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Contents

Understanding the Persistence of Inflation in Argentina: From Peron to Milei*

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Argentina's repeated failures to achieve lasting inflation control reflect not merely technical mismanagement, but also the country's deep-seated political and institutional rigidities. Chief among these are the entrenched corporatist structures linking Peronism, organised labour, and the state, which have long constrained productivity and external competitiveness. These structural distortions have created a self-reinforcing inflationary dynamic, undermining stabilisation efforts across successive regimes. Since taking office in 2023, President Milei's administration has achieved notable short-term gains in fiscal balance and inflation reduction, yet recent political uncertainty and foreign exchange interventions highlight persistent vulnerabilities. Without dismantling the political-economic legacy of Peronism and addressing labour market inflexibility, even well-designed reforms risk failure. The current moment may represent Argentina's last opportunity to break its inflationary trap and achieve sustainable macroeconomic stability.

1. Introduction

Argentina's persistent inflation stands as one of the most enduring economic phenomena in modern economic history. Despite multiple stabilisation efforts – ranging from orthodox to heterodox approaches – the country has struggled to achieve lasting price stability. This recurring pattern suggests that inflation is not

merely the outcome of policy shortcomings or external shocks, but rather the result of deeper institutional and behavioural factors that have evolved over decades.

The roots of Argentina's inflationary dynamics can be traced to the political and economic model that emerged under Peronism in the mid-twentieth century. By linking state intervention, organised labour, and social protection to national identity, Peronism established a distinctive institutional framework that continues to shape policy choices and inflation expectations. As *Calvo and Murillo* (*2012*) note, its adaptability has allowed it to integrate diverse constituencies under a broad narrative of inclusion and sovereignty, ensuring political continuity even amid changing economic paradigms.

A key unresolved question, however, is what makes Argentina different from other Latin American economies that have managed to reduce inflation and sustain institutional reforms. Is Argentina's trajectory the result of a self-reinforcing institutional structure, or do prevailing voter preferences make the return to interventionist policies more likely after each reform cycle? Comparative experience indicates that while other countries in the region have transitioned toward more rules-based macroeconomic frameworks, Argentina's policy environment has remained more path-dependent, reflecting the interaction of historical legacies and societal expectations (*Marzetti and Spruk 2022*).

This paper situates Argentina's inflation problem within that broader political-economic and institutional context. It argues that inflation persistence reflects not only fiscal and monetary imbalances but also the underlying social contract that links distributive politics, state centrality, and collective expectations. The following sections trace this evolution from the early Peronist period to the present, exploring how ideological and institutional continuities have constrained reform efforts and shaped policy outcomes.

The final sections assess whether recent policy initiatives – aimed at restoring macroeconomic stability and institutional credibility – may signal a departure from past dynamics or represent a new phase within Argentina's long-standing adjustment cycle. By framing inflation as both an economic and institutional challenge, this paper seeks to contribute to a more comprehensive understanding of the structural factors behind Argentina's macroeconomic volatility.

2. Inflation in Argentina

"Persistence of inflation in Argentina should not be seen merely as a failure of monetary policy, but as a successful tradition of political survival."[1]

The very mention of Argentina evokes, around the world, a country of immense potential – but also of chronic instability, most notably reflected in persistently high and volatile inflation, and erratic economic growth. This instability has been the backdrop to Argentina's prolonged decline over the past eighty years.

It is therefore crucial to understand the deeper roots of Argentina's inflation persistence – an issue that continues to dominate the country's economic reality. While many emerging markets, especially in Latin America, experienced similar episodes of high inflation and recurrent macroeconomic imbalances during the second half of the twentieth century, most eventually managed to stabilise prices and reduce inflation to reasonable levels. Argentina, however, stands out as an exception. Despite numerous stabilisation attempts, inflation has remained a central and unresolved problem, with far-reaching consequences for investment, output, employment, and external trade.

The actual behaviour of inflation over the last 75 years provides an illustration of the phenomenon (*Figure 1*).

Figure 1
Argentina's recurrent inflation rates (annual, 1945–2024)
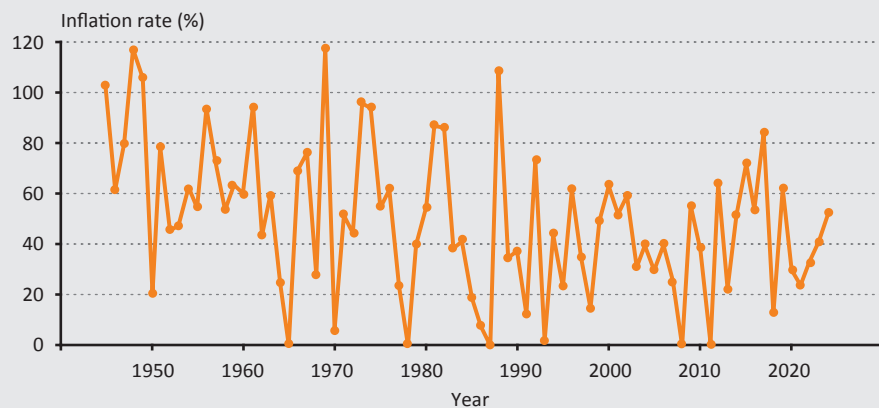
Source: World Bank Database

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[1] The quotations used in this essay are either original formulations or paraphrased expressions constructed to reflect the rhetorical and ideological tone of Argentine political discourse. While not sourced from specific individuals, they are inspired by commonly observed narratives, academic commentary, or journalistic satire related to Argentina's economic and political history.

Inflation has been a trend-less roller coaster with rates that have fluctuated between zero and almost hyperinflation levels. While high inflation was usually followed by emergency stabilisation programmes that managed to control inflation, that was only temporarily and often carried a recessionary tag. The persistence of price increases made the economy highly susceptible to inflationary expectations for all relevant decision-making. This, in turn, induces a high level of indexation and dollarisation throughout the economy, conditioning the design of feasible stabilisation programmes.

The first robust econometric study of inflation, related to the period 1935–1962 was *Diz* (*1970*), who applied the methodology of *Cagan* (*1956*) to test the Quantitative Theory of Money. He found that monetary expansion was the principal driver of inflation for that period, with expectations playing a critical role. There were attempts to replicate these results for other periods, but the results were not always robust due perhaps to high volatility of inflation and the massive structural shocks that hit the economy in the post-war period.[2]

The second notable marker of high and persistent inflation is the number of monetary reforms that took place over the period, usually as part of a stabilisation programme. Between 1945 and 1992 the Argentine peso was substituted five times by a newly denominated currency and, in total, 13 zeros were dropped. As an illustration of the currency loss of value due to inflation, consider that if you were holding 1,000 pesos in 1945, your holdings would be worth 0.0000000001 pesos by 1992.

While high and variable inflation occurs in many countries and monetary reforms are occasionally implemented, the degree of time persistence seen in Argentina is not common. What accounts for such divergency?[3]

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[2] Some of the most widely quoted econometric studies on Argentina's inflation are by *Diz* (*1970*), *Damill and Fanelli* (*1992*), *Kiguel and Liviatan* (*1992*), *Damill and Frenkel* (*2003*), *Basco et al.* (*2009*), *D'Amato and Garegnani* (*2013*) and *Cavallo* (*2013*).

[3] Relevant readings to learn about the longer-run trends in the Argentina economy with a particular emphasis on the inflation problem include *Fanelli and Frenkel* (*1999*), *Canavese and Gerchunoff* (*1996*), *Calvo and Murillo* (*2012*), *Ocampo* (*2021*), *Rodríguez* (*1982*), *Sturzenegger and Werneck* (*2006*), and *Marzetti and Spruk* (*2023*).

3. An explanation – Perón and his legacy

"There is only one thing more permanent than a Peronist policy – its unintended consequences."

One likely reason to Argentina's exceptional trajectory lies in the overwhelming and determining political, institutional, and economic role played over the last 80 years by Juan Domingo Perón and the Peronist movement that he found.

Juan Domingo Perón was a central and the most influential figure in Argentine politics and economics during the twentieth century. He was President in 1945–1955 and then again in 1973–1974, but he conserved maximum power during his 18 years of exile in Madrid, and after his death in 1974 his party continued to have decisive influence in Argentina, whether it was in power or in opposition. His political and economic ideology, shaped by personal experiences, ideological influences, and the historical context of his time, left a lasting structural imprint on Argentina's economy and on its society.

Reviewing the intellectual roots of Perón's political doctrines and economic thought, one can trace the path of the structural and macroeconomic policies that were followed in Argentina since the 1950s. A central claim of this paper is that the policies emanating from the Peronist doctrine are intrinsically inflationary and/or competitiveness-eroding. Therefore, only by dealing with these structural and political dimensions of Peronism alongside the macroeconomic variables in the design of stabilisation programmes one can deal successfully with Argentina's chronic inflation.

4. Ideology and implementation

"Peronism is the only ideology that can turn a fiscal deficit into a glorious national achievement."

Perón's tenure as military attaché in Rome between 1939 and 1941 played a decisive role in shaping his economic worldview. During this period, he closely observed Italian fascist corporatism, but despite admiring Mussolini he did not take Fascism at face value. He was also influenced by three other currents of the time: the American New Deal; the emerging European welfare state, that informed his vision of an active, regulatory, and redistributive state; and by the social doctrine of the church, from whose rhetoric of "social justice", "labour dignity", and organised labour he drew heavily.

Blending all these influences and adapting them to local realities, Perón developed and promoted his own movement, Justicialismo, a political-economic doctrine that amalgamated economic nationalism with social justice. Built upon the triad of social justice, economic independence, and political sovereignty, his model advocated a strong state, powerful trade unions, and public ownership of strategic sectors.

One area where Perón went beyond his intellectual influences is in the role of the trade unions. Peron saw trade unions as pillars of the political system much as Mussolini's syndicates inside the corporatist state. In all social conflicts, Perón tilted strongly towards labour granting unions real benefits, wage gains, paid vacations, social services and political clout. In exchange, the unions acted as the trustable regime's electoral and street muscle. The incorporation of these principles into state doctrine is a central element to understand the endurance of Peronism and its ability to exercise power effectively even years after the disappearance of its leader.

When Perón came to power in 1945, he moved energetically to implement his sweeping reforms that were largely based on this ideology. The period 1947–1952 was the most transformative period of his leadership. During that period the state assumed a dominant role in the economy: it created numerous state-owned enterprises, imposed price and exchange controls, employed public spending as a redistributive tool, and subordinated the Central Bank to executive power. While these measures expanded state influence, they also undermined economic efficiency, discouraged private investment, and fostered a culture of state dependency. They eroded competitiveness and disregarded budget constraints and were intrinsically inflationary.

Perón embarked on an ambitious model of import-substitution industrialisation (ISI) policy to reduce dependence on imports and encourage domestic industry. The widespread use of subsidies, tariffs, and state control over everything that could be considered strategic was established. Industry was promoted but, for budgetary and distributional reasons, exports were, at best, neglected. Agricultural prices were fixed, an export tax on agricultural commodities was introduced, and the government created the IAPI (Instituto Argentino de Promoción del Intercambio) that monopolised foreign trade. Farmers were severely underpaid leading to stagnation in agriculture, traditionally Argentina's key export sector.

One of the most thorough, enduring, and probably most damaging structural consequences of Peronism was the *empowerment of labour unions* as central political actors. The unions became pillars of the regime. Their main platform, the Confederación General del Trabajo (CGT), became a political arm of the

Peronist movement and served the interests of the party as much as those of the workers.

Perón restructured labour laws to guarantee "appropriate outcomes" in collective bargaining and limited dismissals, and created a web of social protections that was unprecedented, as was the amount of power accumulated by the trade unions and its leaders. By 1949, the CGT had become not only the largest trade union in Latin America, but also the politically most influential. The power of trade unions in Argentina has persisted beyond Peronist administrations.

As is well known, in the short run these interventionist policies may work, particularly before inflationary expectations become entrenched. In Argentina, real wages rose, employment expanded, and domestic demand surged. These outcomes fuelled initial growth and popular support. However, this success was achieved by expansionary fiscal policies financed by the Central Bank, strict price controls, and real wage increases not matched by gains in productivity, adversely affecting the competitiveness of the country.

