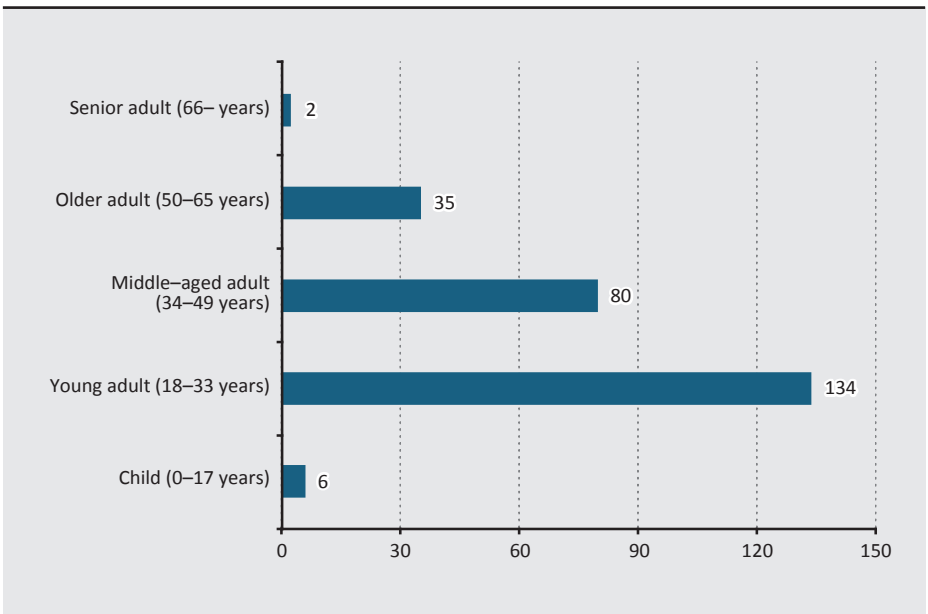
Annexes

Annex 1: Questionnaire questions

- How old are you?
- What is your gender?
- Have you seen robots in pictures or videos before?
- Have you ever seen a functioning robot in real life?
- Do you generally feel positive, negative or neutral when you think about robots? (Please explain your answer)
- Do you have any concerns or fears that robots might harm humanity?
- If you answered yes to the previous question, please specify what you are afraid of. What negative feelings or thoughts do you have?
- How much do you think the following robot resembles a human? (Scale from 1 to 10)
- What impression does the following robot give? (5 points: not disturbing at all; 0-4 points: negative impression; 6-10 points: positive impression)
- Is there a robot visible in the following picture? (The picture shows Hiroshi Ishiguro, the famous Japanese robot designer, and a geminoid.)
- Do you think the robot looks angry? (This question is repeated – showing a female (Robot #1) and a male (Robot #27) robot.)
- Do you think the robot looks surprised? (This question is repeated – showing a female (Robot #1) and a male (Robot #27) robot.) What emotion would you associate with the robot in the picture below?
- Is the robot's smile genuine?
- Do you think it is possible to manipulate human emotions through the robot's facial expressions and body language?
- Do you feel that you understood and perceived the reactions of the robots you just saw?

- Would you trust a robot in a bank customer area if it were this one? (Robot #27's picture is shown.)
- Would you rather trust this robot? (Robot #16's picture is shown.)
- Would you rather trust this robot than the two robots shown earlier? (Robot #21's picture is shown.)
- Please describe which of the three robots above you would rather interact with, and briefly explain why.
- Which ethical concerns among the following do you think designers absolutely need to consider?
- Do you think consumers should always be informed when interacting with a robot? Is notification necessary?

Annex 2: Age distribution of respondents



Annex 3: Evaluation of the human-likeness of the robots' appearance

Robot number	Min	Max	Standard deviation	Mean	Median
#1	0	10	2.33	6.52	7
#2	0	10	1.71	1.81	2
#3	0	5	0.53	0.13	0
#4	0	8	2.22	3.36	3
#5	0	8	2.22	3.33	3
#6	0	9	0.88	0.28	0
#7	0	7	1.87	2.20	2
#8	0	8	1.05	0.52	0
#9	0	8	2.25	2.76	2
#10	0	10	2.79	4.34	5
#11	0	10	1.28	0.74	0
#12	0	9	2.34	3.49	3
#13	0	10	2.94	4.77	5
#14	0	7	1.76	1.57	1
#15	0	9	2.41	3.13	3
#16	0	9	2.38	3.18	3
#17	0	10	2.47	4.29	4
#18	0	9	2.36	3.04	3
#19	0	9	1.29	0.74	0
#20	0	7	0.75	0.25	0
#21	0	6	1.22	0.74	0
#22	0	10	1.97	8.79	10
#23	0	10	2.34	2.46	2
#24	0	8	1.97	2.13	2
#25	0	10	2.54	6.67	7
#26	0	9	2.40	3.38	3
#27	0	10	2.65	5.96	7
#28	0	10	1.22	0.50	0

Annex 4: Impression scores of the robots

Robot number	Min	Max	Standard deviation	Mean	Median
#1	0	10	2.28	4.89	5
#2	0	10	2.38	6.14	6
#3	0	10	2.55	7.38	8
#4	0	10	2.36	5.48	5
#5	0	10	2.45	5.55	5
#6	0	10	2.56	5.70	5
#7	0	10	2.40	5.88	6
#8	0	10	2.64	6.21	6
#9	0	10	2.49	4.71	5
#10	0	10	2.29	2.30	2
#11	0	10	2.64	5.84	5
#12	0	10	2.39	5.48	5
#13	0	10	2.33	1.96	1
#14	0	10	2.60	5.82	6
#15	0	10	2.35	3.99	4
#16	0	10	2.54	5.23	5
#17	0	10	2.23	5.31	5
#18	0	10	2.41	5.58	5
#19	0	10	2.50	5.37	5
#20	0	10	2.57	5.71	5
#21	0	10	2.48	5.75	5
#22	0	10	2.94	4.48	5
#23	0	10	2.79	4.12	4
#24	0	10	2.44	5.52	5
#25	0	10	2.68	4.23	4
#26	0	10	2.36	4.39	5
#27	0	10	2.59	4.16	4
#28	0	10	2.65	6.10	5

Annex 5: Distribution of bank service robot selections

Selected banking robot	Number of Occurrences
Ameca	30
Pepper	60
Kiosk	92
None of them	40
All three	22
Ameca, Pepper	2
Pepper, kiosk	10
Ameca, kiosk	1
Total	257

What's Behind the Bank Account? – Questions about Distinguishing Account Types

Milán Kiss

The essay presents a classification of the types of accounts maintained by financial entities and their different legal definitions. The colloquial term "bank account" can in fact encompass a variety of account types, including payment, deposit, client or electronic money accounts, each of which is subject to distinct regulatory rationales and operating principles. The classification of accounts also determines the prudential measures applicable, the necessary authorisations, the requirements for IT systems and the responsibilities of service providers. The essay delineates the evolution of EU financial regulation, emphasising the significance of the Lamfalussy framework and the role of EU regulations in the development of the prevailing financial institutional system. Accurate accruals are of particular importance for financial sector actors. The type of account has a fundamental impact on the feasibility of the business model and regulatory compliance.

Journal of Economic Literature (JEL) codes: D45, G20, G28

Keywords: bank account, payment account, financial institutions, regulation

1. Introduction

Both for traditional financial players, such as credit institutions or financial enterprises, and for newer players emerging in the financial markets, e.g. FinTech companies, the provision of financial services is done through a register called an account. At the same time, it is not clear to most economists or lawyers that the accounts held by financial entities are not subject to a uniform legal regime and are therefore subject to different prudential requirements. It is generally clear to most experts and ordinary people that there is a difference between *an invoice*, a *general ledger account* and *a bank account.* However, it may not be clear to many

* 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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people that just because an account holds some kind of funds and is managed by a financial entity does not necessarily make it a bank account.

This means that, in the day-to-day practice of financial product development, legal opinions, or economic or financial analysis, even experts can be confused and draw wrong conclusions about accounts and their management. These misconceptions can have far-reaching consequences, as the legal classification of an account can affect the relevant licences (e.g. within the framework of which licensable activity can an account be managed), the IT system used to maintain the account, the "functionality" of the product (e.g. whether it should take five seconds to execute a payment order on the account or days), and the financial consequences (e.g. whether a financial entity can manage the account balance as its own or not). For example, in the case of a FinTech start-up, it is of particular importance whether the service the company intends to provide is a licensable activity and, if so, exactly what kind of authorisation it needs to obtain to start providing the service. Another critical issue for an incumbent service provider is the qualification of the account for the service, although typically not in relation to the licensing of the activity, but rather in relation to service or product development. For both FinTech and incumbent actors, regulatory compliance is of paramount importance, not only to avoid regulatory action, but also to strengthen trust in the financial system (*Müller – Kerényi 2019*).

This essay is intended to help colleagues in the financial sector navigate the services provided by each institution and the types of accounts they offer. Given that the types of accounts are related to the services provided by financial entities and that Hungarian law recognises around 30 different types of financial entities, i.e. institutions, it is important to examine the relationship between services and institutions. However, this relationship is difficult to understand without a historical context, as the developmental path of the institutional system and the related services cannot be seen. Due to limitations of this essay, it impossible to describe all the types of accounts and their characteristics known under current legislation, and accordingly this essay is limited to the most common accounts in practice, i.e. those most commonly encountered in daily banking, which are mainly of a payment services nature. Also, for the same reasons, it is not the aim of this essay to cover all institutions and services, but only to mention those which are essential for an understanding of the subject. The methodology used for this essay is based on an examination of relevant legal documents and literature.

The regulation of financial services is constantly evolving and becoming more complex, but the direction of development is not self-evident (*Müller – Kerényi 2021*). As a result, new solutions have emerged in the last decade alongside pre-existing systems for recording financial assets and liabilities, such as Distributed

Ledger Technology (DLT), which typically allows for the recording of cryptoassets and can be considered as a specific "bookkeeping". In other words, in practice, a centralised and a distributed model for financial liabilities and receivables has emerged. However, an analysis of these latter solutions is not the subject of this essay.[1] An elaboration of such could be the subject of a separate essay or paper.

2. Evolution of the structure of financial regulation

Considering that the current (prudential) regulation of financial entities originates primarily from the European Union (EU), it is essential to examine the development of EU law. Naturally, regulations other than EU law have also had an impact on Hungarian institutions, but to a lesser extent. The EU legislation relevant for this essay can basically be divided into two main periods: the period before the introduction of the euro, and the period after the introduction of the euro, including the economic crisis of 2008–2009 up to the present day. The pre-euro period is less relevant for the topic of this essay and will therefore not be discussed, however it should be noted that the Basel I Convention[2] (1988), which was not directly EU regulation but strongly influenced EU regulatory practice (*Barna et al. 2018*), had the biggest impact on the financial system.

The introduction of the single European currency and foreign exchange is a milestone that significantly changed financial regulation in the EU, including Hungary (*Győrffy 2013*). Following the introduction of the euro, the regulatory environment became much more centralised (*Pelle – Végh 2019*). As this essay does not aim to provide a comprehensive history of EU financial regulation, only those regulatory events that are relevant to the topic are presented.

The main driving forces behind the rules are the payment regulations to facilitate the practical use of the euro, and the Lamfalussy Report published in 2001 by the Council of Wise Men to initially support the stability of securities markets and thus the financial system, and the subsequent Lamfalussy procedure, which has affected the whole financial sector since December 2002. These legislative processes are significant because they include institutions providing financial services and financial services subject to authorisation or other acts of public authority.

[1] A good overview of the current crypto regulation can be found in *Halász* (*2024*).
[2] The Basel I Convention has become a cornerstone of EU regulation, harmonising the rules on capital requirements, thus contributing to the stability of the internal market. The Convention not only strengthened financial stability but also allowed for closer financial integration between Member States and provided a basis for even more complex regulation in the future.

2.1. The payment regulation

On 1 January 1999, the euro was born, also establishing a single monetary policy and the Trans-European Automated Real-time Gross settlement Express Transfer (TARGET) system for central clearing and settlement. On 1 January 2002, euro banknotes were introduced in cash circulation, but different payment systems were in operation in each Member State using the euro (*Kovács 2010*). These systems used different standards with different practical solutions, as national payment regulations differed, reflecting the different payment habits and financial awareness levels of each country. At the same time, payment service providers were not interested in solving the problems, given the significant costs that would have been involved in developing payment service providers' and payment system operators' IT systems, and the fact that payments were typically made within Member States (*Dávid 2008a*).