During the early years of programme implementation, Argentina benefited from the fact that the country emerged from World War II with a large stock of foreign currency and gold, thanks to food exports to war-stricken areas of the world. Perón used these reserves to finance his public works, industry, and social programmes. However, by the early 1950s the reserves had been depleted, initial prosperity turned into stagnation, and inflation rose further. Austerity measures were introduced, including wage freezes and fiscal tightening. This was the first of a total of eight well-defined macro cycles that have affected the country in the last 70 years.

Foreign exchange shortages and a drop in productivity and real wages eroded Perón's support and in 1955 he was ousted by a military coup. After his removal, Perón spent 18 years in exile. However, by then his imprint had already been established and the Peronist ideology remained central in Argentinian politics and economics. The country continued to experience periodic balance of payments crises, chronic inflation, and a steady erosion of competitiveness. It is during this period when it became evident that these dynamics were not merely the results of short-term mismanagement, but were rather rooted in the very institutional architecture constructed during the formative years under Perón.

5. Post-Perón evolution from 1973 to present

"45% of Argentinians are centrists (radicals or social democrats), 30% are socialists, and 25% are right leaners. All the 100% are Peronists."

Perón returned to power in 1973 with massive popular support, but received an economy already destabilised by inflation and political violence. He tried to implement a "social pact" seeking to control prices and wages through a pact between labour, government and employers. His "magic" did not play this time, and the pact unravelled quickly. Inflation continued to climb, going over 60 per cent in 1974.

Perón died in 1974, but successive governments – Peronist and non-Peronist alike – struggled, to no avail, to dismantle the institutional legacy he left behind. A combination of entrenched union power, powerful vested interests, high distributional expectations, and resistance to reform prevented the emergence of a sustained, competitiveness-driven growth model.[4] The military dictatorship that took over in 1976 sought to dismantle Peronist institutions, but not its deeper economic logic. The Junta implemented a neoliberal policy framework under Economic Minister Jose Alfredo Martinez de Hoz. It comprised trade liberalisation, financial deregulation, and a fixed exchange rate. Yet the reform effort collapsed in 1981 under the burden of growing foreign debt and rising inflation. Ultimately, the dictatorship did not improve the structural imbalances.

The return to democracy in 1983 did not reverse the corporativist logic or reduce the state centrality of Peronism. President Alfonsin, from the Radical Party, had the credentials to confront Peronism, but he also failed to overcome Argentine economic malaise. He attempted to combine fiscal reform with wage-led growth. But the programme rapidly crumbled given the hostile reaction of organised labour. Again, the loop was at work, with prices rising to reach hyperinflation rates in 1989 (peaking at 3,000 per cent when annualising weekly rates). Alfonsin's weak political mandate and his major concessions to the trade unions prevented a stabilisation programme and provoked his early resignation, paving the way for a new phase of Peronist rule.

In 1989, Carlos Menem – a Peronist – was elected president. But in a sharp ideological and political pivot, he launched sweeping liberal reforms, including large-scale privatisations, trade liberalisation, and some labour market reforms. Most noticeable, he introduced the "Convertibility Plan" under Economics Minister

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[4] On the enduring effects of labour-based populist incorporation and its institutional legacy in Argentina, see *Collier* (*1999*).

Domingo Cavallo which pegged the peso 1–1 to the US dollar and eliminated all exchange controls. These policies temporarily stabilised inflation and attracted capital inflows, but substantial fiscal deficits and important imbalances in external accounts persisted and made the programme unsustainable. Once again, the competitiveness trap was at work, as competitiveness was eroded due to the fixed exchange rate in the presence of rising wages and costs. While the early 1990s saw growth, the second half of the decade witnessed rising unemployment, stagnation and growing social unrest.[5]

By the end of the decade, public debt had become unsustainable and in 2001 Argentina defaulted and abandoned the convertibility regime. The ensuing crisis led to mass protests, a run on banks, a collapse in GDP, and a profound political vacuum. The country was again on the brink of hyperinflation (*Blejer 2005*).

From the chaos emerged still another brand of Peronism–Kirchnerism. Nestor Kirchner (2003–2007) and Cristina Fernandez de Kirchner (2007–2015) – acting more with political expediency than with ideological conviction – used the discrediting of neoliberalism to reinstate with force many of the symbols and rituals of hard Peronism with its populist and nationalistic economic rhetoric. But it was not only rhetoric. Argentina increased market intervention and renewed many inflationary measures by embracing price and capital controls, export taxes, and more nationalisations, including re-nationalisation of enterprises previously privatised by the Menem government.

5.1. Why Peronist policies can be considered intrinsically inflationary?

The dynamics at play in Argentina are best understood by examining the intrinsic inflationary bias of Peronist economic policy instruments.

Even a casual review of the main instruments that constitute the core of "Peronist Economic policies" reveal that they are incompatible with long-term price stability. The main policies include:

a) *Structural wage-price dynamics*: Peronism institutionalised centralised, politicised wage bargaining through powerful trade unions. Wages become not just a cost variable, but a political entitlement. This resulted in a cost-push inflationary bias. Any attempt to stabilise through wage restraint faced immediate resistance and erosion through periodic catch-up rounds.

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[5] See *McGuire* (*1997*) and *Levitsky* (*2003*).

b) *Fiscal populism*: Peronist administrations tended to prioritise distributive objectives and full employment over fiscal balance. Recurrent fiscal deficits frequently financed by monetary expansion became an enduring feature, although later on this was supplemented by public debt. As most of the fiscal deficits were structurally linked to transfers, subsidies, and over-employment in the public sector finance became a quasi-permanent mechanism.

c) *Indexation and expectations*: The historical frequency of information under Peronist Governments led to backward looking indexation of wages and contracts embedding inflation into the economic structure. This created inertial inflation where price dynamics persist independently of demand shocks.

Initially supported by a favourable global commodities boom, these policies allowed for strong GDP growth and poverty reduction. But as the terms of trade turned around by the early 2010s, fiscal sustainability rapidly eroded, reserves declined, and inflation resurfaced in earnest, increasing social pressures and the return to state-led redistribution, reviving key elements of classical Peronism, including the strategic alliance with organised labour. Competitiveness has lost another round.

6. Between Kirchnerism and Milei: The Macri interlude

"*You can win elections without Peronism, but you cannot govern Argentina without it.*"

Following a prolonged period of Kirchnerist rule, Mauricio Macri was elected President in 2015 with a centre-right, pro-market platform that promised to restore macroeconomic stability, liberalise the economy, and reduce the pervasive influence of Peronist corporatism. It was the first time since the return to democracy in 1983 that a non-Peronist coalition had won the presidency in a free and fair election and completed its term.

Macri inherited a heavily distorted economy: capital controls, export taxes, a bloated public sector, high inflation, and fiscal imbalances. His administration initially enjoyed strong political support and external goodwill. Early measures included the removal of currency controls, elimination of agricultural export taxes, and a resolution of Argentina's long-standing dispute with foreign creditors – steps that restored market access.

However, Macri adopted a gradualist approach to structural reforms, prioritising social and political stability over rapid fiscal adjustment. Public spending remained high, and the government financed deficits through debt issuance rather than politically costly austerity. When global financial conditions tightened in 2018, investor confidence waned, leading to a currency crisis, a return to IMF support, and deepening economic instability.

The Macri administration's failure to deliver sustained growth or reduce inflation – combined with rising poverty and unemployment – undermined its reformist credibility. In 2019, Macri lost the election to Alberto Fernández, a proxy for Cristina Kirchner who was returning as Vice President. This defeat marked the reassertion of traditional Peronism and illustrated the difficulty of implementing non-Peronist reforms within Argentina's entrenched institutional framework.

The Fernandez administration re-emphasised traditional Peronist themes of social protection, public spending and social justice, but the quality of public services, infrastructure and education kept deteriorating. At the same time, inflation soared above 94 per cent in 2022 and real incomes stagnated. Efforts to stabilise the currency through multiple exchange rates and interventions further distorted incentives. By 2023 the country faced another major inflationary crisis and political fragmentation.

6.1. Why Peronist policies can be seen as anti-competitiveness?

The persistence of low competitiveness and recurrent macroeconomic crises in Argentina can be traced to institutional and policy features embedded in the Peronist framework:

a) *Labour market rigidities*: Peronism protection of somewhat-arbitrarily-defined workers' rights created a dual labour market. A formal sector with rigid costs and an informal sector absorbing flexibility. This rigidity reduced productivity growth and discouraged investment in tradable sectors.[6]

b) *Overvalued exchange rates and import substitution*: The Peronist model favoured import-substituting industrialisation and undervalued the role of export competitiveness. Recurrent use of the exchange rate as a nominal anchor (to contain prices) eroded external competitiveness and led to recurrent balance of payment crises.

c) *Protectionism and rent seeking*: High tariff walls and discretionary subsidies protected inefficient industries generating a rent sharing equilibrium between capital and labour under state arbitration – an arrangement incompatible with global competitiveness.

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[6] As documented by *ECLAC-ILO* (*2019:44, Graph II.11*) real wages in Argentina have often outpaced productivity, reinforcing cost-push inflation and eroding external competitiveness.

7. Javier Milei: break from the past and why this time it may be different

"Milei is not just anti-Peronist—he is anti-statist, anti-collectivist, and anti-system."

An important change took place in Argentina in 2023. Once again, the economic results of the Peronist administration were disappointing, but this time there was an additional factor eroding people's confidence in the government and in the Peronist administration – widespread and pervasive corruption reaching the highest echelons of government, including former President Cristina Kirshner. It seems that people were tired of politicians and were demanding a radical change. In this environment, a professionally trained economist, a political outsider, Javier Milei, unexpectedly won the presidency on an ultra-liberal, anti-Peronist platform. The election of Javier Milei in 2023 marked an unprecedented shift in Argentine politics. A libertarian economist with no prior executive experience, Milei rose to prominence through his fiery media presence and radical discourse. Rejecting not only Peronism but also the traditional party system, Milei ran on a platform of "chainsaw economics," pledging to dismantle the "caste" of political privilege and to drastically shrink the state. The main components of Milei's economic programme include:

• Eliminating the fiscal deficit through drastic cuts to public spending, subsidies, and public-sector employment.

• Privatising state-owned enterprises and liberalising trade and capital flows. Liberalising and de-regularising the economy as much as possible.

• Restoring solvency to the Central Bank.

• Liberalising and deregulating labour markets, particularly cutting the power of labour unions in collective bargaining and the ability of trade unions to blackmail firms to alter production patterns for political objectives.

• Reorienting the international alignment of Argentina towards advanced Western economies, strengthening Argentina's presence in the OECD, the BIS, and the G20 rather than in the BRICS.

But Milei's highest priority has been to reduce inflation to arrest the dangerous slide towards hyperinflation that he inherited. During his first year, Milei moved quickly. He eliminated the fiscal deficit during the first year in office through severe expenditure cuts, removed price controls and subsidies, reduced export charges, and stopped monetary financing of the Treasury.

Inflation started to decelerate, to 2.5 per cent monthly in May 2025 from 15.6 per cent a month in May 2023. It is expected not to exceed an annual rate of 35 per cent for 2025. The risk of default has receded, but country risk is still high, although it almost entirely reflects a "risk of return", i.e. the fear lingering in some circles of the establishment that Peronism may still pull off a political comeback.

However, as the mid-term congressional elections in the autumn of 2025 approached, political uncertainty increased and an unexpected electoral loss in by-elections in Buenos Aires in September created an environment of uncertainty, stimulating capital flight. Deciding to protect his disinflationary success, Milei intervened heavily in the foreign exchange market, keeping the value of the peso excessively strong, which hurt the incipient recovery and raised country risk, provoking a run in the US dollar market. Overvaluation of the peso sucked in imports and prevented Argentina from increasing international reserves, as agreed with the IMF, and from building the stock of US dollars it needs to repay a mountain of foreign debt.

Such use of the exchange rate for stabilisation purposes was considered by most observers as a mistake. The government emphasised too much the inflation side and did not cover itself enough on the reserve side. This left it vulnerable to political and external shocks.

These revived the lingering doubts of whether the vicious inflationary cycle would be indeed broken this time, or the Peronists would once again return to power with their old model. In a last moment attempt to halt the sell-off of Argentine assets, the United States Treasury announced that the Trump administration "stands ready to do what is needed" to support Argentina and that "all options for stabilisation are on the table".[7]

The support package has two main elements: (1) a currency swap facility of USD 20 billion between the US Treasury and the Argentine Central Bank BCRA that gives access to US dollars via the Treasury's Exchange Stabilisation Fund (ESF); and (2) an additional USD 20 billion mobilisation of credit lines via private/sovereign funds.

The measures greatly helped to calm the market and played a role in the decisive results of the October 2025 congressional elections. These results show strong public support for the government reform effort and, depending on the political abilities of Milei, the new composition of Argentina's Congress may open the door for negotiating and compromising.

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[7] @SecScottBessent on X, September 22 2025. https://x.com/SecScottBessent/status/1970108242522251304

Milei's presidency represents something genuinely new: a frontal assault on the economic structures built since the first Perón presidency. His diagnosis is that Argentina's crisis is institutional – not just economic – and his strategy reflects this. He created the Ministry for Structural Reforms and entrusted it to a renowned Argentinian economist, former president of the Central Bank Federico Sturzenegger, who is doing an excellent job in cutting the size and increasing the rationality of the public sector. Nevertheless, whether Milei's radical approach can be politically sustained and institutionally consolidated remains the defining question for Argentina's future.

8. Conclusions and policy implications

Despite numerous and often well-designed stabilisation attempts, Argentina consistently failed, over a long period of time, to control inflation in a sustainable way. These failures took place under a variety of political and economic systems. From democratic regimes to military dictatorships, from populists to right-wing governments, from heterodox plans to traditional currency and fiscal rules and so on, each and every stabilisation programme collapsed under the weight of deeper, unheeded and unaddressed distortions. This long succession of debacles did not merely reflect a string of technical errors or analytical blunders, it is rather testimony to a persistent unwillingness and an objective inability of society to confront the true roots of the problem.

Chief among these distortions is the structural inflexibility imposed on the overall economy by the deep politicisation of trade unions. This inflexibility – embedded in innumerable labour-market rules and labour legal practices, strong union power and validating public sector practices – has severely hindered domestic and foreign investment, reduced Argentina's productivity gains, enfeebled external competitiveness, and created a feedback loop in which inflation becomes self-reinforcing. On top of this economic constraint plays the strong political interaction between Perón's ideology, Peronist political activism, and organised labour that established an iron-clad corporatist system, in which wage negotiations, labour protections, and strike powers are politically mediated rather than economically justified. In these circumstances, it was difficult to make real wage adjustments, and the result was a persistent imbalance between real wages and productivity, leading to rising unit labour costs and a loss of external competitiveness, resulting in recurring devaluations and more followed by additional inflationary pressures.

It is therefore not surprising that, despite multiple economic reforms and stabilisation programmes, inflation continues to reemerge in Argentina. Without addressing the political economy of labour-market rigidities and the institutional legacy of Perón and Peronism, reforms are unlikely to achieve lasting stabilisation. The system created a "trap" in which any credible reform effort is either blocked by entrenched political and corporatist interests or undermined by weak or inconsistent implementation.

President Milei has scored significant success at the macro level. His drastic austerity programme slashed the fiscal deficit and, most notably, controlled inflation that was approaching hyperinflation levels as he took over in December 2023. Also, albeit at a slower pace, a significant number of structural reforms were implemented.

With support from the US government, market volatility was also successfully managed around the mid-term congressional elections in the autumn of 2025, where the October results showed strong public support for the government's reform effort. The new composition of Argentina's Congress may open the door for negotiating and compromising. Despite Milei's weak record as a domestic negotiator, he may have no choice. He must succeed in forming a coalition for reform because this may be the last chance for Argentina to shatter Peronism and escape the inflationary trap that has defined its economic trajectory for the past eighty years.

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Ireland and the Euro – From Boom to Bust and Beyond*

Donal Donovan ⓘ

Ireland's experience as an enthusiastic founder member of the euro area in 1999 has been characterised by several distinct phases. The initial years of membership saw a continuation of the unprecedented Celtic Tiger "boom" of the 1990s, largely driven by direct investment inflows of US multinationals. However, as the decade wore on, Irish policy makers permitted the emergence of a property bubble along with a massive surge in government expenditures. With the onset of worldwide financial turbulence in 2008, Ireland was plunged into the worst economic and financial crisis in its history, requiring an emergency bail out from the EU, the IMF, and the European Central Bank (ECB). However, following the successful implementation of the associated adjustment programme, Ireland has experienced a highly impressive economic and financial recovery. This paper reviews events leading up to and during and after the 2008/2009 crisis, with particular reference to the impact of Ireland's euro zone membership and lessons that might be drawn from this experience.

1. The historical context

Ireland's joining the euro zone was a logical continuation of earlier steps to open the economy to foreign investment and accelerate the process of "Europeanisation" that had begun with EU accession in 1973. Previously, since independence in 1922, successive governments had adopted a distinctly protectionist, nationalistic economic posture. European Union (EU) membership was seen as a way of lessening

economic dependence on the United Kingdom (UK), the erstwhile colonial master. In the following decades, the economy began to diversify both geographically, with the share of trade with Europe increasing significantly, and structurally.

A major impetus was the surge in multinational companies operating in Ireland. Increasing worldwide globalisation lessened the disadvantages of peripheral locations, especially when, as in Ireland's case, high value technology and pharmaceutical products were involved. Attractive (and often controversial, both then and now) corporate taxation arrangements featured, as did Ireland's attractiveness as the only English-speaking EU member (apart from the UK), a well-educated labour force and a relatively deregulated economy. Sound macroeconomic policies during much of the period also boosted Ireland's image as a stable and welcoming environment for foreign investors.[1]

Ireland's exchange rate arrangements moved broadly in sync with these underlying structural changes. In 1978, Ireland joined the European Monetary System (EMS), breaking the historical one-to-one parity of the Irish pound with British sterling that had prevailed since independence, essentially via a currency board arrangement. Subsequently, the Irish pound formed part of the newly created Exchange Rate Mechanism (ERM) and floated against sterling in line with movements in European currencies.

However, in early 1993, following the devaluation of sterling, speculation forced the authorities to devalue the Irish pound. Soon thereafter, the ERM adopted wider bands and committed to move towards European Monetary Union (EMU), thereby removing exchange rate pressures. Ireland had earlier passed the Single European Act which entrenched an exceptionally high degree of openness of the economy.

Nevertheless, joining EMU was not without some concerns (see *Fitzgerald and Honohan 2023*). The removal of an exchange rate depreciation option exposed potential competitiveness difficulties should sterling depreciate. On balance, however, it was felt that this risk was outweighed by a likely narrowing of EMU interest differentials and a continuation of deeper integration with Europe.

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[1] But not always: an ill-fated attempt to accelerate growth in the late seventies caused a fiscal and debt crisis. which required the introduction of a major austerity programme.

2. From boom to bust[2]

During 1994–2000 Ireland experienced an unprecedented boom. Real GDP growth averaged almost 8 per cent per annum; unemployment plummeted from 16 per cent to just over 4 per cent and the debt/GDP ratio fell to a modest 40 per cent. However, from 2001 onwards, export growth started to taper off, replaced by a surge in domestic demand, closely linked to the eventual emergence of a classic property bubble. In turn, this led to a major boost in both tax revenues and public expenditure.

The bursting of the bubble in 2008 heralded a deep recession and a fiscal collapse, followed by a domestic banking crisis. Late that year, fearing an imminent bank run, the government announced a comprehensive state guarantee of all domestic banks' liabilities. By 2010, the crisis had intensified as the full costs of the fiscal disaster and the rescue of the failing banks became clearer. No longer able to access international financial markets on reasonable terms and with exceptional emergency ECB lending support that existed at the time exhausted, the government was forced to seek assistance from the EU and the IMF, in coordination with the ECB. Between 2000 and 2012 the debt-to-GDP ratio rose from 38 per cent to 129 per cent; the loan from the IMF was equivalent to an unprecedented 2,322 per cent of Ireland's IMF quota.

This cycle of boom-and-bust stemmed essentially from major mistakes by Irish policy makers – largely acquiesced to by domestic politicians and public opinion. But to what extent did extraneous elements – including those associated with euro area membership – contribute, directly or indirectly, to the eventual debacle?

2.1. The property bubble and bank lending

The Irish property market, after growing steadily, but not spectacularly, experienced a temporary slowdown in 2001, largely reflecting external factors such as the collapse of the dot.com bubble and the impact of 11 September. However, rather than letting prices settle at a reasonable level, the government decided to provide a wide range of significant fiscal concessions to support the sector. Slowly at first, but then at an accelerating pace, the market reignited to eventually become a full-scale speculative bubble.

The key driver was the banks' willingness to provide large-scale financing for both residential and commercial developments on progressively more flexible terms, involving, for instance, interest only loans and rollovers, loan-to-value ratios

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[2] For a comprehensive and detailed discussion by key figures involved in the Irish crash and external commentators, see the contributions contained in *IMF* (*2015*) and *Baudino et al.* (*2020*).

exceeding 100 per cent and a casual attitude to identifying the actual net worth and repayment capacity of borrowers. Banks rushed to catch up with their competitors and participate in a lending frenzy, not only in the Irish, UK, and US markets but in more exotic locations such as India and Cape Verde. Throughout, the media eagerly reported on what appeared to be ever-increasing prices and readily available profits. Bank credit to households and developers rose by 158 per cent and 338 per cent, respectively, in the period 2003–2008 (*Honohan 2010* and *Nyberg 2011*).

This unprecedented expansion in lending was not linked to an increase in deposits, but depended on large-scale capital inflows – initially at low cost – from international financial markets. This funding was quite distinct from the continued surge in foreign investment and financial inflows associated with the operations of multinationals. As time went on, however, funding terms started to shorten, thereby exacerbating banks' vulnerabilities. Ireland's euro area membership undoubtedly provided some comfort to foreign lenders, nor did investors consider seriously that the authorities would ever allow a euro member's banking system to collapse.[3]

The Irish crisis caused considerable debate as to the sharing of responsibility for the reckless lending by the banks – and consequently apportionment of the subsequent bill. Was it driven mainly by Irish eagerness to avail of apparently costless new riches? Or did foreign institutions "push their funds" on Ireland regardless of risk considerations? It is safe to assume that absent euro area membership, the financial environment that enabled the Irish boom would not have been present.

2.2. The failure of financial regulation

Who should be blamed for allowing this essentially unchecked lending by the banks? The earlier EU decision to devolve financial regulation to the national level was a critical factor.[4] Thus, together with the passive approach by the ECB prior to the crisis, meant that the responsibility for ensuring financial stability lay on the shoulders of each national regulatory entity.

The Irish authorities, however, had adopted the so called "light touch" or "principles" approach to financial regulation in vogue at the time. The Financial Regulator[5] focused mainly on the internal processes of the banks, rather than on the substantive analysis underlying their lending decisions. Up until 2007–2008, when

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[3] It has not been possible to ascertain accurately the nationality composition of the lending institutions (see *Fitzgerald and Honohan 2023*)

[4] While prior to the crisis financial sector/bank regulation was in the hands of national authorities, for cross-border banks supervision was vested with the home country regulator, with assumed, but de facto largely not effective, cooperation with the authorities of the host country where the banks' subsidiaries operated.

[5] The Irish system was a hybrid, consisting of a semi-independent Financial Regulator under the umbrella of the Central Bank, which bore overall responsibility for ensuring financial stability. Although rather unwieldy at times, this setup was not considered a major cause of the regulatory failure.

it was too late, both the Central Bank and the Regulator persisted in the view that the exceptional concentration of property-related lending in banks' portfolios did not pose a major danger and that a manageable "soft landing" was in prospect.[6] Group think prevailed and no analysis was undertaken, even internally, to consider alternative outcomes.

As late as 2007 the ECB's Financial Stability Report painted an overall rosy outlook as regards the zone's continuing financial stability. There was no mention of Ireland's situation, which by that stage might surely have stood out as a striking case of increasing financial vulnerabilities. Thus, while the earlier decision to devolve financial regulation was ill-fated, subsequently, the apparent indifference on the part of the ECB to potential vulnerability concerns compounded the problem.[7]

2.2.1. The comprehensive bank guarantee

In late September 2008, in the wake of world-wide financial turbulence and faced with fear of an imminent bank run, the Irish government took the unprecedented decision to provide a full guarantee with respect to the liabilities (i.e. deposits and bonds) of the four domestic banks. The authorities had concluded that allowing any Irish bank to fail was likely to have drastic reputational consequences.

This action – probably the most controversial economic policy in the history of the state – succeeded in forestalling an immediate crisis. However, the government's underlying assumption at the time, namely, that the problem consisted of a temporary shortage of liquidity proved illusory. Subsequently, as the fundamental weakness of the banks became clearer, taxpayers realised they were "on the hook" to bail out the banks' creditors who had engaged in foolish lending.