In response to these problems, the Single Euro Payments Area (SEPA) was born. The SEPA initiative consisted of several components, including the development of common technical standards and the harmonisation of payment methods. However, the original idea was that SEPA would not be introduced through regulation, but organically on a market basis (*Dávid 2008b*). Nevertheless, market "consolidation" did not take place. The reason given by the European legislator for the lack of consolidation was the absence of a uniform and technology-neutral payments regime. Therefore, following the previous regulation cross border euro payments that regulated the minimum fees,[3] the EU harmonised payment services in 2007 with the adoption of the Payment Services Directive (PSD).[4] Among other things, the Directive regulated the content of the framework contract between payment service providers and their customers, liability issues related to certain fraud practices and the detailed rules for the execution of payment transactions, and also reformed the scope of institutions eligible to provide payment services. Most importantly, the Directive defined a list of activities that are considered to be payment services. At the same time, the Directive regulating electronic money institutions[5] (the second Electronic Money Directive, EMD2) was also renewed. These institutions mainly provided services based on payment cards (so-called prepaid cards) that could be topped up (*Dávid et al. 2018*).

The further development of payment regulation is not relevant to the topic of this essay, but it is worth noting that the standard introduced as part of the SEPA initiative was eventually made mandatory by the EU. Thus, from 2014 onwards, all euro payments are to be made via SEPA payment methods under the so-called SEPA End Date Regulation (*MNB 2024*).

[3] Regulation (EC) No 2560/2001 of the European Parliament and of the Council
[4] Directive 2007/64/EC of the European Parliament and of the Council
[5] Directive 2009/110/EC of the European Parliament and of the Council

2.2. The EU financial regulatory system in the light of the Lamfalussy Report

The Council of Wise Men, chaired by Alexandre Lamfalussy, drew up a set of proposals that became the basis for the regulatory hierarchy and structure that currently exists in the EU. This is significant because the system that emerged from the Lamfalussy Report also provides a framework for interpretation. In the framework proposed by the Lamfalussy Report, the EU was to introduce a four-tier regulatory hierarchy. The first level consisted of harmonised or uniform European Parliament and Council directives and regulations resulting from the EU's ordinary legislative procedure. The second level consisted of the establishment of an EU-level Securities and Markets Committee, which would be responsible for developing detailed rules. The third level was for coordination between national supervisory authorities, while the fourth level was for more effective enforcement of EU law (*Lamfalussy et al. 2001*). In the wake of the global economic crisis of 2008–2009, the Lamfalussy framework was revised, resulting in the system we know today. This system has created the European Systemic Risk Board (ESRB), which has been given responsibilities for the design and implementation of macro-prudential policy, and the three European Supervisory Authorities: European Banking Authority (EBA), European Securities and Markets Authority (ESMA) and European Insurance and Occupational Pensions Authority (EIOPA). The European Supervisory Authorities are informally referred to collectively as the ESAs (*DG-FISMA 2019*). The role of the ESAs includes making recommendations to the European Commission on the exercise of its powers[6] and promoting the harmonisation of supervisory practices. Although the ESAs are referred to as authorities in their founding regulations, their actual supervisory function is limited, not including the ESAs' IT-related oversight tasks. By contrast, the European Central Bank (ECB), together with the national competent authorities of the Member States, performs supervisory functions for the largest European financial groups under the Single Supervisory Mechanism (SSM).

[6] Articles 290 and 291 of the Lisbon Treaty give the European Commission the power to adopt delegated and implementing acts under the ordinary legislative procedure. These legislative acts may be either Regulatory Technical Standards (RTS) or Implementing Technical Standards (ITS), depending on their content. The terms RTS and ITS refer *not to the legal form but to the content of the legislation.* For more details, see Articles 10 and 15 of the ESA Regulations (Regulations (EU) No 1093/2010, (EU) No 1094/2010, (EU) No 1095/2010) and the aforementioned articles of the Lisbon Treaty.

Figure 1
Levels of financial regulation

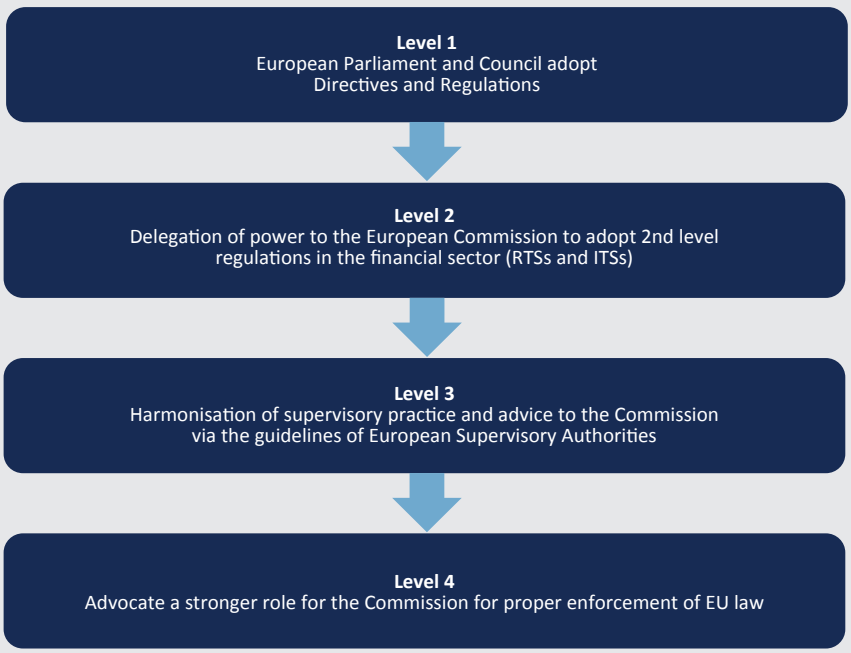

Figure 1 illustrates the levels of regulation, showing that a segment of financial markets has been assigned to a single European supervisory authority, which is responsible for facilitating coordination between national authorities. In other words, they are responsible for fostering regulatory convergence and preparing the Level 2 rules. As a consequence, the European regulatory system follows the traditional financial division: money market, capital market and insurance/pension fund market. It is also important to highlight that, in addition to EU regulation, national regulation has been retained in cases where the EU has not exercised its regulatory competence (*Seregdi 2019*).

It can therefore be said that financial regulation within the EU is multi-level, both at the EU and the Hungarian level. Regulatory measures can be well categorised into the three markets mentioned above, as a kind of framework. The catalyst for regulation has been primarily the introduction of the euro and related infrastructure development, and naturally financial crises and, more recently, digital innovations. Beyond this, national legislation can still be found in financial law (*Müller 2019*).

3. Financial service providers and the services they provide

After reviewing the evolution of regulation, it is worth looking at what service providers have been defined in the framework described above and what (financial) services they can provide.

3.1. Institutions providing financial services

EU financial law recognises so-called institutions. The term "institution" is used in this case as an abstract concept to define a service provider that can be authorised to carry out certain activities or that is obliged to carry out certain activities. EU legislation itself, as well as national law, i.e. Hungarian law, contains provisions governing these institutions. It follows that an expert who is examining, for example, capital requirements, liquidity requirements or rules on executing payment transactions, needs to be familiar with the specific requirements applicable to these service providers. The number of institutions covered by the legislation is constantly changing, but the Digital Operational Resilience Act – DORA[7] – lists some 21 different institutions, which naturally does not include providers as defined solely by Hungarian law. Hungarian law recognises roughly another five different institutions.

In the system that emerged from the Lamfalussy Report, institutions can be divided into three categories. The most important types of institutions include:

- money market institutions: credit institutions, payment institutions, electronic money institutions, cryptoasset providers, financial enterprises;
- capital market institutions: investment firms, central securities depositories, central counterparties, trading venues, stock exchanges;
- insurance and pension fund market: insurance companies, reinsurance companies, institutions for occupational retirement provision, voluntary mutual funds, private pension funds.

[7] Regulation (EU) 2022/2554 of the European Parliament and of the Council

Some institutions may be further subdivided into sub-types, e.g. a credit institution[8] may be a bank,[9] a specialised credit institution or a credit institution set up as a cooperative society (Article 8(3) of Credit Institutions and Financial Enterprises Act, CIFE[10]). Some legislation uses collective terms, e.g. Act on the Pursuit of the Business of Payment Services, PSA[11]. Payment service provider is an umbrella term under the PSD, which includes credit institutions, electronic money institutions, post office giro institution,[12] payment institutions, the Central Bank of Hungary (Magyar Nemzeti Bank, MNB) and the Treasury[13] (Article 2(22) of PSA). Another example of an umbrella term is financial institution, which is a collective term for financial enterprise and credit institutions (Article 7(1) of CIFE). Since the term "financial entity" is not used in current legislation, as opposed to the terms bank, financial institution, payment service provider, etc., it may be appropriate to include all institutions supervised by the MNB under this definition.

3.2. Services provided by the institutional system

The Treaty on the Functioning of the European Union established a common European passport relatively early on to allow the free movement of capital and services (*Lehofer 2024*). However, for the passport to work in practice, it was necessary for certain (financial) activities to be subject to authorisation and, where appropriate, notification. This meant that the scope of these activities or services themselves had to be defined. The regulation of these activities and services was further complicated by the fact that they had to be integrated into the private law of the Member States, in Hungary the Civil Code.[14]

[8] It has to be noted that the term 'money institution' is not recognised in the legislation and is now considered an obsolete concept, as the Act on Money Institutions and activities of Money Institutions was abolished by the 1996 Act on the Law on Credit Institutions and Financial Enterprises.
[9] It has to be pointed out that the Civil Code uses the term bank to mean a person or undertaking authorised to collect deposits and maintain a payment account, but this definition is not in line with EU or Hungarian financial legislation. The Civil Code may be justified in keeping the text compact and simple, but it might have been more appropriate to find a purely private law concept when codifying the new Civil Code. Nevertheless, in practice the use of the Civil Code's definition does not pose any particular problems.
[10] Act CCXXXVII of 2013
[11] Act LXXXV of 2009
[12] In Hungary, under the Postal Services Act it is Magyar Posta Zrt.
[13] The Hungarian State Treasury performs the functions of the treasury by law.
[14] Act V of 2013

Table 1
Examples of services that can be provided by each financial entity

Title	Money market institutions				Capital market institutions			Insurance and pension market institutions	
	Credit institution	Payment institution	Electronic money institution	Financial enterprise	Investment firm	Managers Investment fund	Central securities depository	Insurance undertaking	Reinsurance undertaking
Taking deposits	X						X		
Lending and opening credit lines	X	X	X	X			X		
Financial leasing	X			X					
Issuing electronic money	X		X						
Payment services	X	X	X				X		
Investment services such as portfolio management or investment advice	X				X		X		
Investment fund management						X			
Central securities depository services							X		
Insurance services								X	
Reinsurance services									X

Note: The table does not indicate if an institution is restricted in the provision of a service, e.g. a central securities depository may grant credit or disburse loans if the provision of banking-type services is directly linked to core or ancillary services.

Table 1 provides an overview of the logic of the system, but it is important to stress that it is only an example and that neither the list of institutions[15] nor the list of activities is exhaustive. Furthermore, certain activities have been merged for the sake of transparency (e.g. investment services activities are regulated in several points by Article 5(1)(2) of Act on Investment Firms and Commodity Dealers, and

[15] Of course, not all institutions can be clearly categorised as money, capital or insurance/pension markets, but for the sake of clarity, this not too significant inconsistency can be disregarded.

on the Regulations Governing their Activities, IRA).[16] Some activities/services have been made subject to authorisation or notification by EU or national law, in this case Hungarian law: either by the transposition of EU directives or by legislation adopted under national competence. Subsequently, these services have been mapped with certain institutions. Naturally, the table is only intended to point out the logic, because for each institution the legislation may define separately the actual conditions for the provision of a given service. Thus, for example, a payment institution may open a credit line for its customers, from which a money loan may be granted, but subject to restrictions on, inter alia, the purpose of the loan, its duration and the source of the loan (Article 6(1)(2) of Payment Service Providers Act, PSPA[17]) However, the same restrictions or additional conditions may apply to other institutions as well. For example, a central securities depository may only collect deposits in connection with its central securities depository services and, if it provides such services, it is subject to prudential requirements equivalent to those of credit institutions in relation to the activity (Central Securities Depository Regulation, CSDR[18] Articles 54–60). Certain activities are prohibited for certain service providers. An example is that a financial enterprise may not provide payment services and also may not collect deposits (Article 9(1) of CIFE). Within each service, the specific type of account to which the activity licenced can be interpreted. For example, in the context of payment services, payment accounts, deposit-taking and the acceptance of other repayable funds from the public are managed as deposit accounts, electronic money is issued and redeemed, and electronic money is managed as an electronic money account in relation to electronic transactions.

4. Accounts for certain services frequently encountered in practice

As shown above, the current financial system is extremely complex. On the one hand, this is because there are a large number of financial entities defined by regulation and because these entities can, within certain limits, provide a significant number of services. At the same time, it is inherent in finance that the ultimate object of transactions is money, i.e. a debt which must be recorded in some form. These records are called accounts. Although accounts are no longer kept on paper in books, but in IT systems in the age of digitalisation (*Kovács 2024*), this does not change the legal and financial/economic perception of accounts.