Donovan and Murphy (*2014*) critically assessed possible alternatives to the guarantee. These included "doing nothing"; waiting for European institutions to intervene; and/or limiting the scope of the guarantee by maturity or liability class. They concluded that given the circumstances prevailing at the time, the guarantee may have been the "least worse" solution available.[8]

The Irish authorities' dilemma was exacerbated by the absence of any generalised, euro-wide support structures as the crisis spread. Although national authorities

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[6] To illustrate, the Central Bank's published "soft landing" scenario assumed that property prices would decline by 15 per cent. In the event, residential prices fell by just over 50 per cent and the value of commercial developments in many cases dropped by up to 80 per cent. The IMF's view during 2006–2007, in the context of its Financial Sector Assessment Program, was similarly benign. (For a fuller discussion of the IMF's role in the Irish Crisis, see *Donovan 2017*.)

[7] The first sign of a looming financial crisis had already started to appear in late 2007 and early 2008, when the UK Government intervened to guarantee the deposits of Northern Rock and prevent a total bank failure.

[8] However, there was broad agreement that the inclusion of subordinated debt, though not a large component of total bank liabilities, was probably a mistake.

were in broad agreement that no bank was to be allowed to fail, *Honohan* (*2010*) concluded that the message via informal contacts with the ECB was clear, namely, "that each national authority would have to take whatever measures might prove necessary to deal with its own situation". Thus, a "wait-and-see" attitude on Ireland's part most likely would only have, at best, postponed the day of reckoning. In sum, the Irish case, as well as some others, highlighted that, in addition to not having a cohesive approach to identifying financial stability concerns, the overall EMU structure at the time lacked contingency arrangements to deal with possible crises.

2.3. The fiscal collapse

If the taxpayer had not been forced to bear the banks' losses via the 2008 bank guarantee, might Ireland's fiscal deterioration have been manageable? Perhaps, but on balance unlikely. The budget moved from a small surplus in 2007 to deficits of 7.3 per cent and 14 per cent of GDP in 2008 and 2009, respectively, before reaching an unheard-of 31.2 per cent in 2010 (excluding the one-time costs of bank recapitalisation, it was 11 per cent).

During the early 2000s, on the back of soaring revenues directly and indirectly related to the property boom, the authorities had boosted expenditures across-the-board and lowered taxation rates, while still maintaining a broadly balanced budget. However, with the crash, revenues evaporated virtually overnight, while unemployment rose sharply and recession deepened. This led to unavoidable expenditure pressures. The Department of Finance's borrowing requirement began to soar.[9]

As with risks to financial sector stability, the unsustainability of Ireland's underlying fiscal position went largely unnoticed prior to the crisis. No analysis was undertaken (even internally by the Irish Department of Finance) of budgetary scenarios based on other than the "soft landing" hypothesis. Nor did the central bank raise the alarm. By many accounts, a fear of "frightening the horses" that could lead to a meltdown of public confidence was an important inhibiting factor.

What role did external assessments play? As noted already, the IMF painted a rosy assessment of the budgetary outlook; and neither did the OECD raise significant concerns. In tandem, architectural weaknesses undermined the possibility of the EU/eurozone authorities exercising a restraining influence. The Maastricht Treaty limits (national budget deficits not to exceed 3 per cent of GDP and the debt-to-

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[9] A 2007 IMF report had projected Ireland's "structural" budgetary position (i.e., cyclically adjusted and including one-off factors) as a small surplus in 2005–2009. Yet, two years later, according to IMF "re-estimates", the structural deficit in terms of GDP in fact had reached 9 per cent and 13 per cent in 2007 and 2008, respectively.

GDP ratio to be below 60 per cent of GDP) were violated by a majority of countries, many by wide margins and for significant periods. For reasons that many believed were political in nature (although fears of an adverse market reaction may have played a role), no fines were ever levied on those members (including France and Germany) that broke the rules. Nor did the Maastricht ex post system provide means for identifying, let alone addressing, structural budget weaknesses, of which at that point Ireland was the most glaring example.

2.4. The bail out and beyond

In late 2010, following the earlier Greek bail out, the Irish authorities bowed to the inevitable and requested an emergency three-year loan from the EU and the IMF, in conjunction with the ECB (collectively known as the "Troika"). The programme agreed with the Troika had two major elements: a major fiscal retrenchment, and the complete overhaul of the by then almost broken banking system.

The experience with the bail out was widely considered to have been highly successful. Unlike in many, if not most, IMF interventions, all of the programme's periodic quantitative targets were observed and all disbursements of needed financial assistance were made without any delay. The budget deficit was reduced from 11 to 3 per cent of GDP over three years. Unemployment, which had soared from 4 per cent in 2007 to 14 per cent by 2009, fell to 2 per cent in 2015, while government 10-year bond spreads, which had peaked in 2011 at 6.5 per cent, declined to one per cent by 2013. Very substantial progress was achieved in rehabilitating the banking system. Ireland repaid the loan from the IMF well ahead of time.

A number of distinguishing features in the Irish programme are worthy of note.

First, while major budgetary cuts were implemented (including a progressive reduction in public sector salaries from inflated levels), the authorities took a principled decision not to lower the levels of basic social assistance entitlements. This helped avert widespread social unrest.

Second, although unemployment remained high throughout (accompanied by the reemergence of considerable emigration from Ireland), by and large public opinion accepted, if at times grudgingly, the necessity of "austerity", following the excesses of the boom. A new coalition government formed in early 2011 included the centre-left Labour Party which, prior to the election, had stated to the Troika their intention to support the programme's conditions. The incoming Taoiseach (Prime Minister) reportedly told a Davos gathering that the problem was that "We had all partied" – a sentiment that many would have had difficulty contesting. Also, while in Dublin, the Troika team engaged extensively with the media and civil society representatives to explain the programme's rationale. Nevertheless, although there was relatively

little public debate at the time about there being no realistic alternative to a major fiscal retrenchment, in subsequent elections, the Labour Party was accused of being a "poster boy" for austerity and suffered devastating defeats.

Third, however, a source of considerable controversy was the treatment of claims of lenders to the banks which were covered under the bank guarantee. During programme negotiations, the Irish authorities sought to impose haircuts (discounts) on some of these claims, notably those on two institutions that were clearly insolvent. Although reportedly some IMF staff were supportive, the EU and the ECB were resolutely opposed, citing harmful systemic, precedent-setting implications. During a teleconference of G7 finance ministers (Ireland was not present), then US Treasury Secretary Timothy Geithner also strongly opposed any such initiative, and it was rejected (*Geithner 2014*). In early 2011, the possible burning of some bondholders was raised anew by Irish representatives, but was again rejected. Given their complete dependence on the Troika to secure needed budgetary financing, the authorities had little choice but to agree.[10]

Fourth, even at the height of the crisis the multinationals remained impressed with the authorities' willingness to openly acknowledge their mistakes and take the necessary remedial actions. The continued contribution of this sector to exports helped to cushion the adverse impact of the fall in domestic demand on output and employment.

Finally, despite some tensions at times (especially vis-à-vis the ECB), at no stage was the possibility of a departure from the euro area ever mooted seriously, even by the (relatively small) group of politicians at the far left of the spectrum. During the most turbulent period of the EU's negotiations with Greece, senior Irish officials informally indicated little sympathy with what they viewed as unreasonable demands by the Greek authorities. Similarly, the theoretical possibility of a return to the link with UK sterling was never contemplated – such a link would have been viewed as a "negative anchor" in both political and economic senses.

2.5. Successful post-program recovery

Ireland's post-programme recovery and a return to fiscal and financial stability turned out to be a well-known success story, indeed deemed by many as "remarkable" (see, for example, *Honohan 2024*).[11] During the past decade, growth performance has been among the highest in the EU. Unemployment fell quite quickly and has remained very low, accompanied by net immigration. The budget

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[10] Given the absence of relevant data, it was not possible to speculate as to whether the nationality distribution of bondholders may have influenced this political decision.

[11] *Kinsella* (*2014*) discusses the relative contributions to this outcome of what he terms "good luck" (largely the continued – and ever expanding – presence of the multinationals) and successful implementation of the adjustment programme.

has on average been close to balance or registered a small surplus and the debt-to-GDP ratio has declined steadily to manageable levels (38 per cent in 2024).[12]

A significant concern, however, is that government expenditures have risen very substantially in the last few years, in the wake of ever-increasing revenue from the taxation of profits of multinationals (these currently contribute almost 30 per cent of total revenues.) The reasons for this sustained upsurge are not entirely clear, although changing US taxation arrangements are believed to have played a significant role at various times.

On the positive side, the authorities have established a "rainy day" fund to help cushion possible adverse budgetary developments. More recently, given the uncertain global economic environment, they have emphasised the risks associated with reliance on revenue from the multinational sector. To some observers, this situation is eerily reminiscent of the dangers stemming from excessive dependence on revenues from one particular (unstable) source and which was the key element that led to Ireland's earlier fiscal crisis.

3. Conclusions

Ireland's membership of the euro zone has been described – perhaps rather unfairly – as something of a "mixed blessing" (*Fitzgerald and Honohan 2023*). On the one hand, Ireland availed of the classic benefits of a currency union (principally, removal of exchange rate risk and lower transaction costs). These, together with Ireland's enthusiastic embrace of the Single Market, accelerated the process of Europeanisation of the economy and helped attract major multinational investment inflows.

That said, membership did not meaningfully constrain Irish policy makers from the folly of their ways before the global financial crisis of 2008/2009. The lack of effective financial regulation, the failure to rein in an out-of-control property bubble and the unsustainable expansion in public expenditures, together with reduced taxation rates, were all "home grown". They occurred without, it seemed, meaningful recognition, let alone intervention, on the part of European partners.

However, membership did significantly limit Ireland's options once the crisis broke. The absence of concerted intervention by Europe left Ireland with little choice but to introduce the 2008 bank guarantee. Subsequently, the lack of agreement on dealing with potentially insolvent financial institutions meant that even a limited "bail in" of bond holders by Ireland had to be taken off the table.

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[12] Using an alternative measure (GNI, gross national income), designed to reduce the distorting effect of multinationals' financial transactions, the debt ratio was 67 per cent.

Ireland's crisis was, in one sense, a relatively straightforward instance of extremely lax financial sector supervision accompanied by a massive fiscal expansion. Unlike in Greece, Ireland did not have deep rooted structural issues relating, for instance, to weak governance, excessive state regulation or widespread tax evasion.

The fundamental euro area architectural weaknesses subsequently led to important euro reforms including the introduction of a centrally (ECB) supervised financial regulatory system (SSM) together with much improved financial stability analysis, a significant enhancement of the methodological and procedural elements of more centralised budgetary oversight and an acceptance that creditors in future will have to share in the costs arising from failed institutions.[13] Also, the European Stability Mechanism (ESM) has been established as a body, somewhat akin to the IMF, that could provide fiscal support to euro member countries facing difficulties. However, there is continued reluctance to introduce a full banking union which would, for instance, involve a common deposit insurance scheme and, as highlighted by *Draghi* (*2024*) and others, much remains to be done to address other structural barriers, including as regards achieving greater financial integration.

The major policy errors by the Irish authorities may have partly stemmed from an implicit belief that euro zone membership would provide a protective shield and prevent any major disaster. This proved not to be the case. Although the Troika bail-out alleviated what otherwise might have been a more traumatic outcome, the human and social consequences of the Irish crash nevertheless proved highly damaging.

What might countries considering adopting the euro draw from Ireland's mixed experience?

While the major post-crisis reforms described above are intended to address the most striking earlier deficiencies in euro area architecture, arguably, some elements have yet to be fully tested.[14] For example, how might increasing fiscal strains (reflecting a combination of geopolitical tensions, a pushback against free trade, immigration and demographic pressures and infrastructural investment needs) be dealt with by euro-wide budgetary surveillance? The experience in the early post-Maastricht period is not an encouraging precedent.

One cannot be sure – no more than Ireland could or should have been – that euro membership will act as a sufficiently stringent bulwark against pressures, from wherever they might emanate. An applicant country thus needs to have a strong

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[13] The SSM took over direct supervision of the four remaining Irish based banks. Credit policies have undergone a very significant tightening. For instance, Irish residential mortgage rates remain distinctly higher than the euro area average; this partly reflects greater lending risks that in turn are associated with historical and cultural resistance to the repossession of household properties.
[14] *Rogoff* (*2025*) refers to "the inevitable next euro crisis".

independent commitment to appropriate fiscal and financial policies and be willing to resist any possible backtracking, including by larger members. Otherwise, it is possible that, over time, some potentially less positive features of a currency union can emerge, to the detriment of both the zone as a whole and individual members, as happened, with devastating impact in the case of Ireland.