The study of money as an economic concept is not the subject of this essay, but *Szabó – Kollarik* (*2017*) and *Kolozsi et al.* (*2024*) can be used as a guide to this topic. It should be noted however, that according to current legislation, money is defined as banknotes, coins, scriptural money and electronic money (Article 2(19) of PSA).

[16] Act CXXXVIII of 2007
[17] Act CCXXXV of 2013
[18] Regulation (EU) No 909/2014

Since it is of critical importance for the legal operation of financial institutions to know exactly which activity is subject to licensing, and since financial institutions provide most of their services using accounts, it is very important to examine the regulation under which two very similar accounts fall. Therefore, in the next part of the essay, the most commonly used account types in practice are presented, highlighting their characteristics that can be used as criteria for differentiation. Of course, there are many other account types that institutions use, but due to space limitations, it is not possible to present them all. For this reason, as explained in the introduction, the accounts used in the management of daily financial affairs, typically related to cash flow, are presented.

4.1. Payment accounts

The most commonly used type of account in economics and in everyday language is the *bank account* (*Dávid – Kovács 2019*). The main feature of this account is that the "money on it" can be used by the account holder to meet daily expenses. Indeed, before the first Payment Services Directive, only credit institutions were allowed to maintain such accounts (here we also refer to the fact that a bank is a subtype of a credit institution), but the PSD introduced payment institutions, and the predecessor of EMD2 introduced electronic money institutions. The main purpose of the introduction of these institutions was to increase competition in the payments market, i.e. to ensure that payments services (simply put, any remittance service, such as credit transfers, direct debits or card payments) should not be provided exclusively by credit institutions. This led the legislator to create the concept of a *payment account*. According to the current legislation, a payment account is an account, including a bank account, held in the name of one or more payment services users for executing payment transactions (Article 2(8) of PSA). The legislator has added the phrase 'including a bank account' to the definition in order to ensure legal continuity, i.e. legislation, contracts, etc. which previously referred to a bank account should be considered as a payment account.

But why does it matter whether an account is a payment account or not? The answer is simple: if the account is a payment account, the entire payment regulation regime will apply. This includes, for example, the execution times set out in the MNB Decree on the execution of payment transactions,[19] including the rules on instant payments. These payment orders under 20 million forints must be executed within 5 seconds every calendar day of the year. This is an IT development and operational challenge that justifies an examination of the legal nature of the account. For example, the mandatory interfaces (in common phrase "PSD2 APIs[20]") required by the Second Payment Services Directive[21] (PSD2) for open banking do not need to be

[19] Decree No. 35/2017. (XII.14.) of the Governor of the Magyar Nemzeti Bank on Execution of Payment Transactions
[20] Application Programming Interfaces
[21] Directive (EU) 2015/2366

provided for accounts that are not payment accounts (Articles 38/A, 38/B and 38/C of PSA). Another important aspect of payment accounts is the associated contractual framework. If an account is a payment account, the PSA specifies the mandatory content of the framework contract and the way and deadline for amending the contract.[22] These provisions do not allow for any derogation for customers who are consumers and micro-enterprises, i.e. they are *jus cogens*. One of the biggest risks for payment service providers (i.e. credit institutions or payment institutions) in relation to payment accounts is fraud, as the payment regulation imposes a de facto objectified liability on payment service providers for payment transactions not authorised by the customer.[23] In other words, if the payment transaction is not authorised by the customer, the payment service provider is liable for the amount of the payment transaction unless it proves that the damage caused by the unauthorised payment transaction was caused by the payer either by fraudulent conduct or by a deliberate or grossly negligent breach of his contractual obligations (*Biró – Kiss 2024*).

It is worth pointing out that the term "current account" is still commonly used colloquially for payment accounts. However, the current Hungarian private law does not use the term current account as a synonym but rather defines its relationship with the payment account as a partial relationship. The new Civil Code continues to use the term current account, which is a general term, in the context of the recording of mutually offsettable claims. Thus, for example, a current account relationship may be a (current) account that is used for settlement between a utility supplier and its customer. The Civil Code defines a payment account as a sub-type of this account. However, the Civil Code is not very detailed, leaving the detailed regulation of the use of accounts to sectoral public law provisions (*Kovács 2018*).

In connection with payment accounts, it is also worth mentioning the so-called client account. A client account is a restricted account for keeping records of client funds, which is used exclusively for transactions related to investment services, ancillary investments services or commodity exchange services provided by the account manager [Article 5(1)(130) of Capital Market Act (CMA)[24]]. Since the purpose of a client account is to withdraw and deposit money, and not to settle daily payments (e.g. groceries or utility charges), but rather to settle the cash leg of securities transactions, as a general rule it cannot be considered as a payment account. Therefore, the payment regulations do not apply to these accounts.

[22] As the Curia pointed out in judgment Pfv.I.20.685/2024/5, both favourable and unfavourable amendments to a framework payment agreement unilaterally initiated by the payment service provider may be initiated at least two months before the amendment. While this restriction indeed provides a high degree of protection for consumers and micro-enterprises, it nevertheless significantly limits the ability of payment service providers to react to market changes.

[23] Among other things, the judgment of the Curia of Appeal (Pfv.20685/2024/5) interprets the rules on liability for payment transactions.

[24] Act CXX of 2001.

However, under the current legislation, a credit institution providing investment services may, on the basis of the client's explicit request, also settle the cash flows relating to the investment services provided by the client on the client's bank account (Article 148 of CMA). This rule shows that the concept of bank account has not changed since the codification of the Act in 2001, i.e. under the current regulatory regime it is understood as a payment account. Thus, a payment account may also qualify as a client account if the account holder is a credit institution that provides payment services and also provides investment services (rather than acting as an intermediary for the services of a separate payment service provider) and the customer has explicitly agreed to this.

4.2. Deposit accounts

In its legal and economic content, a deposit account is much closer to the common concept of a bank account, since the Civil Code provides that "under a deposit agreement, the depositor is entitled to pay the bank a certain sum of money, the bank is obliged to accept the sum of money offered by the depositor, to repay the same sum of money at a later date and to pay interest" (Article 6:390(1) of Civil Code). As *Gárdos* (*2016: p. 7*) explains, "in everyday language, phrases such as 'I deposit my money in the bank', 'I keep my money in a bank account', 'my money is in a deposit account' are common. Contrary to the perception reflected in this wording, the account holder does not actually have money in the bank. [...] the sums deposited by the account holder or by other persons for the account holder's benefit become the property of the bank or, if the deposit is not made in cash, as is customary, and therefore there is no question of ownership, they constitute the bank's assets. The depositor loses the ownership of his money when he 'deposits' it, i.e. when he pays the deposit to the bank; the depositor, or account holder in general, has no claim on the bank as a property right, but only as a claim on the amount credited to the account. The items credited to the account reflect the account holder's claim against the bank." The high risk inherent in the transfer of the title of the money is the reason why only a small number of types of institutions are allowed to carry out deposit-taking activities under the strictest prudential standards. Put simply, a deposit account becomes a deposit account if it holds a claim for the purpose of transferring title of the money so that the depositor can later get more money (increased by interest payment) back. This transfer of ownership also justifies existence of deposit insurance schemes. Since a non-credit institution payment service provider cannot treat the funds it receives as deposits, deposit insurance (e.g. the protection of the National Deposit Insurance Fund (Országos Betétbiztosítási Alap, OBA) in Hungary) is not meaningful for these service providers. A "bank run" in the traditional sense cannot happen, against which the protection of deposit insurance could be justified (*Kallóné Csaba – Katona 2018*). Thus, deposit accounts are also linked to the basis of the stock covered by the

OBA, which is the amount registered in the deposit accounts of credit institutions (Article 212 and 213 of CIFE).

Whether an account qualifies as a deposit account is of particular importance. Because if the answer to the question is yes, there are a number of strict rules that the institution collecting the deposit must comply with. For example, with some exceptions, it can only operate as a credit institution and is subject to strict capital and liquidity requirements (e.g. the rules of the CIFE or the CRR[25]). In addition, deposit-taking institutions are the MNB's monetary policy counterparties[26] and can therefore use the MNB's monetary policy instruments, but they must also comply with obligations (e.g. reserve requirements). This is also economically very important, as endogenous monetary theory is based on the ability of a financial institution to accept deposits, while of course simultaneously lending money (*Ábel et al. 2016*). In other words, a credit institution is the financial institution that is exclusively entitled to accept deposits and simultaneously lend money in the current legal environment, i.e. it is able to create *commercial banking money.*

But why do people call a payment account and a deposit account simply "bank accounts"? The most obvious answer is that for a long time only credit institutions provided payment services and collected deposits. In addition, credit institutions have used, and still use, a single account structure for payment transactions and deposit taking. This is possible because the credit institution is allowed to treat the positive balance of a payment account as a deposit (Article 6(1)(8) of the CIFE). Therefore, both the rules governing payment services and the rules governing deposits apply to accounts opened in this way. However, the fact that it is possible to transfer money to or withdraw money from a deposit account does not necessarily make it a payment account, since the purpose of using the account is not necessarily to conduct the day-to-day financial transactions of the account holder. When in doubt, it is always necessary to examine the purpose of the account and its use. Such investigations can even lead to litigation, as illustrated by Court of Justice of the European Union (CJEU) case C-191/17, in which the CJEU ruled on the difference between payment accounts and savings accounts. In the case, the CJEU examined whether an account that is used exclusively for savings purposes can also be a payment account, i.e. whether such accounts must also comply with payment legislation. In its judgment, the CJEU explained that, as a general rule, there is a difference between the two accounts and gave criteria for determining the differences.

[25] Capital Requirements Regulation (CRR) – Regulation (EU) No 575/2013
[26] See the terms and conditions of the MNB's monetary policy operations in the HUF and foreign exchange markets.

4.3. Electronic money account

In parallel with the spread of FinTech providers in the EU, the establishment of an electronic money institution for the provision of money transfer services has become increasingly popular. There are two main reasons for this. One reason is that the directive on the prevention of money laundering and terrorist financing[27] provides a kind of exception to these institutions, whereby simplified customer due diligence up to a certain amount is acceptable when establishing a new business relationship. Another reason is that electronic money can be held in a wallet. For the second reason it is worth looking at what electronic money is. The CIFE transposing the definition of EMD2 into Hungarian law provides a complicated definition, according to which electronic money is an electronically stored amount represented by a claim against the issuer of electronic money, which is issued against the receipt of funds for the purpose of making payment transactions and which is accepted by a party other than the issuer of the electronic money (Article 6(1)(16)of CIFE). If one examines the definition carefully, it largely resembles a payment account. This conceptual confusion stems from the fact that the differences between the scriptural money stored on a payment account and the IT devices and solutions for storing electronic money have disappeared due to technological progress. Previously, electronic money was actually stored on a physical device, and electronic money issued using these devices is called hardware-based electronic money. An example of this is the prepaid card mentioned earlier. In contrast, the value stored in a payment account was simply scriptural money. However, the need to ensure that prepaid cards could be topped up arose, so that behind the prepaid device there is an account, i.e. an electronic money account was created. The result was that it became virtually impossible to distinguish between the two types of accounts from an IT and financial point of view. As the EBA's FAQ 2022_6611[28] or the CJEU's case C-661/22 show, the answer to this question is far from trivial, given that neither interpretation points to a clear distinction between the two types of account. In the case of the EBA FAQ, the EBA does not provide any differentiation criteria for the questioner's questions on the difference between a payment account and an electronic money account and on whether a payment can be received into an electronic money account but only notes that a salary can be received to such account. In its judgment, the CJEU only states that if a payment institution does not use the funds received immediately to execute payment transactions but only credits them to an account held by it for the purpose of subsequent payments, this does not constitute the issuance of electronic money. Thus, the Court has still not provided clear guidance on the distinction between payment services and electronic money services, including accounts for the provision of those services.

[27] (EU) Directive 2015/849 and Act LIII of 2017 transposing it into national law
[28] See question and answer at https://eba.europa.eu/single-rule-book-qa/qna/view/publicId/2022_6611 (Downloaded: 2 February 2025.)

The MNB has taken an approach to distinguish between the two types of accounts by considering whether or not the account used to store electronic units (i.e. the wallet) can be directly topped up. In simple terms: whether or not it has its own payment account number or international bank account number (IBAN) (*Bárdits 2021*). Of course, this answer also has shortcomings, but it is nevertheless useful in practice. Unfortunately, the currently available draft regulations (the draft third Payment Services Directive and the draft Payment Services Regulation) do not solve this problem on the basis of the publicly available Commission proposal.[29]

The importance of the issue is that if the payment service in question is exclusively an electronic money issuance service, it can only be provided by a credit institution or an electronic money institution, not by a payment institution. In other words, the prudential framework in which the service must be provided by the service provider differs widely between credit institutions and payment or electronic money institutions. For these accounts, the previous statement is also true, i.e. for electronic money accounts that are not qualified as payment accounts, the payment services regime does not apply.

4.4. Other types of accounts frequently encountered in practice

The previous three subsections described the types of accounts most commonly used by FinTech and other service providers. However, it is appropriate to highlight three additional account types, as they are also commonly used, but their regulatory treatment is not self-evident.