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Which Text Method to Choose for Analysing Central Bank Communication? A Comparison of Artificial Intelligence and Previous Techniques*

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Our study compares the characteristics of text analysis methods on communications text samples of the US Federal Reserve and four Central and Eastern European central banks. Based on our results, methods based on BERT-type models are the most accurate at capturing the monetary policy, real economic and inflation information contained in central bank texts, outperforming OpenAI GPT-4.1 and GPT-5 models. BERT-type methods are faster than GPT models and can be run offline without a subscription, but their disadvantages are that the models require separate training, which entails hardware and labour costs, and that modifying the method is cumbersome. Conversely, GPT models are more flexible and have proven to be more accurate on new central bank samples. The dictionary-based methods used as benchmarks are significantly less accurate, but their use may be justified in certain cases due to their speed, cost-free operation and the transparency of the method.

Journal of Economic Literature (JEL) codes: C55, C63, E52, E58

Keywords: central bank communications, artificial intelligence, text analysis

1. Introduction

Automated analysis of central bank communication texts is becoming increasingly widespread as these methods become more accurate. The primary objective of our study is to answer the naturally arising question: which of the many existing methods should we use under different circumstances? To this end, we compare the most popular text analysis methods currently in use in respect of several characteristics (accuracy, speed, cost). The differences in the effectiveness of the methods may be of interest for the central bank communication literature, for

example, with regard to which methods are worth using to measure the market impact of communication; for market participants, in terms of which method can be used to interpret central bank communication more accurately; and for central banks themselves, which seek to monitor their own impact and the information available to market participants.

Since the late 1990s, central bank communication has played an increasingly important role in the monetary policy toolkit. Communication explaining the background of decisions and forward guidance disclosing central bank forecasts has served several purposes.[1] First, central bank transparency helps to achieve the central bank's inflation target by anchoring the expectations of economic operators and can mitigate the incorporation of short-term shocks into long-term expectations (*Blinder et al. 2008*; *Dovern et al. 2012; Eusepi – Preston 2010*). Second, more accurate knowledge of the central bank's forecasts and reaction function coordinates the expectations of market participants (*Ehrmann et al. 2010*; *Naszódi et al. 2016; Seelajaroen 2019*), which increases the predictability of the economy, reducing market volatility and the term premium of yields (*Poole et al. 2002*; *Gábriel – Pintér 2006*; *Horváth et al. 2014*). Third, through communication, the central bank can influence the market yield curve at a broader and more relevant horizon with respect to the real economy than with traditional base rate decisions. This facilitates monetary transmission.[2]

It is important for market participants to interpret central bank communication as accurately as possible. On the one hand, communication conveys information about the central bank's reaction function, which allows conclusions to be drawn about the variables that the central bank will take into account in its future decisions and the weight it will assign to such variables. On the other hand, communication also contains the central bank's views and forecasts on the state of the economy (the so-called information effect, *Romer – Romer 2000*). The information effect can be useful for market participants, because the central bank can devote relatively more resources to forecasting (e.g. it has a larger and better-prepared professional staff than most market participants). A more accurate interpretation of the information content of communication is valuable to market participants, because more accurate forecasts can provide a competitive advantage (e.g. trading consistent with more accurate interest rate forecasts than those of other participants is likely

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[1] *Blinder et al. (2008)* provide a comprehensive summary of the early international literature on central bank communication. From the domestic literature, we would like to highlight the studies by *Csortos et al.* (*2014*), *Bihari* (*2015*) and *Bihari – Sztanó* (*2015*), which deal with experiences of forward guidance, and the study by *Nagy Mohácsi et al.* (*2024*), which compares central bank communication practices in developed and emerging markets.

[2] Empirical analysis of *Gürkaynak et al.* (*2005*) showed that on the days of the Fed's interest rate decisions the market impact of communication was greater than the impact of traditional interest rate policy decisions, using a sample that mainly covered the 1990s. Later, in the 2010s, when traditional interest rate policy instruments lost much of their significance due to the *zero lower bound*, central bank communication became even more important as a policy tool.

to be a profitable strategy) and can also make their investment decisions more sound in general.

In addition to the literature on central bank communication, our study is also related to the IT literature on automatic text analysis,[3] whose methods have also found their way into the economics literature.[4] The branch of economic literature on text analysis that is most relevant to us deals specifically with the analysis of central bank communication. Central bank tonality[5] analysis was originally dominated by dictionary/rule-based approaches with varying complexity (*Apel – Blix Grimaldi 2012*; *Hansen – McMahon 2016*; *Correa et al. 2017*), but from the mid-2010s, these were joined by simpler supervised learning algorithms (*Tobback et al. 2017*) and unsupervised learning algorithms for topic identification (*Hansen – McMahon 2016; Hansen et al. 2018; Thorsrud 2018*). From the 2020s onwards BERT-type large language models became increasingly popular[6] (*Pfeifer – Marohl 2023*; *Gambacorta et al. 2024*). In the last two to three years, generative artificial intelligence models began to be used (*Fanta – Horváth 2024*; *Hansen – Kazinnik 2024; Peskoff et al. 2024; Geiger et al. 2025*).

Given the objective of our study, it is most closely related to the segment that also deals with the comparison of text analysis methods. More specifically, our study primarily seeks to assess how effectively these methods can identify three fundamentals (monetary policy, real economic activity, inflation) and assess their tonality (tight/loose in the case of monetary policy and high/low, accelerating/ decelerating in the case of the other two).

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[3] Machine text analysis initially sought to automate the steps of traditional linguistic analysis, thus originally followed a rule-based approach. However, the path leading to the models currently in use has moved away from this direction and has led instead toward machine learning, both supervised (i.e. that uses human-annotated samples) and unsupervised. A notable milestone on this path was the application of deep learning algorithms (based on neural networks) to convert words (tokens) of texts into numerical values (Word2Vec: *Mikolov et al. 2013*, GloVe: *Pennington et al. 2014*), followed by the transformer architecture (*Vaswani et al. 2017*), which was better also at capturing the context of words. One of the first truly popular and still widely used large language models based on transformers is BERT, Bi-directional Encoder Representation from Transformers (*Devlin et al. 2019*), whose internal structure and parameter estimation method enabled it to arrive at a base model (the so-called pre-training phase) with advanced text analysis capabilities on its own, through self-learning instead of human annotation. The reason for the continued popularity of BERT models is that their source code and base model parameters are publicly available, so the model does not require resource-intensive pre-training to be used; it is sufficient to adapt the model to the task-specific application through fine-tuning (which, however, typically still requires human annotation). In the 2020s, development has entailed the creation of increasingly larger language models and the spread of generative models (e.g. GPT: *Brown et al. 2020*, Llama: *Touvron et al. 2023*), which have reduced the need for task-specific supervised training. Currently, the most important developments seem to be related to tool use by generative models, including RAG applications (*Lewis et al. 2020)*, which involves effective interactions with knowledge base; code writing and web search capabilities; and more general independent tool use and related optimisation ReACT (*Yao et al. 2023)*, on which artificial intelligence agents and agent systems are based. Another direction of development is to make models more cost- and scale-efficient (e.g. DeepSeek: *Li et al. 2024*).

[4] *Gentzkow et al.* (*2019*) provide a detailed summary of this development up to the end of the 2010s.

[5] Tonality refers to the product of direction (sign) and intensity. For example, a statement relating to monetary policy may be hawkish or dovish in orientation (sign) and it can be less or more so in either direction (intensity).

[6] This also includes other models based on the RoBERTa (Robustly Optimized BERT Approach) of *Liu et al.* (*2019*) and FinBERT of *Huang et al.* (*2022*), which, like the original BERT study (*Devlin et al., 2019*), are built upon the architecture presented therein.

Our study is most closely related to the papers of *Kim et al.* (*2024*)*, Gambacorta et al.* (*2024*)*, Pfeifer – Marohl* (*2023*) and *Hansen – Kazinnik* (*2024*), which also deal with different methods of analysing central bank texts and provide comparisons between them. Their comparisons include several BERT-type methods that we also use and GPT models one series earlier than the ones we tested. One of the main differences between these studies and ours is that in our case, we measure the performance of the models on central bank texts from several countries, which allows us to answer the question of how well individual models perform across text samples of different central banks. Another important difference is that our study contains human annotations for three fundamentals separately for each sentence,[7] whereas these studies typically study either the general sentiment of the sentences (positive/neutral/negative) or indications of the monetary policy orientation of the sentences (from loose monetary policy to tight monetary policy) without topic breakdown. Topic breakdown naturally highlights the different performance of the methods for each fundamental.

The GPT prompts developed for our study also take steps towards extracting information from central bank communications that go beyond tonality (more detailed topics, level/change, timing, fact/expectation), and in this respect, we connect to the papers of *Byrne et al.* (*2023*), *Evdokimova et al.* (*2023*), *Geiger et al.* (*2025*) and *Yao et al.* (*2025*), which also deal with some of these aspects.

We are publishing our annotated database and a large part of our codebase to support research and analysis in this field.[8]

2. Data and methods

2.1. Text sample and human annotations

Our text data comes from three sources, with the policy statements of the Magyar Nemzeti Bank (MNB) accounting for the largest share. The texts of 32 randomly selected statements from the period 2017–2024 comprise a total of 2,465 sentences. As for the other sources, we used texts published by two studies (*Gorodnichenko et al. 2023*; *Niţoi et al. 2023*) that were freely available on the internet, and we used

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[7] Human annotations (also known as manual or hand-coded labels) are manually performed sentence evaluations. The purpose of these annotations is to serve as a "grading key" with which we can measure the accuracy of automatic text analysis models. Since manual evaluations can also contain errors, the annotations are performed by several (two) analysts as common in the literature. Only matching annotations are taken into account in evaluation exercises. (Human annotations also play a further role in BERT-type models, where they serve as training samples in the supervised learning step.) In our case, the annotations were performed by colleagues from the central bank. It may be argued that central bank analysts can produce higher quality annotations than market analysts, but this is not necessarily the case, as central bank analysts have the same information (the specific sentence or communication they are required to evaluate) as anyone else who analyses this public content.

[8] Available on the authors' project page https://gitlab.com/central_bank_tonality/kocsis_matraipitz_2025_codes. Note that the paper's disclaimers apply to the supplementary data: published items do not reflect an official view of the MNB.

their annotations as a starting point for creating our own annotations. From the study of *Gorodnichenko et al.* (*2023*), we used the texts of the US Federal Reserve FOMC post-decision statements from 1997 to 2010 – a total of 1,243 sentences – along with their published 3-state (loose/neutral/tight) evaluations. *Niţoi et al.* (*2023*) published a sample of annotated sentences from the 2007–2022 statement texts of four central banks (Polish, Hungarian, Romanian and Slovak). We filtered out the sentences from the MNB to avoid duplication with our own sample and to prevent the MNB data from becoming even more dominant compared to the other central banks in the sample. As a result, we used a total of 1,398 sentences from the Czech, Polish and Romanian central banks using this source. Our total sample thus contains 5,106 central bank communication sentences, roughly half (48.3 per cent) of which are from the MNB sample.[9]

For each statement (sentence), we asked two analysts from the MNB staff to evaluate the texts with respect to three macroeconomic fundamentals:

– MPOL (monetary policy):[10] (positive) information suggesting a tight, restrictive ("hawkish") monetary policy; (neutral) information that mostly suggests a neutral policy; (negative) information suggesting a loose, expansionary ("dovish") monetary policy; (no fundamentals) no information on the given topic;

– REAL (real economic activity):[11] (positive) favourable real economic information indicating a strong economy; (neutral) information that is mostly neutral in terms of the economy; (negative) unfavourable real economic information indicating a weaker economy; (no fundamentals) no information on the given topic;

– INFLA (inflation):[12] (positive) information indicating higher or accelerating price dynamics; (neutral) information indicating stagnating and/or long-term average price dynamics; (negative) information indicating lower or slowing price dynamics; (no fundamentals) no information on the given topic.