An escrow service is a service under which funds are deposited and managed on behalf of the customer in a separate escrow account with or without interest, in accordance with the terms and conditions laid down by law (Article 6(1)(79) of CIFE). In this case, the statutory condition refers to the rules of the Civil Code on escrow contracts (Article 6:360 – 6:368 of Civil Code). In connection with the accounts opened as a result of escrow contracts, it should be pointed out that the money transferred by the depositor does not become the property of the depositary and cannot be disposed of by such. In other words, the most important difference between a deposit and an escrow is the motive of transfer of ownership. This is the reason why the money received in escrow by a credit institution does not become part of the liquidation assets in the event of insolvency of the credit institution (Article 57(4) of CIFE), since it is not the property of the credit institution. Therefore, the amount given to a credit institution cannot be invested either, it must be kept solely by the escrow account holder. The new Civil Code has introduced the legal institution of the so-called "irregular escrow" (Article 6:367 of Civil Code), which nevertheless allows the transfer of ownership of the object in the case of an escrow

[29] See https://finance.ec.europa.eu/publications/financial-data-access-and-payments-package_en for more details (Downloaded: 2 February 2025.)

contract in the case of fungibles. This legal instrument of the Civil Code raises the question of the difference between an escrow and a deposit. The MNB has pointed out in an opinion that the sectoral regulation of the CIFE treats an irregular escrow as a deposit, and therefore the collection of an irregular escrow is considered to be deposit collection, i.e. a credit institution activity (*MNB 2022*). In other words, the distinction between escrow and deposits is important, as the relevant question is whether or not the credit institution can dispose of the funds received as its own.

It is also worth highlighting accounts related to credit lines and lending. For example, in contrast to the Accounting Act or everyday terminology, in the system of CIFE and the Civil Code credit is understood as a credit line opened for the customer, while a loan is understood as the amount of money actually disbursed (Article 6(1)(40) of CIFE). Considering that both credit and lending are a liability for the customer (consumer or business), while the payment account receivable is an asset, it is appropriate to separate the two accounts from each other in a legal sense (of course, this is also true for the balance sheet of a credit institution, only in reverse). The separation of credit and lending accounts from payment accounts may be significant. If the purpose of the legal relationship is not to enable the customer to handle its daily cash flow, but to finance an activity (e.g. the working capital of a business or the purchase of a home with the help of external funds), the account is not a payment account. For example, an account used to settle the mortgage debt of a consumer is not a payment account, and therefore no execution of instant payments to or from such an account is required, which means a significant IT development and operational burden. Another service that may be relevant for FinTech companies is the so-called Buy-Now-Pay-Later (BNPL) service, which is a form of lending. At the time of writing, however, Hungarian legislation does not contain explicit provisions for BNPL, and this will only change with the transposition of Directive (EU) 2023/2225. For this reason, only the MNB's legal practice is available[30] on BNPL service, which interprets it in the context of credit purchase activity. However, due to the limitations of this essay, a deeper analysis of the BNPL service is not possible.

5. Summary, conclusion

In conclusion, the current regulation of financial entities is complex, regulating both the institutional structure and the activities that make up the system, all in great detail. In order to understand financial institutions, it is necessary to place their development in a historical context, thus clarifying the evolutionary process that has resulted in today's complex and multi-level system. The introduction of the euro was one of the main sources of the development of the current system.

[30] For details, see the MNB's opinion at https://alk.mnb.hu/data/cms2627536/BNPLpublikalhatoaf.pdf (Downloaded: 16 May 2025).

The introduction of the single currency catalysed the development of infrastructure and institutions through, among other things, the payment services regime. In addition to the introduction of the euro, the structure developed by the Council of Wise Men, led by Alexandre Lamfalussy, has had a significant impact on the functioning of financial entities. The essay describes the current logic of regulation that defines institutions and types of activities. These activities are mapped to the service providers that perform them. The actual provision of services is carried out by means of accounts.

It can also be stated that the examination of accounts used in the provision of services is of paramount importance, as it is essential to know exactly which legal requirements must be complied with, both for prospective and incumbent service providers. This is because compliance with the legislation can incur significant costs. It is therefore not inconsequential, for example, whether or not an IT system must be operated on a 24/7 basis, or whether the service provider can use the customer's funds as its own, and what liability the provider has vis-à-vis the customer. The differentiation of services is not trivial in practice because the technology solutions that support them, and often their financial/economic content, are very similar.

The aim of this essay is to prepare a guide on the structure of the financial institution system, the services it provides and the accounts held within the framework of these services, which can help FinTech and traditional players to understand the logic of financial regulation and decide practical issues. As a result, we can conclude that the bank account used in everyday life is an outdated concept, and instead, the concept of a payment, deposit, escrow or loan settlement account, which can be derived for the purpose of an account agreement, can be used. These account products have specific properties that differ significantly from each other. Of course, there are also complex products, such as payment accounts, the positive balance of which can be treated as a deposit by the credit institution. It is also possible for the balance of the payment account to fall into the negative range, i.e. a loan can be disbursed against a credit line. In these cases, all of the regulations applicable to each account type apply simultaneously. Thus, it can be stated that just because we "keep money" in an account and it is maintained by a licensed service provider, the account does not become a bank account, as the issue is more complicated than that.

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The Power of Trade – Protectionism and Liberalisation over the Past 400 Years*

Eszter Szabó – Eliza Süle

Foreign trade, including various tariff measures and their impact on individual economies and the global economy, has been a topic of great interest in every era, including the present. This paper reviews key tariff and trade policy measures from the past 400 years. We consider it essential to emphasise that our paper takes an economic history approach and is not intended to evaluate current or future customs measures. In recent centuries, cycles of liberalisation and protectionism have alternated in international trade. Throughout history, tariffs and other restrictions have served to protect domestic sectors from foreign competition or to acquire and strengthen economic power, while increasing state revenues has also been among the objectives. Protectionist measures were typically accompanied by price increases even in the short term, although they also stimulated domestic production growth. However, in addition to the macroeconomic effects, the international political and social consequences of trade policy instruments should also be considered.

1. Tariffs as industrial policy instruments

Industrial policy is a form of state intervention and regulation aimed at promoting economic development and supporting domestic industrial production. As early as the 1500s and 1600s, some countries were already using various trade measures to achieve their economic and political goals. However, industrial policy only emerged in an organised, centralised form in the latter half of the 17th century, with its full development due to the Industrial Revolution. Technological progress transformed the social and economic environment, new industrial centres emerged, and states began to realise industry's multiplier effect on economic development.

* 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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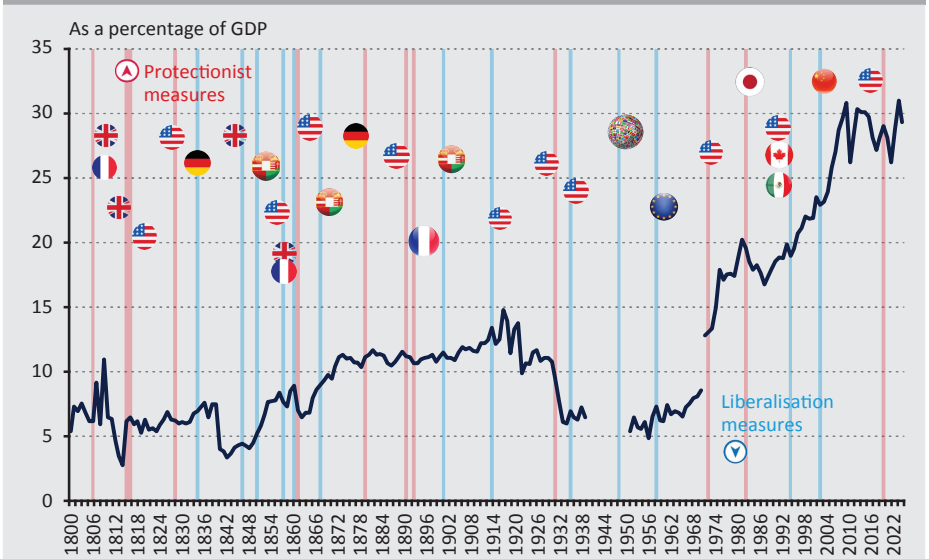
Tariffs and other trade measures constitute a group of industrial policy instruments. Other industrial policy instruments include subsidies, public investments, infrastructure development, regulation and support for technological development. In this paper, *we focus on tariffs and other trade policy instruments*. Tariffs play an important role in industrial policy as they affect international trade and the structure and competitiveness of the economy. Tariffs enable the protection of domestic industries from foreign competition, thereby stimulating domestic production. They can contribute to increasing employment in protected sectors and supporting technological development. However, tariffs and other trade restrictions can also have negative effects. They typically result in higher prices and reduce competition, which can lead to industrial distortions and create trade tensions between partner countries.

Throughout history, cycles of protectionism and liberalisation have alternated (*Figure 1*), shaped by political, economic and social goals and factors. In the 16th and 17th centuries, with the spread of global trade networks and colonisation, the world's economies became more open. The development of trade based on the Portuguese, Spanish, Dutch and English colonies created new opportunities and laid the foundations for a globalised economy. Subsequently, however, protectionism came to the fore with mercantilism.

Figure 1
Evolution of trade openness based on the ratio of global exports to global GDP (1800–2023)



Source: Federico-Tena World Trade Historical Database

2. The age of mercantilism: convergence through isolation

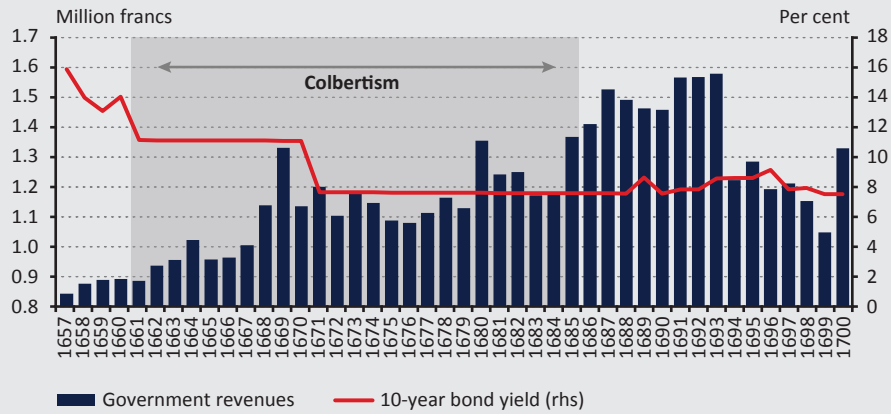
Mercantilism, the first complex national economic strategy, spread through the major Western European economies in the 17th century. This trend of economic policy and theory merged with absolutism in France and Spain and manifested itself in offensive economic policy measures. In England, it became one of the foundations of the new constitutional monarchy, while the German Empire's "Reichsmerkantilismus" served as a striking example of partial isolation.

Mercantilist economic policy aimed to protect domestic industry and create a strong economic hinterland to finance the frequent wars that characterised the period. In a world of new economic opportunities opened by colonisation, mercantilism emphasised achieving a surplus in the foreign trade balance and state intervention.

Mercantilist economic policy viewed the imposition of tariffs and the accumulation of precious metals as the basis of economic welfare and power. To increase the price competitiveness of domestic production sectors, protective tariffs were introduced to try to squeeze out imports and encourage exports. The colonial hinterland played a key role in protectionist economic policy, providing the necessary raw materials for the mother country, while manufactured industrial products were exported back to the colonies.

In France, foreign goods were kept out by imposing tariffs, and domestic industrial companies were supported with low-interest loans in the 1660s and 1680s. The introduction of an income tax-based reform of the state tax system is associated with the name of Jean-Baptiste Colbert, Minister of Finance, who also balanced the fiscal budget by increasing government revenues. This also made budget financing significantly cheaper (*Figure 2*). Due to the low profitability of agricultural products, Colbert favoured the export of industrial goods, which led to a significant decline in agricultural production, sometimes causing chronic food shortages and famines.

Figure 2
French government revenues and budget financing costs (1657–1700)



Source: Global Financial Data

3. Mercantilism in England – role of the Navigation Acts in British hegemony

The Navigation Acts were a series of laws enacted by the English Parliament in the 17th and 18th centuries. Their purpose was to control maritime trade and increase revenues from the colonies. The acts were a milestone in England's rise as a naval power and placed all colonies under the authority of the English Parliament.

The first Navigation Act was enacted in 1651, stipulating that goods could only be transported to England by ships with English crews, carrying English goods, or vessels registered in the country of the goods' origin. This excluded the Netherlands, which dominated maritime trade, from intermediary trade with English territories. The Act contributed to the rapid growth of the English fleet while putting the Netherlands at a disadvantage. The English colonies could only trade through England, which increased English revenues but made goods more expensive for the colonies. As a result of the Act, war broke out in 1652, ending in the defeat of the Netherlands in 1654, giving England a dominant role in intermediary trade.

The first Navigation Act was followed by others throughout the 17th and 18th centuries, which tightened and expanded the regulation of English (and later British) maritime trade and strengthened English dominance. The measures included further regulation of colonial trade: certain colonial goods could only be exported

to England or from England to English colonies, the colonies were not allowed to trade directly with other countries, colonial export duties were introduced, and measures were taken against the increasing spread of smuggling. Customs revenues and English trade dominance increased, but the Acts caused tension on the international and colonial levels.

It has long been debated whether British mercantilist policy played a role in the deterioration of Anglo–American relations, but the extent to which it contributed to the outbreak of the American War of Independence remains questionable. According to estimates by *Harper* (*1939*), the restrictions represented a cost equivalent to 2.3 per cent of colonial income in 1773. However, 90 per cent of these costs were concentrated in the southern states (especially the tobacco plantations of Maryland and Virginia), reducing the region's income by 2.5 per cent (*Irwin 2020*).

By the end of the 18th century, due to the expansion of long-distance trade, interconnected trade networks and production capacities, it became increasingly clear that mercantilist policies limited economic growth. According to Adam Smith, mercantilism mistakenly identified wealth with the accumulation of precious metals, whereas, intrinsically, true prosperity can only be achieved through the division of labour and efficient production. In parallel with the development of free trade, mercantilism gradually receded into the background from the end of the 18th century, but in later periods of economic history the customs practices of this economic philosophy reappeared again and again.

4. The impact of Napoleon's Continental System on international trade

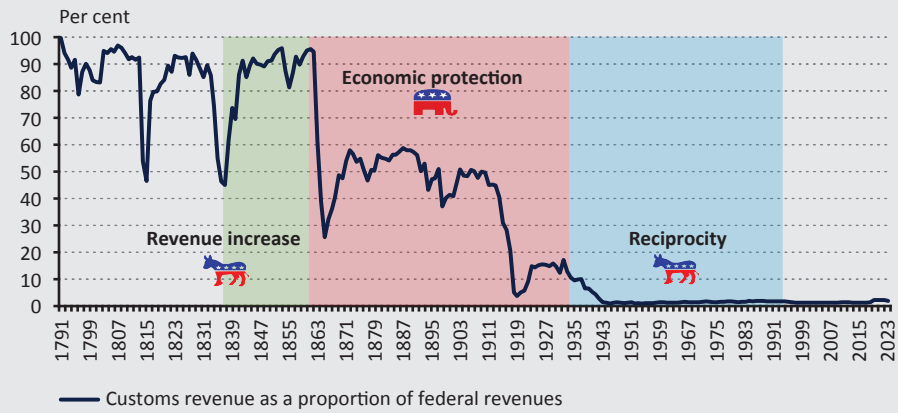
Napoleon's trade blockade (1806–1814) aimed to weaken the British economy and establish a continental trade system. To this end, the import of British goods to Europe was banned. As a result of this measure, smuggling became widespread, and the negative economic effects of the blockade (e.g. price increases, factory closures) were more severe in Europe, as British trade shifted to new markets.

The Napoleonic Wars had a negative impact on the United States as well. At the end of 1807, President Jefferson and the US Congress decided to impose an embargo to protect American ships and sailors from naval engagements between the British and the French. As a result, the country came extremely close to completely cutting itself off from international trade, to a state of autarky. The embargo lasted for 15 months and, as research shows, resulted in a welfare loss equivalent to 4.4–5.0 per cent of GDP (*Irwin 2005; Irwin 2020; Arkolakis et al. 2012*).

The Napoleonic Wars did not bring an end to trade restrictions. The United Kingdom enacted the Corn Laws (discussed in detail in the next section), while the United

States introduced its first protective tariffs. The American tariffs imposed earlier were primarily intended to increase government revenues, the Customs Act of 1816 was the first to aim at protecting domestic industry. Until the start of the Civil War, customs duties accounted for the vast majority of federal revenues (*Figure 3*).

Figure 3
Customs revenue as a percentage of federal revenue in the United States (1791–2023)



Note: The coloured columns represent the three major phases of US trade policy, based on Irwin (2020). Between 1837 and 1860, customs policy aimed to increase federal revenue, and the Democratic Party dominated American politics. Between 1861 and 1933, tariffs sought to protect domestic industries from foreign competition and control was typically held by the Republican Party. Between 1934 and 1993, mutual trade relations came into focus, in line with the views of the Democratic Party.

Source: Historical Statistics of the United States

5. The Corn Laws – the last restriction on free trade

The British Corn Laws were primarily tariffs and other trade restrictions imposed on imported grain in the first half of the 19th century. The law was enacted in 1815 (see *Table 1 in the Annex*) when – as the Napoleonic Wars ended – grain prices started to drop. These laws aimed to keep prices elevated to protect domestic producers from foreign competition.

The restrictions harmed industrial production and caused social tensions and a deterioration in the United Kingdom's trade balance. The imposition of tariffs made imports more expensive, while higher domestic grain prices led to food price increases. As a result, the cost of living rose, leading to social tensions. Due to high food prices, wages also had to be raised to ensure workers could make a living, which increased the cost of industrial production and thus reduced the competitiveness

of British industry in the international market. British grain producers benefited from higher prices, which increased their incomes and encouraged agricultural production.

The consequences of the 1845 famine led to the repeal of the Corn Laws. Although opponents had campaigned for free trade and the repeal of the Act from the outset, the restrictions remained in place for decades. However, in 1845, famine struck Ireland due to the potato blight, which increased demand for cheap grain. Under growing social and economic pressure, Prime Minister Sir Robert Peel repealed the Corn Laws in 1846, paving the way for free trade and lower food prices.

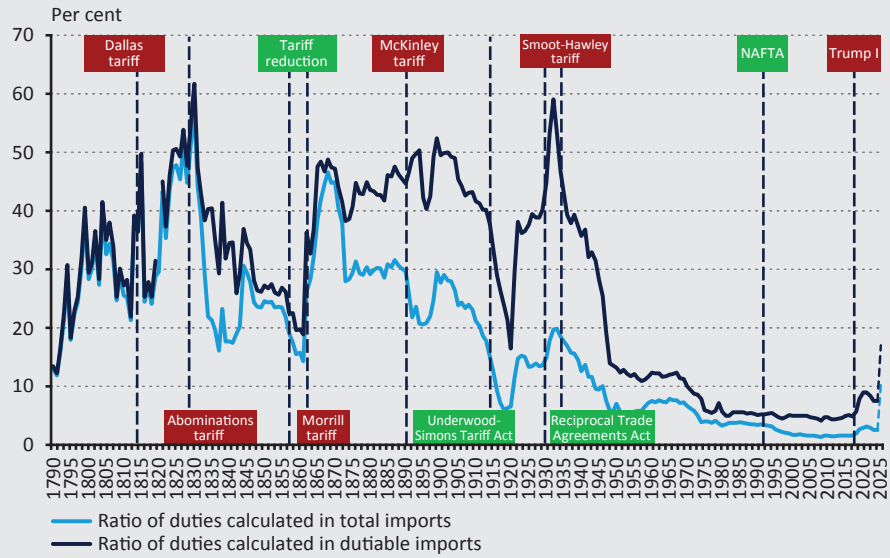
Free trade expanded the United Kingdom's trade relations and made the country the world's leading trading power. Lower food prices allowed industrial wages to stabilise, increasing the competitiveness of British industry. The macroeconomic effects of the Act were not significant, but it had a major impact on income distribution. It adversely affected the top 10 per cent of society, while the welfare of the bottom 90 per cent improved (*Irwin – Chepeliev 2021*).

6. Trade developments in a changing global economy

In the mid-19th century, the leading economies moved towards free trade. As a result of negotiations and agreements between Prussia and the German states, the German Customs Union Treaty came into force in 1834, creating the Zollverein, which was joined by additional German territories in the following years. The customs union played an important role in the formation of modern Germany. In 1850, the Habsburg Empire incorporated the various parts of the empire into a single customs territory, thus bringing the historical Hungarian territories into a single trade zone with the Austrian imperial territories.

In 1860, the United Kingdom and France signed a free trade agreement. The Cobden-Chevalier Treaty provided a pattern for other countries to conclude free trade agreements. In the United States, the highest customs tariffs in US history were introduced in 1828 (*Figure 4*), but by the middle of the century, liberalisation had also begun overseas.

Figure 4
Share of customs duties in total imports and imports of dutiable products in the US (1790–2025)



Note: Green indicates customs duty reductions, red indicates restrictive measures.
Source: US International Trade Commission, Douglas A. Irwin

In the final decades of the 19th century, protectionism gained ground again. The newly unified nation-states of Italy and Germany sought to strengthen their domestic industry and agriculture by imposing tariffs; furthermore, the United States and France also introduced trade restrictions. In the USA, protectionist measures benefited industrial production in the northern states by protecting them from foreign competition. However, the southern states were more dependent on imported products, and rising prices caused problems. After the Civil War, the Republican Party, which represented northern interests, came to power, and tariffs remained high for a long time.

The French Méline Tariff of 1892 had wide-ranging social effects. The Méline Tariff aimed to protect French agriculture from foreign competition by raising tariffs on agricultural products. A study by the Banque de France concluded that the tariff increased relative prices in agriculture – a sector employing low-skilled labour – compared to industry, thereby reducing the returns to education, which in turn influenced decisions to have children. As a result of the tariff, in counties where grain production accounted for a high share of local employment, educational attainment declined, and birth rates increased (*Bignon – García-Peñalosa 2018*).

7. Global trade in the 20th and 21st centuries – competition and interconnection

The 20th century began with trade liberalisation measures, which led to a general reduction in customs tariffs. The customs system was modernised in the Austro-Hungarian Empire. The dual customs system was unified, and a new taxation system was introduced. The economic reform aimed to strengthen integration and increase competitiveness. In the United States, the Underwood-Simmons Act significantly reduced tariffs and introduced the first federal income tax.

World War I brought about drastic changes in international trade relations. Naval blockades reduced the flow of goods, and the countries involved in the war focused on developing their domestic industries to meet the needs of the war, which led to a decline in free trade. In 1916, global exports accounted for nearly 15 per cent of global GDP, but by 1921 this figure had fallen below 10 per cent, a level not seen since the 1870s (*Figure 1*). European economies became heavily indebted, while the economic power of the United States grew. After the war, the Republican Party came to power in the United States, strengthening protectionist views. Americans were concerned that European countries would take advantage of low tariffs and flood the United States with their products, so tariffs were raised in 1921 and 1922.

The increased supply during the war and the recovery of European agricultural production in the second half of the 1920s led to overproduction, which in turn resulted in a decline in agricultural prices. During the 1928 presidential campaign, Herbert Hoover promised to raise tariffs on agricultural products, but other sectors of the economy soon demanded protection as well. Finally, during the Great Depression, the Smoot-Hawley Tariff Act was enacted, which (together with retaliatory measures) further exacerbated the crisis. According to estimates by *Crucini and Kahn* (*1996*), as a result of the tariffs in the early 1930s, US GNP may have fallen by 2 per cent. Compared to the fluctuations typical during the crisis, the impact does not seem significant; however, if introduced at any other time, the Smoot-Hawley Tariff Act alone would have led to a recession. After the global crisis, a comprehensive customs policy law was enacted in the United States, which significantly reduced tariffs and gave the president greater power over customs policy.

World War II resulted in dramatic losses and transformed the global trading system. The USA and Western Europe moved towards free trade. Reconstruction required vigorous international trade, and the negative experiences of protectionist policies between the two world wars encouraged countries to cooperate under more liberal rules (*Botos 2009*). The Bretton Woods system was established in 1944, the General Agreement on Tariffs and Trade (GATT, later WTO) was adopted in 1947, and the European Economic Community (EEC, EC, later EU) was established in 1957.

By contrast, a closed economic system was developed in the Soviet Union and the countries in its sphere of influence. In the 1970s and 1980s, the United States adopted protectionist measures. The Nixon administration introduced dutiable imports to encourage other countries to revalue their currencies against the US dollar, and from 1981, the Japanese authorities resorted to voluntary export restraints to prevent stricter measures that American car manufacturers were pushing for (*Collyns – Dunaway 1987*). However, trade liberalisation continued, particularly after the regime change in Eastern and Central Europe. In the 1990s, the North American Free Trade Agreement (NAFTA) was adopted, and European integration deepened. China joined the WTO in 2001, which contributed significantly to the expansion of international trade.

From the second half of the 20th century, liberalisation of international trade was typically in the interest of the dominant economies. *Furceri et al.* (*2018*) examined the macroeconomic effects of tariffs using data from 151 countries between 1963 and 2014. They concluded that a 3.6-percentage point (one standard deviation) increase in tariffs over five years results in a 0.4-per cent decline in output through the decrease in labour productivity. Advanced economies benefit more from free trade, and thus the output decline is greater in these countries, at 1 per cent. The authors also find that the effects of trade policy are asymmetric, with tariff increases hurting the economy more than reductions benefit it.