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[9] In the case of the MNB, complete statements were included in the database; thus, we know the exact context of the sentences in this sample. However, the texts taken from the two studies contain sentences randomly selected by their authors without precise source references; therefore, the sentence context cannot be used in those cases.
All statement texts used are in English. In the case of the MNB, we used official English-language statements, and the texts used as the basis for the annotations in *Niţoi et al.* (*2023*) are also based on English-language statements.
[10] Including interest rate policy, minimum reserve policy, foreign exchange market interventions, central bank liquidity stimulus programmes, quantitative easing programmes.
[11] This includes information on GDP growth, real macroeconomic activity, total income, output, industrial production, investment, real estate market turnover, consumption, retail turnover, unemployment rate and employment. However, references to exports and fiscal expenditure are only considered relevant if they are explicitly mentioned as components of GDP.
[12] This includes consumer and producer prices, wages (unless the reference is to real wages) and property prices.

Our analysts could take into account the human annotations published by *Gorodnichenko et al.* (*2023*) and *Niţoi et al.* (*2023*) when preparing their own annotations. However, since these were not available in the breakdown by fundamentals that we specified, they had to supplement the original annotations with at least the topic information. In addition, they could override the original tonality annotations if they disagreed with them.

Finally, for every sentence and fundamental (*Table 1*) where the annotations of the two analysts agreed, we saved the annotation, and for annotations that did not agree, we removed the sentence (for that fundamental) from the sample. The annotations did not match in roughly 15–20 per cent of cases, leaving 80–85 per cent of the sample (4,164, 4,175 and 4,328 sentences out of 5,106 for the three fundamentals, MPOL, REAL and INFLA, respectively).

Table 1

Distribution of human annotations used

	Number of sentences			Percentage of sample		
	MPOL	**REAL**	**INFLA**	**MPOL**	**REAL**	**INFLA**
Positive	251	499	471	4.9%	9.8%	9.2%
Neutral	176	171	268	3.4%	3.3%	5.2%
Negative	400	538	344	7.8%	10.5%	6.7%
No fundamentals	3,337	2,967	3,245	65.4%	58.1%	63.6%
Classification mismatch (=invalid)	942	931	778	18.4%	18.2%	15.2%
Total	5,106	5,106	5,106	100.0%	100.0%	100.0%
Of which: valid						
MNB	1,993	2,018	2,048	47.9%	48.3%	47.3%
Fed FOMC	886	943	1,057	21.3%	22.6%	24.4%
CNB	562	537	559	13.5%	12.9%	12.9%
NBP	364	338	348	8.7%	8.1%	8.0%
NBR	359	339	316	8.6%	8.1%	7.3%
Total	4,164	4,175	4,328	100.0%	100.0%	100.0%

Note: The table shows the distribution of the human annotation sample used in our study in columns according to fundamentals (MPOL: monetary policy, REAL: real economic activity, INFLA: inflation) and in rows by annotated category values and distribution by central bank. The 'positive'/'negative' classification indicates tightening/easing in the case of MPOL, improvement/deterioration in real economic conditions in the case of REAL and acceleration/deceleration of inflation in the case of INFLA. The 'neutral' value indicates no change or historical average values. The 'no fundamentals' classification indicates when, according to the annotators, there was no information on fundamentals in the sentence. The 'classification mismatch' value indicates sentences where the two annotators' classifications differed; these annotations are considered invalid and are not used in training/testing.

Source: Authors' calculations

2.2. Text analysis methods

2.2.1. Rule-based methods

For 10–15 years, rule-based or dictionary-based models dominated the economic literature and, within that, the literature on text analysis of central bank communication. Many such methods identified the topics and/or tonality of the fundamentals in the text based on whether the expressions corresponding to the rule/dictionary of the given topic/tonality could be found in the text (for example, typically, the words 'base rate' and 'increase' would indicate the MPOL fundamental and a tightening tonality).

We replicated and adapted four such methods for our purposes on our central bank texts.[13] The methods of *Evdokimova et al.* (*2023*) and *Mátrai-Pitz – Siket* (*2023*) are very similar applications, both contain word lists on the topics of fundamentals and their tonality, and both deal with pitfalls such as opposing signs in the case of employment/unemployment rates, as well as dilemmas regarding negations. In addition to working with different dictionaries, the main difference between the two methods is that while *Evdokimova et al.* (*2023*) conduct the analysis at the sentence and clause level, *Mátrai-Pitz – Siket* (*2023*) disregard sentence boundaries and apply a window-based, keyword-centred approach. *Mátrai-Pitz – Siket* (*2023*) are available for the REAL and INFLA fundamentals, while *Evdokimova et al.* (*2023*) are available for all three fundamentals.[14] The third, rule-based method by *Fulop – Kocsis* (*2023*)[15] differs from the previous two mainly in that it implements regular expressions for topics and tonality expressions, so that instead of individual words, expressions consisting of words at a certain distance from each other identify the fundamentals. This allows for more complex structures. Moreover, this method focuses on fundamental information that is relevant for measuring market effects; thus, the rules only attempt to capture forward-looking information. The fourth method by *Picault – Renault* (*2017*) contains an n-gram dictionary generated from ECB communication texts for the REAL and MPOL fundamentals. Similar to the previous method, this one also allows for longer word combinations and expressions, but here the dictionary of expressions is compiled automatically based on the occurrence of expressions (only neighbouring words) in the sample, rather than manually by human experts.[16]

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[13] We preferred newer methods that provided estimates at the sentence level for the fundamentals we examined. An important reference in the literature, *Apel – Blix-Grimaldi* (*2012*), was not included among the selected methods because, on the one hand, it optimised the search method at the statement level rather than at the sentence level, and on the other hand, their hawkish-dovish estimates (and of many studies that followed) provide a combined estimate of the tonality of the REAL and INFLA fundamentals.

[14] The method of *Evdokimova et al.* (*2023*) also divides the REAL and MPOL fundamentals into several subtopics, which we aggregate as appropriate.

[15] Compared to the published version, the code used here also contains rules for the INFLA fundamental, which follow the same logic as the other fundamentals.

[16] We used the authors' lexicon and replicated their method in Matlab to produce EC (economic) and MP (monetary policy) sentiment components, which we aggregate into the REAL and MPOL fundamental tonality classes at the sentence level that matches the output required by our application.

2.2.2. BERT-type supervised learning methods

Methods based on large language models using transformers can achieve significantly more accurate text analysis performance than rule-based methods. These are also becoming increasingly popular in the field of central bank communication. One approach that relies on domain adaptation typically relies on large language models such as BERT, developed by *Devlin et al.* (*2019*), or similar models such as RoBERTa (*Liu et al. 2019*). These pre-trained base models are sometimes further trained on the language of the specific field. Domain adaptation requires a large amount of text specific to the field's language (in our case, economics/central banking) and significant computational resources.

Finally, the models (whether BERT-type base models or domain-adapted models based on BERT-type base models) must be trained for the specific task (e.g. interpretation and annotation of central bank texts). This step, called fine-tuning, is a supervised learning step. Model fine-tuning requires a training sample, which is typically based on human annotations.

We selected four models from the literature that are most relevant to the current central bank context and whose underlying publications have received the most citations in recent years. One of these is the model published by the authors of the BIS (*Gambacorta et al. 2024*), which domain-adapted the RoBERTa base model specifically for central bank texts (RoBERTa+Sp+Pa).[17] The authors used the hawkish/dovish annotation of Fed communication sentences published by *Gorodnichenko et al.* (*2023*) for fine-tuning. *Pfeifer – Marohl* (*2023*) fine-tuned BERT, RoBERTa and other models on central bank communication texts. Of these their fine-tuned RoBERTa model performed best, published as the CentralBankRoBERTa model. This is the second BERT-type model that we use in our study.[18]

The third and fourth models are based on FinBERT models. On the one hand, we use the *Huang et al.* (*2022*) FinBERT-tone model, which pre-trained/domain-adapted the BERT architecture using 4.9 billion tokens of financial text (corporate announcements, financial analyses, earnings reports).[19] On the other hand, we use the *Gössi et al.* (*2023*) FinBERT-FOMC model, which fine-tuned another FinBERT model (a BERT model domain-adapted to Reuters news by *Araci 2019*) using annotations (negative/neutral/positive tonality) from FOMC reports.[20]

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[17] Of the models published on https://bis.org/publ/work1215.htm, we used the version in which speeches were used for domain adaptation, in addition to research papers.

[18] This model therefore does not include domain adaptation, only fine-tuning. However, it may be worthwhile to start with such fine-tuned models for our own fine-tuning in cases where the preliminary fine-tuning is similar to our own application. In this case, the model still contains the information from the previous authors' training sample. The model used is available at https://huggingface.co/Moritz-Pfeifer/Central-BankRoBERTa-sentiment-classifier.

[19] The model used is available at https://huggingface.co/yiyanghkust/finbert-tone.

[20] The model used is available at https://huggingface.co/ZiweiChen/FinBERT-FOMC.

The four selected models were fine-tuned using 3,323 human-annotated sentences for the main results (in the case of the sample split in *Section 3.3,* we used the total MNB and non-MNB subsamples, 2,465 and 2,641 sentences respectively for fine-tuning), of which we used a randomly selected 20 per cent for validation during training. We did not use this part of our annotated database for testing the methods.

When fine-tuning the models of the BERT family, we built an output head above a single encoder that makes independent decisions on the monetary policy, real economic and inflation dimensions consistently with a multi-label layout. The multi-label solution trains a common language representation while making separate decisions for each task, thus better matching the actual content structure and utilising the data more efficiently. The modelled linguistic phenomena (polarity verbs, modifiers, negation, uncertainty expressions) reinforce each other, allowing the model to learn more stable and general patterns from fewer samples. Several robustness elements also support the quality of fine-tuning: (i) weighted loss to highlight rare classes and monetary policy tasks; (ii) handling missing labels; (iii) macro-F1-based model selection and early stopping to avoid overfitting.[21]

2.2.3. Generative AI methods based on GPT models

Another popular group of methods based on transformers and large language models turns to the use of generative artificial intelligence. The promise of generative artificial intelligence models, such as OpenAI's GPT models (version 3.5 and above),[22] is that, their superiority regarding the model size and large pre-training make them generally suitable for most tasks. Therefore, it is sufficient to describe the specific task in a (well-written) prompt without having to perform the supervised learning and fine-tuning steps described before. This provides savings on human annotation, eliminates the need for computational capacity to run fine-tuning and calling the model does not require a large computer as GPT models are run on OpenAI's servers. For more complex cases, it is recommended to provide a few input-output examples in the prompt (few-shot learning), and for even more complex cases, the Chain-of-Thought method has become popular (*Wei et al. 2022*), which breaks the task down into smaller, sequential steps (typically also requiring explanations of the sub-tasks), causing the model to devote more time/energy to

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[21] We applied weighting at two levels in the training. On the one hand, we compensated for the imbalance at the class level – especially in the extreme categories (positive, negative) – so that the model would not skew towards the majority, "no information" direction. On the other hand, at the task level, monetary policy errors were given greater weight in the loss, as the model typically performed worse on learning this task. With partial labelling, sentences where one or two dimensions are missing were also utilised. The loss was the weighted average of the cross-entropies of the tasks, which omits the missing labels, thus ensuring stable learning even with unbalanced annotations.

[22] Several other generative artificial intelligence products have emerged alongside GPT models (Google Gemini, Anthropic Claude, MS Copilot, DeepSeek models). The reason for selecting GPT is that we had a subscription for its API. Among the free generative AI models (e.g. Meta Llama), those that our computing capacity would allow us to use perform significantly worse; therefore, they are not included in the comparison.

the solution. In our case, the use of the Chain-of-Thought method is obvious (for example, topic identification is one step, tonality is another, and the identification of several other types of information are also separate steps, as discussed in *Section 4*).

From 2024 H2, OpenAI is also publishing so-called reasoning models (o1, o3, o4 and then the GPT-5 series), which promise to perform the Chain-of-Thought steps internally. In the study, we used the best available reasoning (GPT-5) and non-reasoning (GPT-4.1) models at the time of writing the study, which OpenAI released in August 2025, running each on three available model sizes (nano, mini and normal). Larger models offer better performance, but require longer runtimes and involve higher costs.