Alvarez and Yilmazkuday (*2025*) studied the pass-through of tariffs to inflation based on US data from 1990 to 2024. The results show that a 1-per cent increase in tariffs raises inflation by 0.09–0.1 per cent, depending on whether trading partners also impose tariffs. Consumption falls by 0.27–0.29 per cent, while output declines by 0.02 per cent. The authors conclude that protectionism has inflationary and recessionary effects. At the same time, the welfare costs of tariffs can be reduced through expansionary monetary policy.

The trend towards trade liberalisation reached a turning point in 2018 when Donald Trump imposed tariffs on numerous American-imported products. The measures mainly affected goods from China and led to a trade war between the two countries. In the USA, prices for intermediate and final goods rose significantly, the range of products available narrowed, supply chains were transformed, and tariffs were fully passed on to the prices of imported products. Similar effects were observed in countries that introduced retaliatory measures. Tariffs may have reduced US GDP by 0.2–0.3 per cent, the capital stock by 0.1 per cent, while increasing core PCE (Personal Consumption Expenditures) inflation by 0.1–0.3 percentage points (*Amiti et al. 2019; Fajgelbaum et al. 2020; Barbiero – Stein 2025; York 2025*). Rivalry with China did not ease during the Biden administration, and the rather protectionist Inflation Reduction Act (IRA) was passed, which, among other things, links an industrial development programme worth several hundred billion dollars to climate protection (*Farkas et al. 2023*). However, the programme's future has

become uncertain due to the different energy policy goals of the second Trump administration.

More recent literature shows that imposing trade restrictions typically harms the macroeconomy. *Auclert et al.* (*2025*) examine the short-term effects of import tariffs on GDP and the trade balance. They conclude that tariffs have a recessionary effect if intertemporal and export substitution are more significant than import substitution, which is typically the case in practice. Retaliatory measures by trading partners further exacerbate the situation. Research by *Baqaee and Malmberg* (*2025*) focuses on capital stock, considering the long-term effects of trade wars. Capital investments require imported inputs, and thus tariffs reduce capital stock by raising the relative price of capital compared to labour. When capital stock adjusts, the decline in wages and consumption is greater than in static models, and accordingly adjustment does not mitigate but rather amplifies the negative effects of tariffs.

Irwin (*2025*) summarises the literature on the effects of trade reforms in developing countries. In general, it can be concluded that more liberal trade policies have yielded measurable economic benefits. Numerous studies using different methodologies have concluded that economic growth was 1.0–1.5 percentage points higher in countries implementing reforms. At the same time, however, there is considerable heterogeneity, as the degree of liberalisation and the macroeconomic environment vary, and microeconomic results show that lower tariffs on intermediate goods increased productivity in sectors producing domestic final goods.

8. Conclusion

The overview of the centuries-long history of global trade processes reveals vital lessons. Periods of protectionism and liberalisation have alternated depending on which trade policy measures served the economic and political interests of the dominant powers at the time. As a general observation, it can be noted that the imposition of tariffs and other restrictions typically led to price increases, while supporting growth in protected sectors (agriculture and/or industry).

In addition to macroeconomic effects, it is also worth considering the distributional impact of trade policy measures, at both the domestic and international levels. The English Navigation Acts essentially led to war with the Netherlands, generated tensions in the colonies and probably played a role in the outbreak of the American War of Independence. However, they enabled England to become a dominant maritime power. Napoleon's trade blockade supported belligerent purposes. The British Corn Laws provided advantages to landowners, while their repeal put a broad section of society in a more favourable position. In the United States, trade restrictions helped the development of northern industry while adversely affecting the southern states, leading to conflict.

Tariffs and other instruments influence incentives in an economy and, like all political decisions, provide advantages to one group in society while providing none or fewer advantages to others. In addition to the economic objectives of measures, their political and social consequences must also be considered.

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Annex

Table 1
Major trade policy regulations throughout history (1800–2018)

Year	Customs legislation	Country	Description	Impact
1806–1814	Continental blockade		Banned the import of British goods into Europe.	Serious negative effects in Europe, while British trade shifted towards new markets.
1815	Corn Laws		Preventing the inflow of cheap foreign grain to protect domestic producers.	Higher food prices, lower purchasing power, and slower growth.
1816	First protective tariffs		The first tariff measure aimed at protecting the domestic industry. Previously, tariffs primarily served to increase government revenues.	It benefited northern industry, while rising import prices caused problems in the south.
1828	Tariff of Abominations		The highest tariff in US history, introduced to protect the domestic industry.	It benefited northern industry, while rising import prices caused problems in the south.
1834	German Customs Union (Zollverein)		The customs union between the German states was established.	Growing trade, industry and infrastructure development
1846	Repeal of Corn Laws		The repeal of the Corn Laws enabled the import of cheap grain.	~+0.6–1.5% GNP per capita, falling prices, expanding consumption
1850	Customs reform		Establishing a common customs area to increase internal trade and unify the economy.	Developing industry, increasing integration
1857	Tariff reduction		A significant reduction in protective tariffs, especially for industrial products.	Lower prices, faster growth
1860	Cobden–Chevalier Treaty		Free trade agreement between the United Kingdom and France	GDP impact: UK: ~+0.7%, France: ~+0.5%, served as an example for other countries as well.
1861	Morrill Tariff		Raising tariffs to increase revenues and protect domestic industry.	A new protectionist period began in the US.
1867	Austro-Hungarian Compromise		The Austro-Hungarian Monarchy was created, and closer relations were established, affecting customs policy as well.	Developing industry, increasing integration
1879	Bismarck's protectionist tariff system		Protecting domestic industry and agriculture from foreign competition.	Increasing industrial production, but higher import prices
1890	McKinley Tariff		Protecting US industry and agriculture by significantly raising import tariffs.	Increasing industrial production, but higher prices and declining foreign trade
1892	Méline Tariff		Protecting agriculture from foreign competition and increasing tariffs on agricultural products.	Increasing agricultural production, but higher prices and social tensions

Year	Customs legislation	Country	Description	Impact
1900	Modernising the customs system		Economic reform, which unified the dual customs system and introduced new customs tariffs and a new taxation system.	Increasing industrial production and foreign trade, lower prices
1913	Underwood–Simmons Tariff		Significant reduction of import duties and introduction of the first federal income tax.	Lower prices, improved competitiveness, growing industrial production
1930	Smoot–Hawley-Tariff		The second-highest tariff in US history. It increased tariffs on more than 20 thousand imported products.	It exacerbated the effects of the Great Depression and led to retaliatory measures.
1934	Reciprocal Trade Agreements Act (RTAA)		A significant reduction in tariffs after the Great Depression. The US President is granted more power over customs policy.	Higher growth, lower prices
1947	GATT		An internationally recognised system of trade rules was established.	Reducing tariffs and trade restrictions
1957	Treaty of Rome		The European Economic Community (EEC) was established as the precursor to the EC and later, the EU.	GDP impact: ~+1.3–5.5% on average. About half of the increase in GDP per capita in the CEE countries between 2004 and 2019 is due to EU accession.
1971	"Nixon shock"		Introducing dutiable import to encourage other countries to revalue their currencies against the dollar.	It was phased out four months later when the major currencies were revalued at the Smithsonian Agreement.
1981	Japan voluntary export restraint		The number of Japanese cars allowed on the US market was maximised (between 1981 and 1994).	GNP impacts: USA: ~+0.2% Japan: ~(–0.4)%
1993	NAFTA		North American Free Trade Agreement	GDP impacts: USA: ~+0.08–0.5%, Mexico: ~+1.31%, Canada: ~(–0.06)% Development of supply chains, economies of scale
2001	China's accession to the WTO		China joins the World Trade Organisation.	Faster commercial and economic growth.
2018	Tariffs of the first Trump administration		Imposition of tariffs on several imported products (e.g. steel, aluminium), mainly from China.	GDP impacts: USA: ~(–0.2)–(–0.3)% Core inflation: ~+0.1–0.3%

Source: Edited based on Caliendo – Parro (2015), Fajgelbaum et al. (2020), Grassi (2024), Irwin – Chepeliev (2021), Komlos (1991), Mayer et al. (2019), Timini (2023), Villareal – Fergusson (2014), and York (2025)

The Interpretation of Differentiated Integration in Economics

Béla Bottyán

Halmai Péter (ed.):
Tagállami integrációs modellek – A gazdasági kormányzás új dimenziói az Európai Unióban
(Member State Integration Models – New Dimensions of Economic Governance in the European Union)
Dialóg Campus Kiadó, Budapest, 2019, p. 277
ISBN: 978-963-531-082-1

The authors of the studies in *Member State Integration Models* analyse European integration models while also considering member state-specific aspects. This is the first time the interpretation of differentiated integration in economics has been presented in the Hungarian literature. The studies offer insights into a research process, and its results, the starting point of which was presented at a 2015 conference (also reported on in this journal; see *Kovács 2016*). The content of this book, however, is markedly different: it primarily focuses on differentiated integration, which was not discussed at the conference, not even as a subtopic.

The thirteen studies cover issues of economic governance, centred mostly on the potential consequences of economic integration, the differing positions of and the differences between the member states, as well as eurosceptic efforts. The ideas formulated are explored by the authors in the light of the EU's differentiated integration and with a view to economic and social developments.

The relationship between a multi-speed Europe and governance structures at various levels is a major topic discussed in the book. In the introduction (pp. 11–14) and the first study (*Bevezetés: tagállami integrációs modellek /Introduction: Member state integration models/*, pp. 15–26), editor *Péter Halmai* discusses the concept of differentiated integration (or multi-speed Europe) as a starting point, describing its role and significance in European integration.

* 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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As Halmai notes, in the multi-speed integration model, a group of member states set and implement shared objectives first, with the assumption that the other member states will later join this closer cooperation. In differentiated integration, however, a specific group of member states is not subject to the same EU rules as the others. This differentiation has short-, medium-, and long-term effects that need to be addressed. The issue of differentiated integration has been long discussed by integration theorists. Since the last two enlargements in 2004 and 2007, particular attention has been paid to this issue. According to the author, in the new millennium, the EU–27 has become too large and too heterogeneous, and now the only way forward is differentiated integration. Differentiation may be a tool for managing the heterogeneities among EU member states by allowing countries with different levels of integration to cooperate, taking their different economic and political characteristics into consideration. With this, it is possible to overcome the stalemate in the integration process, as substantiated by the developments in the euro area crisis, which are discussed in detail in several studies in the book, but differentiated integration may also trigger trends of disintegration and dissolution.

The study by *Tibor Palánkai* (pp. 27–50) explores the relations between integration and cohesion in the EU in detail, covering global inequalities, as well. The further widening of the inequality gap, the "inequality turning", is mostly due to globalisation and current global integration trends. Palánkai underlines that in order for the EU's social and economic system to be sustainable in the long term, the inequalities resulting from globalisation must be addressed. However, the effectiveness of cohesion policies remains uncertain, as the EU has not been able to respond properly to the inequalities that led to the cohesion or solidarity crisis.

In her study, *Többsebességes vagy menüválasztásos jövő? A differenciált integráció elméleti és gyakorlati kérdései az Európai Unióban* (*Multi-speed or à la carte future? Theoretical and practical issues of differentiated integration in the European Union*), *Boglárka Koller* highlights that the Treaty of Lisbon was a milestone in the codification of differentiated integration, as it clearly defined the framework of cooperation and the processes of taking initiatives and of implementation. For the future of the European Union, one crucial question is which types of differentiated integration will be implemented: will integration evolve into a community that is multi-speed yet open to everyone, or into a set of cooperations where individual choices can be made as if from a menu?

In the comprehensive study *Differenciált integráció: gazdasági integrációs modellek* (*Differentiated integration: models of economic integration*, pp. 67–142), *Péter Halmai* points out that differentiated integration is not an alternative to an ever closer integration, but should rather be seen as an additional method besides the main trend, deepening core integration. Halmai poses the question of whether differentiated integration has evolved as an inevitable structural attribute of

European integration and whether this process will lead to a stronger core Europe or fragmentation of the European Union. Differentiated integration is a method that supports the implementation of a pragmatic integration strategy. Its value is most significant in times of crisis. In this regard, differentiated integration has been an effective tool for integration management. With regard to Grexit and Brexit (for details on the latter, see *Halmai 2020b*), this must all be reevaluated, as these latest forms of differentiation clearly constitute a disintegration trend.

The European Union is a system of differentiated integration. This is true for various policy areas both in terms of the levels of centralisation (vertical differentiation) and territorial scope (horizontal differentiation). This is because differentiation is inherent to deepening and expansion. The growth and consolidation of the EU occurred through the expansion of its power, policies and membership. The model of differentiated integration can be interpreted in the interaction between mutual dependence and politicisation. Differentiation between member states (internal differentiation) is a consequence of supranational integration, which results from the conditions of a high level of mutual dependence and politicisation. However, external differentiation (the selective political integration of non-member countries) occurs in highly interdependent yet only marginally politicised policy areas. As a potential solution to the problems, Halmai points to the chance of a comprehensive reform of the Economic and Monetary Union and the creation of a total economic union (*Halmai 2020a; 2021; 2022; 2024*), a prerequisite of which is the review of competencies and, if necessary, further transfer of sovereignty. However, the member states currently take different positions on this issue.