2.3. Evaluation metrics used

To evaluate and compare the methods, we use statistical methods that are best suited to our discrete, multi-class and unbalanced data. In our application, each sentence can take four discrete values (positive, neutral, negative, no fundamentals) for all three fundamentals, of which the "no fundamentals" class is the dominant part of the sample (*Table 1*). In terms of evaluation metrics, we also expect both the recall (which measures what percentage of items belonging to a given label were retrieved and what percentage were missed – type II error) and precision (measuring what percentage of predictions of a given label were correctly identified vs the percentage that were incorrect – type I error) statistical indicators to be addressed by our evaluation. These criteria are best met by the macro-averaged F1 statistics (*Grandini et al. 2020*).[23]

The macro-averaged F1 statistic is the arithmetic mean of the F1 statistics taken for each value category (*i=1,...,K*). The F1 statistics for each value category (*F1$_i$*) are the harmonic mean of the binary recall (*TruePoz$_i$/(TruePoz$_i$+FalseNeg$_i$)*) and binary precision (*TruePoz$_i$/(TruePoz$_i$+FalsePoz$_i$)*) for each category (*Takahashi et al. 2022*):

$$F1_i = 2\frac{Precision_i + Recall_i}{Precision_i^{-1} * Recall_i^{-1}} \tag{1}$$

$$\overline{F1}_{macro} = \sum_{i=1}^{K} F1_i \tag{2}$$

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[23] The most popular classification statistic is accuracy (the number of correctly predicted labels divided by the number of items), which has the problem that in the case of unbalanced data, the category with a large number of items (in our case, 'no fundamentals') will determine the statistic. Balanced accuracy corrects for this but is limited to recall, thus ignoring type I errors. Nevertheless, we also calculated balanced accuracy statistics for all our results, which resulted in values similar to the F1 statistics reported.

Takahashi et al. (*2022*) developed asymptotic standard errors for the macro-averaged F1 statistics, but we use bootstrap confidence intervals due to the unbalanced sample and low number of elements in some categories.[24]

The evaluation of the methods is performed on a randomly selected 40-per cent subsample of the entire sample, where in the case of the MNB, we use randomly drawn entire statements, and in the case of the other central banks, we draw 40 per cent of sentences into the test set.

3. Results

3.1. Initial evaluation of model classification performance

Our main findings, the macro-averaged F1 statistics of various methods, are presented in *Table 2*.

Based on the F1 metric, a clear hierarchy emerges among the model families. The highest values for all fundamentals are achieved by BERT-type models. Based on the (bootstrapped 95 per cent) confidence intervals, these models are significantly better than all rule-based models and most GPT models. For the REAL and INFLA fundamentals, even the F1 values of the weakest BERT-type models are significantly higher than the F1 values of the GPT family, with the exception of the GPT-5 model, for which the F1 point estimates are also higher, but the confidence intervals overlap here. GPT-type models have significantly higher F1 statistics than rule-based models for all fundamentals.[25]

The better predictions of the BERT family may generally be due to the fact that these task-specific fine-tuned models are better suited to the domain and labelling rules than the online, more general-purpose GPT models. The fine-tuned models learn the central bank-specific style of our data, the sentence structures that best fit the annotations (including, ad absurdum, systematic errors in the annotations). In addition, they are characterised by a higher degree of determinism and consistency. By contrast, GPT models are universal-purpose models that are not specifically optimised for a given task, and although their significantly larger model size, task-specific prompts and CoT reasoning techniques improve their performance on a given task, they still lag behind the fine-tuned models of the BERT family.

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[24] For this, we used Jacob Gildenblat's code as a basis: https://github.com/jacobgil/confidenceinterval
[25] We need to emphasise that the original rule-based methods that we used of various authors were developed for different applications (and for different datasets), not specifically the one used in our research, so they needed adaptation to our application output requirements. This represents an 'unfair' disadvantage which may contribute to the weaker performance of these models compared to the BERT-type and GPT-based models, which were created and tuned specifically for these tasks.

These results are largely consistent with those reported in the literature. *Kim et al.* (*2024*) compared models in identifying positive/neutral/negative sentiments in Fed FOMC reports. Based on their results, BERT-type models had significantly higher F1 values than the rule-based VADER method, and the FinBERT-FOMC model's F1 value also outperformed GPT-4 in their case, although it fell short of the F1 value of the Llama models. *Huang et al.* (*2022*) also reported higher F1 values for BERT-type models compared to other rule-based models. *Gambacorta et al.* (*2024*) found that regarding monetary policy tonality identification the accuracy of their RoBERTA+Sp+Pa model outperformed the performance of the then-standard GPT models (series 3.5 and 4) and other generative large language models (Llama, Mistral) in most cases.[26] Based on the results of *Pfeifer – Marohl* (*2023*), BERT-type models performed better in sentiment classification compared to rule-based machine learning methods.

The differences between model families are generally greater than those within model families. Based on the F1 confidence intervals of BERT-type models, the differences do not reach the usual statistical error threshold, but based on point estimates and the three fundamentals as a whole, the FinBERT-tone model of *Huang et al.* (*2022*) appears to be the best. In the case of inflation, the F1 value is highest for the *Pfeifer – Marohl* (*2023*) CentralBankRoBERTa model.

There are few surprises in the comparisons between GPT models. Increasing model size improves F1 statistics (the difference between nano and mini models is significantly greater than between mini and normal models). Chain-of-Thought models are weaker than Reasoning models. Among the GPT models, the GPT-5 model produces the highest F1 statistics for all three fundamentals.

Among the rule-based models, the method developed by the authors of the MNB (*Mátrai-Pitz – Siket 2023*) stands out from the rest for both fundamentals for which this method is available (REAL, INFLA). The regular expression-based model (*Fulop – Kocsis 2023*) and *Evdokimova et al.* (*2023*) achieve lower but similar statistics to the method of *Mátrai-Pitz – Siket* (*2023*) on these fundamentals. All of the methods produce weaker F values on the MPOL fundamental, which may indicate that the vocabulary of this fundamental is the most complex and that it is the most difficult to establish rule-based identification for it. The weaker performance of the *Picault– Renault* (*2017*) method may be explained by the fact that this method is specifically tailored to ECB communications, which is not part of our sample.

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[26] The performance order was reversed in special cases: on the one hand, when fine-tuning GPT and Llama models and, on the other hand, when the task was to evaluate the tonality of longer news texts instead of sentences on a smaller training sample.

Table 2
Macro-averaged F1 statistics

Authors	Model	MPOL	REAL	INFLA
Evdokimova et al. (2023)	rule-based	0.357	0.532	0.540
		[0.334 – 0.383]	[0.511 – 0.551]	[0.518 – 0.563]
Mátrai-Pitz – Siket (2023)	rule-based	na	0.541	0.576
		na	[0.514. 0.574]	[0.550. 0.603]
Fulop – Kocsis (2023)	rule-based, regex	0.261	0.532	0.555
		[0.245 – 0.287]	[0.502 – 0.570]	[0.527 – 0.586]
Picault – Renault (2017)	rule-based, n-gram	0.204	0.285	na
		[0.189 – 0.227]	[0.268 – 0.303]	na
Huang et al. (2022)	BERT-family, FinBERT-tone	**0.794**	**0.844**	0.838
		[0.761 – 0.826]	**[0.814 – 0.874]**	[0.811 – 0.863]
Gössi et al. (2023)	BERT-family, FinBERT-FOMC	0.763	0.823	0.809
		[0.727 – 0.795]	[0.791 – 0.853]	[0.780 – 0.838]
Pfeifer – Marohl (2023)	BERT-family, C.B.RoBERTa	0.778	0.827	**0.839**
		[0.744 – 0.812]	[0.795 – 0.857]	**[0.812 – 0.865]**
Gambacorta et al. (2024)	BERT-family, CB-LM RoBERTa	0.754	0.830	0.823
		[0.718 – 0.788]	[0.798 – 0.860]	[0.795 – 0.851]
OpenAI (2025)	CoT, GPT-4.1-nano	0.516	0.604	0.661
		[0.482 – 0.550]	[0.577 – 0.633]	[0.631 – 0.692]
OpenAI (2025)	Reasoning, GPT-5-nano	0.584	0.646	0.610
		[0.549 – 0.623]	[0.615 – 0.686]	[0.582 – 0.644]
OpenAI (2025)	CoT, GPT-4.1-mini	0.712	0.733	0.701
		[0.682 – 0.744]	[0.700 – 0.769]	[0.669 – 0.733]
OpenAI (2025)	Reasoning, GPT-5-mini	0.716	0.748	0.747
		[0.684 – 0.751]	[0.717 – 0.780]	[0.716 – 0.777]
OpenAI (2025)	CoT, GPT-4.1	0.711	0.714	0.684
		[0.677 – 0.748]	[0.681 – 0.750]	[0.652 – 0.719]
OpenAI (2025)	Reasoning, GPT-5	0.738	0.778	0.762
		[0.704 – 0.773]	[0.746 – 0.813]	[0.730 – 0.792]

Note: The table shows macro-averaged F1 statistics and bootstrap confidence intervals for the evalua-
tion of model estimates against human annotations for 14 models and three fundamentals. We used
a randomly selected sub-sample of 2,384 sentences from the statements/sentences of five central banks
as the test sample. We highlighted the models with the highest F1 statistics for each fundamental.
Source: Authors' calculations

3.2. Evaluation of classification performance components

Next, we examine the background of the differences seen between F1 statistics using the components of the metric. The tables in the *Annex* provide the most detailed breakdown of observations by fundamentals, value categories and hit/error types.

Figure 1 analyses the background of the aggregated F1 indicator by value category (but averaged across fundamentals). Based on the figure, all methods are best in identifying the 'no fundamental information' category. Identifying the presence of fundamentals is a topic identification task, and it seems intuitive that this is an easier task than labelling tonality. By contrast, the most difficult task for all methods seems to be identifying the 'neutral' category. This is understandable, on the one hand, because the 'neutral' category is located between the other two tonality categories (swapping positive and negative labels is more difficult than swapping neutral with either of the other two) and, on the other hand, because the 'neutral' category can be most easily confused with cases where the information about the fundamental is also uncertain.

The relative performance differences between the model families are significant. BERT-type models continue to perform the best in all value categories, but their advantage is particularly significant in the recognition of the neutral category compared to other model families. Rule-based models lag behind other methods the most in the 'neutral' category and least in the 'no fundamentals' category.[27]

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[27] Based on the tables in the *Annex*, the number of elements in the 'neutral' category is about one-half or one-third of the positive and negative categories, but the hit rates are much lower for all methods. Type II errors are particularly high in rule-based methods (these are false negatives, i.e. when the method categorises a neutral value item in other classes), with fewer than 10 hits out of around 70–100 neutral cases for rule-based methods, while the hit rate for BERT-type methods is well over 50 per cent, and for GPT models it is typically 20–30 per cent. By contrast, for the 'positive' and 'negative' categories, the rule-based (true positive) hit rates are around 30–50 per cent, while for BERT and advanced GPT methods, they are typically 70–80 per cent, with little difference between the two families. Based on this, it is primarily the performance in the 'neutral' category that determines the differences in F1 statistics between the model families.

Figure 1
F1 statistics broken down by category
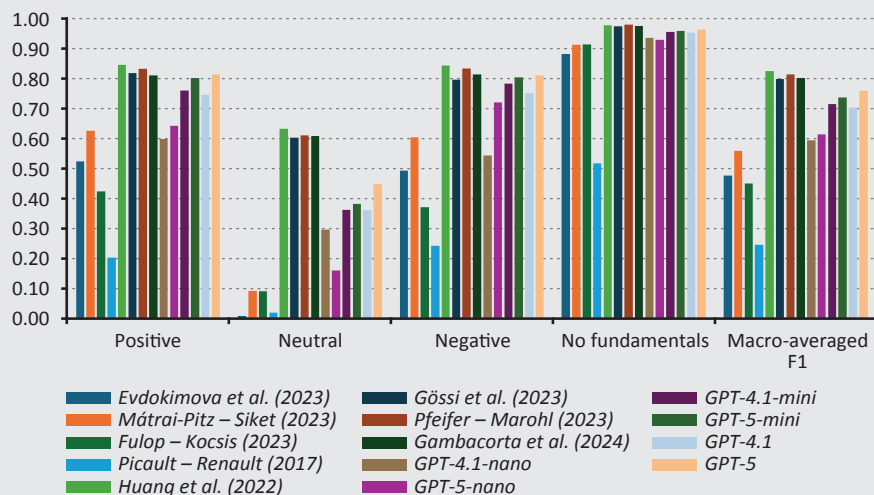
Note: The figure shows the point estimates of the F1 indicator values by method and label category (positive/neutral/negative/no fundamental) broken down by the average of the three fundamentals. The values can be grouped by fundamentals because the positive/neutral/negative values are most consistent with tight/neutral/loose monetary policy orientation in all three fundamentals.