In *Maastrichti kompromisszum: vele, vagy nélküle?* (*Maastricht compromise: with or without it?*, pp. 143–166), *István Benczes* focuses on the introduction of more stringent fiscal rules and the possibilities of a fiscal union. While the need for a reform of economic governance has clearly emerged at various levels, with the specific ideas and proposals presented after 2010, the leaders of Europe have opted for more stringent legal regulation. The author of the study agrees that the current momentum is significant, but is critical to the process of the establishment of the fiscal union. In his summary, Benczes underlines that while going beyond the Maastricht compromise may be a long-term goal, it is not likely to happen in the short term.

The banking union and the fiscal union are also major topics in the book. In his study (pp. 167–182), *László Csaba* analyses in detail to what extent the Fiscal and Banking Union's operational experience and the expected complementary measures will constitute a new phase in the development of European integration. The Fiscal and Banking Union supports faster crisis management, but the financial vulnerability of non-participating member states may pose a risk. The single market and uniform rules must be preserved, even if the open system of cooperation allows for member

states to coordinate in varying configurations. However, the creation of a fiscal union implies significant changes, and the implementation of this requires that economic disparities between member states first be reduced. Full integration into the union will be necessary for each member state, in order for the Fiscal and Banking Union to provide real stability.

The study *Külső egyensúlytalanság az euroövezetben. Megoldás-e a többszintű kormányzás?* (*External imbalance in the euro area. Is multi-level governance the solution?*) by *Gábor Kutasi* describes theories of multi-level governance that presuppose the coexistence of a multi-level political community and multi-level (both horizontally and vertically) governance structures. The debt crisis of the euro area exposed the structural problem of the single market. The key point is that the current account imbalances in the euro area are the results of disparities in competitiveness within the area. These disparities stem from the single currency and the heterogeneity of development across the member states, and these issues must also be addressed.

In her study, *Erkölcsi kockázat és szolidaritás a GMU-ban: a görög válság tanulságai* (*Moral risk and solidarity in the Economic and Monetary Union: lessons from the Greek crisis*), *Dóra Győrffy* discusses the moral risks involved in providing bailout packages. On the one hand, bailouts may encourage irresponsible lending among investors, but on the other hand – with a view to the principle of solidarity – if a member state is in trouble, it is in the interest, and it is the responsibility of the whole Union to help that country. This dilemma was clearly acute in the case of Greece, the biggest loser of the European financial crisis. The bailout packages required budgetary constraints that were unprecedented in the past 50 years in the OECD countries. These enormous sacrifices were meant to keep Greece in the euro area. The reasoning for this is described in detail in the study. Through the analysis of the structure of Greece's economy and the composition of debt, the author points out that leaving the euro area would not solve a single problem of the Greek economy, but would result in enormous costs both for the Greek households and for other members of the euro area.

In his study, *A jogharmonizáció integráló erejének gyengülése* (*The weakening integrating power of legislative harmonisation*), *László Kecskés* describes how legislative harmonisation has strengthened integration since the beginning of the legal functioning of the European Communities in 1958 and then analyses its effects on economic and political integration processes in the EU. *Miklós Király's* study, *A nemzetközi magánjog kodifikálásának útjai az Európai Unióban és tagállamaiban* (*Codification of international private law: the paths taken by the European Union and its member states*) explores the unification of law with regard to international private law.

László Várkonyi focuses on the changes in the decision-making and legislative processes in the EU with regard to commercial policy in *Intézményközi harcok az EU kereskedelempolitikai döntéshozatali, jogalkotási folyamataiban* (*Inter-institutional battles in decision-making and legislative processes in the EU's commercial policy*; this author also has another study in the book: *Lisszaboni Szerződés: EU-s és tagállami beruházási hatáskörök /The Treaty of Lisbon: EU and member state investment competencies/*). In the period after the European Economic Community was established and before the Lisbon Treaty came into force, the common commercial policy was mostly shaped by the dialogue of two entities: the European Commission and the Council, which consists of the representatives of the member states. The stakeholders discussed the exact definition of the subject of commercial policy and the areas where member states can enact national legislation and engage in international negotiations. It was also discussed to what extent they can directly and actively take part in bilateral or multilateral negotiations and become parties to international treaties. However, the Treaty of Lisbon brought about major changes in the previous practice of commercial policy. As the competencies of the EU changed, tensions between the Commission and the Council increased, and the European Parliament took on a major role, which put the cooperation on a new footing. However, a balance has still not been reached.

In his study, *Többsebességes Európa – magyar érdekek a GMU mélyítése során* (*Multi-speed Europe – Hungarian interests in the deepening of the EMU*), *Géza Hetényi* points out that the most palpable manifestation of multi-speed European integration is EMU. While every EU member state is a member of EMU, the single currency, the euro, is used by 19 member states[1], and the remaining 8 must strive to introduce it[2]. The development of EMU to date and the direction of further deepening reveal a widening gap between the countries within and outside of the euro area, resulting in two-speed integration. Member states on the periphery cannot exploit cooperation opportunities, which may restrict them from pursuing their interests, especially if the number of such countries is to decrease further. Consequently, the ever-widening gap will pose an increasing challenge to the introduction of the euro.

The main conclusion of the book is that the future development of the EU is fundamentally affected by the management of the economic and political inequalities among the member states and by deepening integration. Differentiated integration and the use of various governance models may support the proper management of challenges in the future and contribute to the stability of the EU.

[1] The euro is currently used by 20 EU member states.
[2] Currently, only 7 states must strive to introduce the euro.

The work's strengths include that the authors, when formulating their responses, apply a complex economic approach, incorporating not only theoretical but also practical considerations. This is especially clear in the analysis of the various forms of differentiated integration and their effects on the EU.

Overall, *Member State Integration Models* offers in-depth, high-quality analyses and well-founded conclusions about the economic and political integration of the EU.

It is mostly recommended for economists, political scientists and lawyers seeking a deeper, expert-level, scientific understanding of the EU's integration processes. The book is also suitable for wider audiences interested in issues related to the EU's future and the development of economic governance.

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Report on the 15th Annual Financial Market Liquidity Conference

Zsuzsa Réka Huszár – Soma Csaba Lehotzky – Burentegsh Dorjjugder – Jinlong Li

1. Opening of the AFML conference

The 15th Annual Financial Market Liquidity Conference (AFML) took place on 14–15 November 2024 at the new Buda campus of the Corvinus University of Budapest (CUB). This highly anticipated event served as a premier platform for thought leaders, researchers and practitioners to explore the evolving dynamics of financial market liquidity, fostering an exchange of innovative ideas and collaborative solutions. In keeping with tradition, the conference was organised by leading Hungarian academic and research institutions, including the Institute of Finance at Corvinus University of Budapest, the KRTK Game Theory Research Group at the HUN-REN Centre for Economic and Regional Studies, and the Faculty of Economics at Eötvös Loránd University. In addition to the Hungarian organisers, under the aegis of the CY Initiative of Excellence the ESSEC Business School also participated as a co-organiser.

The two-day programme featured several keynote speeches by distinguished professors from leading Australian, Canadian and European universities, as well as panel discussions, research presentations and paper pitching sessions. Participants explored and discussed financial market topics related to market structure, risk management, and the intersection of technology and liquidity. Beyond financial liquidity topics, sustainability research also featured prominently. The event was sponsored by KELER CCP and Morgan Stanley, whose support underscores the importance of linking academic research with industry practice to address the challenges and opportunities in financial markets.

* 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 conference was opened by Professor *Bruno van Pottelsberghe*, the rector of CUB. After welcoming the participants, he highlighted the importance of high-quality research programmes and events such as the AFML to foster the exchange of ideas and to develop and build lasting research connections, in order to boost quality research output from Central and Eastern Europe. After the opening speech, the conferences commenced with two keynote presentations. Associate Professor *Zsuzsa R. Huszár* introduced the first keynote speaker, Professor *Renée B. Adams* from Oxford University.

2. The first day of AFML Conference – the first and the second keynote speeches and morning parallel sessions

Professor Adams' presentation, with the provocative title 'How to Save the World', explored the role of women in the shareholder/stakeholder debate and in connection with corporate governance and sustainability considerations in management. The presentation became a lively interaction with active engagement by the audience, reflecting the strong general interest in the topic and a desire to better understand the tensions between shareholder value maximisation and stakeholder value maximisation.

The presentation included a broad overview of Adams' research agenda examining corporate governance related topics, such as board composition, bank governance, group decision-making, the governance of central banks and gender diversity on and off boards (see for example *Adams and Lowry* (*2022*), while focusing on current trends in sustainability perception and commitment among students. The study presented was based on classroom experiments among Oxford University MBA students testing their attitude towards shareholders and stakeholder value maximisation.

The experiment aimed to measure the degree of 'shareholderism' among the participants, defined as the extent to which individuals prioritise shareholder interests over those of stakeholders, such as employees, the community, creditors and society in general. The results revealed that MBA students, on average, exhibited a slightly lower degree of shareholderism compared to corporate directors, albeit statistically and economically not significantly different. The mean shareholderism score for directors was 3.4, while for MBA students it was 3.32 on a scale of 1 to 5. Interestingly, the collected data also indicated that female MBA students tend to be more pro-shareholder than their male counterparts, challenging the common narrative that women are inherently more stakeholder oriented.

Further analysis showed that the attitudes of MBA students towards shareholder and stakeholder value maximisation were influenced by their personal values. The study utilised Schwartz's value theory, which identifies ten value types, including

universalism, which emphasises understanding, appreciation, tolerance and protection for the welfare of all people and nature. The findings suggested that students with higher universalism scores were less likely to prioritise shareholder interests, aligning with the broader literature on the impact of personal values on corporate decision-making.

The experiment also highlighted the importance of cultural and institutional contexts in shaping attitudes towards shareholder and stakeholder value maximisation. The responses of MBA students were compared to those of directors from different countries, revealing significant variations based on cultural and legal environments. This underscores the complexity of generalising findings across different contexts and the need for a nuanced understanding of how personal and contextual factors interact in shaping corporate governance practices.

The presentation by Adams concluded with a Q&A session, followed by the introduction of the second keynote speaker, Professor *Robert Faff*, who recently also joined CUB as a research professor. Faff's presentation focused on his pioneering efforts in advancing responsible finance research through the preregistration initiative in the Pacific-Basin Finance Journal (PBFJ) as the publication's Editor-in-Chief. He began by emphasising the main principles of scientific inquiry, which extend beyond mere research to include the discovery of new patterns and the accumulation of verified information to generate knowledge.

Faff identified three pillars of responsible science: credibility, relevance and independence. Credibility is achieved through the application of reliable and rigorous methodologies, while relevance requires addressing real-world issues. Independence is equally critical, as it ensures an unbiased perspective and avoids conflicts of interest. He further stressed the importance of open inquiry, advocating for a balanced approach to research and literature review that embraces diverse topics. This framework, he explained, fosters a more robust scientific process by maintaining methodological rigor and addressing practical challenges in research.

To illustrate contemporary challenges in scientific integrity, Faff referenced a 2023 report by the UK House of Commons, which revealed that most scientific publications in the UK are not reproducible, a finding that underscores a global reproducibility crisis in modern science. Reproducibility is vital for generating reliable knowledge, but issues such as publication bias against null findings (i.e. papers findings no significant support for valid research hypothesis) and research waste still persist. Some key recommendations from the report were highlighted, such as open access data, which are easy to find, readily accessible, interoperable and reusable (FAIR principles). Faff, explained that his PBFJ preregistration research initiative aims to address these issues by fostering transparency and mitigating biases in research.

Preregistration involves publicly registering research protocols and analysis plans before data collection or analysis begins. Faff outlined its three primary benefits: enhancing transparency by providing a clear research roadmap, reducing risks of p-hacking through predefined analyses, and enabling more accurate replication of studies by other researchers. Drawing on work by *Nosek and Lakens* (*2014*), he explained how preregistration strengthens the scientific progress, specifically addressing the p-hacking concerns. He noted that this shift from prioritising statistical significance to methodological soundness also facilitates the publication of null results, thereby enriching scientific understanding and reducing publication bias. Concluding his presentation, Faff argued that this framework can incentivise researchers to tackle bold and risky questions grounded in solid theoretical foundations while addressing real-world problems.

Following the two motivational keynote presentations, three parallel sessions with long and short paper presentations took place. The 'Commodities and Derivative Securities' session was chaired by Professor *Mihály Ormos* from ELTE, while Professor *Péter Bíró* from CUB chaired the 'Theory' session, and Professor *Robert Faff* moderated the 'Flash talks' sessions. The latter short paper pitching session, at which PhD students and young researchers pitched ideas to receive feedback from distinguished editors, continued in the afternoon session.

The first two parallel sessions were structured to accommodate three or four 30-minute paper presentations, sometimes with expert discussants where the presenters had specifically requested formal feedback. This structured approach was implemented to enhance the quality of future publications and foster meaningful academic dialogue among participants. The morning sessions provided a comprehensive platform for researchers to present their findings and receive valuable peer feedback before breaking for lunch.

In the third interactive session, in the morning, 8 presenters were allocated 15 minutes to provide short pitches of their work and Q&A. The presenters were primarily students working on their doctoral studies at CUB and researchers from the region. One of the foreign presenters at the pitching session was Associate Professor *Rafal Sieradzki* from Cracow University of Economics, who is currently a visiting scholar at New York University (NYU) Stern School of Business. He gave a short summary of his paper, entitled 'Systemic risk indicator based on Implied and Realized Volatility' (*Sakowski et al. 2023*).

3. The first day of the AFML conference – afternoon parallel sessions and the third and fourth keynote presentations

The second block consisted of three parallel sessions. The two standard paper sessions, entitled 'Asset pricing, Macroeconomics, and Greenwashing' and 'Banking and lending' were chaired by Professor *Ágnes Lublóy* from the Stockholm School of Economics in Riga and by Professor *Álmos Telegdy* from CUB, respectively. Presentations during the afternoon sessions covered wide-ranging topics including short-term return reversals, monetary policy, inflation tax avoidance, firm-level greenwashing and the effects of export promotion.

The third parallel session was again dedicated to Flash Talks, under the mentorship of Professor *Robert Faff*. 8 presenters were given 15 minutes to pitch. Among them, *Bálint Várgedő*, a CUB PhD student, presented his paper 'Green firms are less risky: Results from a Preferential Capital Requirement Program in Emerging Europe', using unique regional data from the Magyar Nemzeti Bank, the central bank of Hungary. For every presentation, Professor Faff spent 5 minutes to share his views, which received acknowledgement from both the presenters and the audience. The afternoon parallel sessions concluded with a coffee break, followed by the third keynote presentation of the conference.

In the afternoon, the third keynote speech was delivered by Professor *Rose Liao* from Rutgers University, USA. Liao presented one of her ongoing research projects on the topic of 'Labour Laws and Responsible Sourcing' (*Hu et al. 2024*). The main empirical research questions provide an in-depth understanding of how labour laws impacted US companies' import choices and supply chain management decisions.

Using 18 million freight shipment records, Liao and her co-authors found that US firms imported 6% more from countries that improve labour conditions through mandatory workforce policy (MWP) regulations, especially from new suppliers. MWP is recognised when the policy is workforce-oriented to increase labour welfare, which is determined by the authors under the guidance provided by US labour law and worker protection. The authors manually collected MWP adoptions worldwide from the Carrots & Sticks database, a publicly available database providing information on country-level ESG policies around the world. One of the key research findings was that US firms increase imports from supplier countries that experience positive changes in labour policy, despite the higher operating costs. Liao explained that these firms could obtain more favourable evaluations (e.g. social rating or supply chain ratings) regarding employee conditions by importing more from countries which improved labour welfare despite higher operating costs. She explained that they wanted to answer the important question as to whether countries should pass labour law measures. They found that emerging market

adoptions, export-oriented country adoptions and lower skilled-workers country adoptions of MWP have a stronger effect of increasing imports from US companies.

This was the first empirical study using shipment-level seaborne import information for an extended timeframe from 2007 to 2019 to examine whether and how US firms adjust global supply chains with workforce policy changes. The study concluded by highlighting its important policy relevance, showing that US firms increased imports from supplier countries that experienced positive changes in workforce policy. This effect was particularly notable when the firms were headquartered in so-called 'blue states' (i.e. US states where the weighted average of Democratic party representation in the Senate and House delegations exceeds 50%) and in industries with high human capital intensity and employee mobility. Overall, the research suggests that sustainability and human rights issues play a significant role in US firms' supply chain decisions. Additionally, it was found that after a supplier country's MWP adoption, the affected firms received increased ratings on employee welfare.

The afternoon plenary session of the conference's first day featured online a keynote speech by Professor *Thomas J. Walker* from Concordia University, Canada. The presentation, co-authored with *David Ung* and *Moein Karami*, was titled 'On the Preparedness of Local Governments and Municipalities for Natural Disasters.' Walker began by providing an overview of natural disasters in Canada, the types of disasters (e.g. blizzards, floods, storms and wildfires) and the scope of damages. He highlighted Canada's vulnerability to all major categories of natural disasters by mentioning the *Public Safety Canada* (*2024*) report and discussed the varying levels of preparedness across provinces.

In examining the existing body of research, Walker noted a predominance of studies focusing on specific local areas or individual types of natural disasters and their costs. The research presented aimed to address the limited comprehensive country coverage, by evaluating the preparedness of provinces and municipalities across Canada, investigating each region's exposure to different types of natural disasters and assessing the readiness of policymakers and emergency workers to mitigate such risks. The initial research conjecture was that areas with higher exposure to natural disasters would demonstrate more robust preparedness measures.

In terms of data collection, Walker and his team relied on the Canadian Disaster Database (CDD) and the Emergency Events Database (EM-DAT). He also highlighted the challenges of coverage in these databases and mentioned how it could be useful if the database had better coverage. Because of the challenges in measuring spending, they proposed a qualitative assessment asking whether a province had a budget, a certain timeline or any action plan for disasters or whether provinces prepared citizens by educating or having consultants to evaluate preparedness.

After that, they assigned scores considering the weight of the action plan in place in the budget, initiatives, timelines and education plans.

The findings revealed significant variations in preparedness across municipalities and provinces. Cities such as Vancouver, Ottawa and Montreal demonstrated high preparedness scores at the provincial level, while Prince Edward Island ranked relatively low. Overall, the research indicated that provinces with high exposure to natural disasters tend to exhibit better preparedness. However, some regions with substantial disaster exposure still showed deficiencies in their readiness.

Walker highlighted challenges in evaluating financial market responses to disasters, particularly with respect to provincial bond yield spreads. He explained the difficulties of conducting event studies for certain types of disasters and noted that disaster impacts are not always reflected uniformly in provincial or federal bond yields. The presentation concluded with an interactive Q&A session, during which audience members provided feedback and posed further questions about the research.

The first day of the conference concluded successfully with engaging discussions and insightful presentations, setting a strong foundation for the second day sessions. Participants exchanged meaningful ideas and discussions and networked throughout the day.

4. The second day of the AFML conference – parallel sessions and the fifth and sixth keynote speech

The second day of the conference started with keynote speaker Professor *Albert J. Menkveld* from Vrije Universiteit Amsterdam, the Netherlands, who presented his research entitled 'Pricing Variance in a Model with Fire Sales' (*Menkveld 2024*). Before his presentation, Menkveld gave a brief introduction of his prior work on Nonstandard Errors, which has received much attention in the field. Following the introduction, he focused on the motivation of his research: how and why the pricing of the second moment is relevant. He asked several questions thought-provoking questions: Can nontraded risk generate a positive volatility risk premium (VRP)? What is the size of the premium? Can nontraded risk rationalise crash patterns? To answer these questions, he proposed a Grossman-Stiglitz-type model. This model implies that the volatility risk premium is nonnegative. Second, the model also yields a relatively simple analytical expression for the VRP. Thirdly, the model can explain that the VRP is slow to decay in the months after a crisis.

This model could generate two additional facts related to the puzzling pattern of higher volume trading at lower liquidity during post-crisis periods. These additional observations were based on intraday trading data for SPY and an actively traded

exchange-traded fund (ETF) that tracks the S&P 500 index. More specifically, the model consists of three stages. In the first stage, all agents are homogeneous and can buy or sell variance swaps. In the second stage, some agents suffer a nontraded risk ('endowment') shock and can trade the risky asset to hedge. The remaining agents endogenously become liquidity suppliers. In the final period, payoffs are realised, and agents consume. The key result that the model delivers is that variance swaps mitigate the utility cost due to nontraded risk shocks. In equilibrium, implied variance exceeds the expected realised variance because the benefit to those who suffer the shock exceeds the cost to those who do not. The model equilibrium yields relatively simple closed-form expressions for asset returns, market liquidity and variance swaps.

Using long time-series of real-world data from 1993 to 2022, Menkveld found that the average variance risk premium was positive and the US equity index derivatives trading volumes were elevated in post-crisis months. Furthermore, this elevated volume is traded at higher costs, as the market is less liquid during the post-crisis period. Apart from this, the empirical findings are explained by a model where agents experience fire-sale risk. These findings provided a novel perspective on VIX dynamics: regulators should become more vigilant when the VIX is abnormally high relative to the real-world volatility, as it is associated with higher risk of fire sales. Future research is encouraged to identify policies that could mitigate these post-crisis patterns. If policies make those few agents experience less fire-sale demand, markets might recover more quickly after a crisis. The extent to which such policies exist and whether they are desirable from a welfare perspective is left for future research.

The Plenary Session continued with the online presentation of Professor *Jonathan A. Batten* from RMIT University, Australia. His talk was based on the research paper titled 'Currency Portfolio Management under Exchange Rate Uncertainty'. Batten and his co-authors' empirical research focused on the importance of the US dollar in international finance. While the economies of the USA, China and the EU each contribute approximately one quarter of global GDP, the US dollar continues to maintain its strength in the global financial market. The key goal of the research is to understand the dominance of the US dollar in the foreign exchange market.

The study analysed the currency preferences of non-financial firms managing global asset and liability portfolios. Multinational corporations, for example, were exposed to multiple currencies through international financing, multi-currency revenues and offshore subsidiaries. Moreover, the US dollar maintains a strong presence in international trade, settlements, external debt, international bonds and foreign exchange reserves, according to a BIS report by *McGuire et al.* (*2024*). This raised the question: if the US dollar is so dominant, why do smaller currencies still play

a role in trade and settlement? What significance do these smaller currencies hold in the financial system?

The research employed EGARCH (1,1) method combined with MIDAS (Mixed Data Sampling) to facilitate improved currency forecasting by integrating information from various data sources with varying frequencies, particularly from news. The study examined currency returns using sentiment measures. Six currencies – GBP, EUR, CHF, JPY, CAD and AUD – were analysed against USD in a portfolio, with portfolio weights adjusted in response to shocks driven by sentiment or news data. Initially, the authors examined the daily prices of these selected currencies, expressing all values in USD. They then incorporated sentiment measures into the analysis. The dataset included the currency pairs USD/GBP, USD/EUR, USD/JPY, USD/CAD, USD/AUD and USD/CHF, alongside three sentiment indicators: financial sector sentiment, monetary policy sentiment and USD-related news sentiment.

The authors' findings aligned with existing research on the dominance and stability of the US dollar in the global currency market. They explained that they began with a simple model to analyse how sentiment influences corporation's currency choices. The study assumed that an investor initially allocated wealth equally across different currencies, both with and without sentiment considerations. Using various models and technologies, Batten highlighted the significant role of smaller currencies while reaffirming the continued dominance of the US dollar. He concluded his speech by emphasising the significance of integrating sentiment data into currency analysis and real-world portfolio management.

Following the last keynote speech, attendees enjoyed a brief coffee break, providing an opportunity for informal discussions and networking. The conference then resumed with another compelling plenary session, featuring invited speakers *Gabor Pinter* and *Wenqian Huang* from the Bank for International Settlements (BIS), *Simon Jurkatis* from the Bank of England, UK, and Associate Professor *Tommy Lee* from Central European University (CEU), Austria. Chaired by Professor *Laurence Daures* from ESSEC Business School, France, the session focused on the overarching theme of Strategic Behaviour in OTC Markets, with a dedicated discussant contributing further insights. After this session, the two-day conference concluded with parallel sessions covering Corporate Finance and Market Microstructure as well as Sustainability and Social Innovation, allowing participants to explore specialised topics in depth.

5. Concluding remarks

The 15th AFML Conference concluded following a two-day intensive discourse with plenary and parallel sessions touching on various topics of the current financial literature, ranging from repo and foreign exchange markets to how extreme weather events influence bank lending. The conference featured six keynote speakers with renowned names such as Professors Renée Adams, Robert Faff, Rose Liao, Thomas Walker, Albert J. Menkveld and Jonathan A. Batten. In addition to the keynote speeches, 44 flash talks and presentations were conducted by invited speakers from domestic and international research institutions and universities.

Overall, the 15th AFML conference covered a wide range of empirical and theoretical topics, providing a unique opportunity for the participants to discuss the most recent research techniques, exchange ideas regarding current research topics and participate in networking sessions with researchers from all around the world. The event also offered opportunities for young scholars to meet with senior researchers to foster the creation of new research networks, supporting the development of the field.

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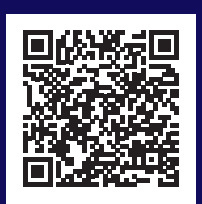

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