Source: Authors' calculations

The macro-averaged F1 statistic (2) is the harmonic mean of the macro-averaged recall and precision metrics, which are the unweighted averages of the recall and precision metrics for each value category. *Figure 2* compares recall and precision metrics between methods in terms of both fundamental identification (averages of the 'no fundamental information' category across fundamentals) and the identification of signed tonalities (averages of the 'positive' and 'negative' categories across fundamentals).

Based on the figure, the order previously seen in the model families' performances mostly prevails, but there are some interesting differences compared to the aggregated statistics. On the one hand, in terms of identifying fundamentals, rule-based models generally achieve much better results in terms of precision than recall, with *Mátrai-Pitz – Siket* (*2023*) catching up to the GPT models and *Fulop – Kocsis* (*2023*) surpassing such models in this respect. According to these findings, rule-based models tend to be weak in terms of type I errors (they often miss fundamentals that human annotators find), but they make fewer type II errors (so fundamentals identified are rarely incorrect). An exception in this regard is the model of *Picault – Renault* (*2017*), which, on the contrary, is strong in recall.

However, rule-based models are generally weaker than the other two model families in terms of positive/negative tonality identification, which is consistent with the results shown in *Figure 1*. Tonality is significantly more difficult to capture for all methods, but even more so for fixed dictionaries, because typically several words together specify this content, and the words that make up the components also have many synonyms, making them difficult to list. Large language models, on the other hand, are better at capturing the context of words. GPT models are generally strong at highlighting these information elements, but BERT-type models can adapt even more accurately to a given technical environment or jargon through fine-tuning (and domain adaptation). GPT models can only outperform BERT models in the tonality recall metric for larger reasoning models (i.e. they can achieve a higher proportion of true positive/negative tonality, but their precision is weaker; therefore, the estimated positive/negative tonality is often inaccurate).

Figure 2
F1 statistics broken down by category

Note: The figure shows the point estimates of the F1 indicator values by method and label category (positive/neutral/negative/no fundamental) broken down by the average of the three fundamentals. The values can be grouped by fundamentals because the positive/neutral/negative values are most consistent with tight/neutral/loose monetary policy orientation in all three fundamentals.
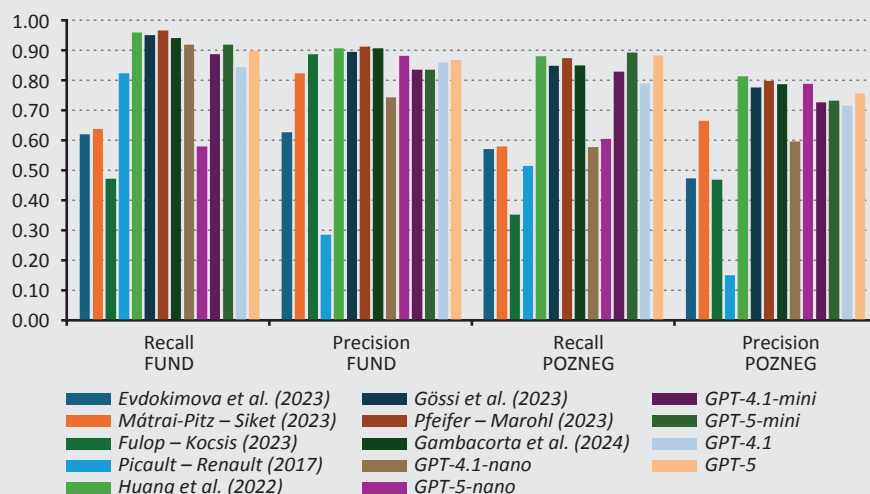
Source: Authors' calculations

It is also interesting to note that, with regard to the components shown in both figures, the order of the two FinBERT and two RoBERTa-type models (of the point estimates) remains the same (the FinBERT-tone indicators are higher than FinBERT-FOMC, and the CentralBankRoBERTa indicators are higher than those of the RoBERTa+Sp+Pa model), although the differences are not statistically significant.

3.3. Generalisation ability based on central bank split samples

So far, we have selected the test sample from the entire set at random; thus, these results allow us to predict how accurate different methods could be in terms of unseen central bank text. Next, we split the sample by central bank sources, which allows us to predict how transferable/consistent the model performances are expected to be on the texts of other central banks.

We divided the sample into two parts, with one sub-sample containing only MNB communications and the other containing communications from the four other central banks.[28] This time, we trained/fine-tuned the BERT-type models on non-MNB texts before testing them on the MNB test samples, and we used MNB texts for training before testing on the non-MNB test sample. Sub-sample testing can provide an indication of how training with a given central bank text sample will result in classification outcomes for texts from other central banks in the case of fine-tuned models. Similarly, for other methods, this test can indicate whether the rules/ prompts lead to different classification results between different central banks. The sample division also results in an additional test (which cannot be handled separately from the previous ones) in that, while the non-MNB central bank texts are random sentence draws from statements, in the case of MNB texts, our samples treat entire statements together, which may be an advantage for some methods (notably *Fulop – Kocsis 2023* and GPT models, with reasoning models taking into account the entire statement when annotating sentences), and human annotators were also able to take context into account when labelling MNB sentences. MNB texts account for almost one-half of the total sample, leaving a sufficiently large number of elements for testing even rare categories.

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[28] If we further split up the four other central bank texts, we would not have enough observations in the categories with low numbers of elements.

Figure 3
F1 statistics by sub-sample and fundamentals
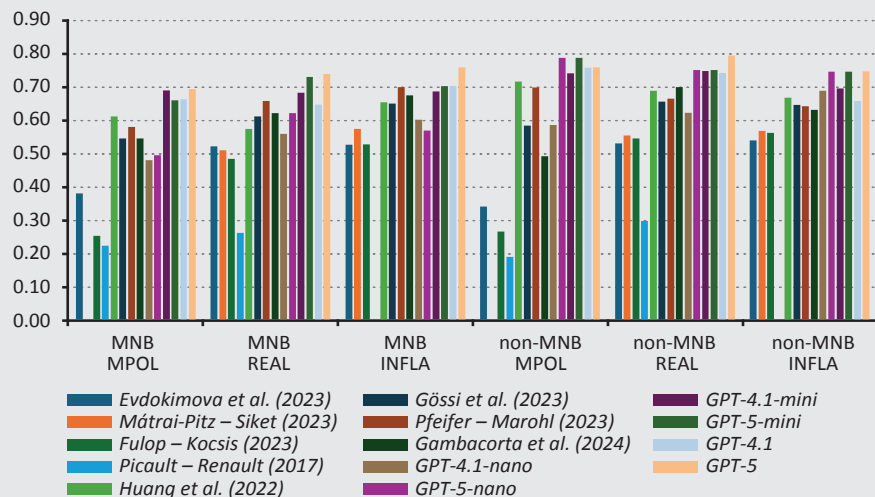
Note: The figure shows the point estimates of the F1 indicator by method and by three fundamentals narrowing the test sample to two sub-samples: a sub-sample containing only MNB statements and a sub-sample containing texts from the four other central banks. This time, we trained/fine-tuned the BERT-type models on non-MNB texts before testing them on the MNB test samples, and we used MNB texts for training before testing on the non-MNB test sample.

Source: Authors' calculations

One important lesson from *Figure 3* is that the classification performance of BERT-type models decreases significantly when the training sample and the test sample come from different central banks. BERT-type models still offer significantly stronger classification performance than rule-based models, but they lag behind the performance of the best GPT models. Therefore, in order to realise the performance advantage of BERT-type models, it is essential to fine-tune them for specific text types and tasks, as they are less suitable for generalisation and efficient performance on data external to training.

For the most part, the order within the previously seen model family remains unchanged, with *Huang et al.* (*2022*) having higher F1 metrics than the other FinBERT-type model, and the *Pfeifer–Marohl* (*2023*) model performing better than the other RoBERTa-type model. Among the rule-based models, *Mátrai-Pitz – Siket* (*2023*) and, in the case of the MPOL fundamental, *Evdokimova et al.* (*2023*) are usually the strongest, while among the GPT series, the GPT-5 model typically produces the highest F1 values. Our preliminary expectation that GPT models

(and the *Fulop – Kocsis 2023* rule-based method) will achieve better classification results on MNB texts due to their knowledge of the context of the sentences is not confirmed; in fact, in the case of the MPOL and REAL fundamentals, the F1 values are higher on the non-MNB sample, while the results are mixed for the INFLA fundamental.

In comparisons across fundamentals, in the case of rule-based methods, the MPOL F1 values for both sub-samples lag significantly behind the values achieved for the other two fundamentals. However, this difference is not evident in the case of BERT-type and GPT models. In the MNB sub-sample, most models perform somewhat weaker on the MPOL fundamental, but in the non-MNB sub-sample, the models perform more mixed across fundamentals.

3.4. Speed and costs

Another consideration when choosing models may be the runtime and the costs of running the models. Our own experiences are presented in *Table 3*. It should be noted that the runtime depends largely on the hardware used for rule-based methods and on-prem BERT-type models but does not matter for GPT models (which run in the cloud). The runtime shown in the table can, of course, be significantly reduced if parallelisation is possible, but where we used parallelisation, we multiplied the experienced runtime by the number of execution threads so that the values shown in the table would be understandable/comparable without parallelisation. The runtime does not include the time required to create the models (in the case of BERT-type models, annotation and model training; in the case of rule-based and GPT models, the creation of rules and prompts).

In terms of costs, it should be noted that we only measured the costs of GPT runs in the table and did not consider the indirect, potentially significant costs associated mainly with BERT-type solutions (costs associated with greater server capacity: labour and energy costs related to hardware procurement, installation and maintenance, human annotation costs).

Table 3
Runtime and direct costs of running

	Runtime (minutes)		Price
	MNB test sample	Non-MNB test sample	USD
Evdokimova et al. (*2023*)	0.4	0.4	0.0
Mátrai-Pitz – Siket (*2023*)	0.3	0.1	0.0
Fulop – Kocsis (*2023*)	0.8	0.8	0.0
Picault – Renault (*2017*)	0.9	0.9	0.0
Huang et al. (*2022*)	20.3	18.4	0.0
Gössi et al. (*2023*)	16.5	16.1	0.0
Pfeifer – Marohl (*2023*)	21.6	15.0	0.0
Gambacorta et al. (*2024*)	17.9	20.2	0.0
GPT-4.1-nano	182.8	241.0	2.7
GPT-5-nano	101.0	605.1	3.1
GPT-4.1-mini	211.7	275.7	12.2
GPT-5-mini	129.5	766.7	7.4
GPT-4.1	240.9	278.3	51.8
GPT-5	209.9	1,140.7	46.8

Note: The table shows the runtime and direct execution cost (USD) of the two parts of the test sample (a total of approximately 2,100 sentences) for each method on our server (we adjusted for time savings due to parallelisation; thus, the time requirement shows how many minutes it would have taken to run the test sample on our server with 1 execution thread).

Source: Authors' calculations

Taking these disclaimers into account, we can conclude that in terms of direct runtime, rule-based methods were 10–50 times faster than BERT-type models. There were no significant differences in speed between BERT-type models (within the model family), while CoT GPT models were about ten times slower, and the speed of GPT reasoning models (GPT 5 series) depended largely on the test sample: on the MNB sample (where the model could evaluate the sentences of statements together), it was somewhat faster than the CoT GPT models, but on the non-MNB test sample evaluated sentence-by-sentence, it was three to four times slower than the CoT models. In terms of direct execution costs, there were significant differences between GPT models depending on model size, with a factor of 5 between categories.

4. Extensions

At the end of the study, we would like to briefly discuss research directions that we consider promising based on the literature and our own experiences.

One such direction, which we have seen in a few studies and which we also use in our own codes, is extending the information retrieval of central bank

communications in multiple directions. The literature standard continues to be tonality identification on a simple positive/negative or hawkish/dovish scale. Of course, the information contained in communication is much more complex, and its more accurate understanding may help measuring and explaining communication market effects and other central bank applications.

Yao et al. (*2025*) attempt to identify macroeconomic causal chains in Fedspeak communication that can be understood behind monetary policy orientation. *Geiger et al.* (*2025*) use a Chain-of-Thought prompt technique to determine the intensity of the tonality after the sign and then evaluate this monetary policy stance in the text together with other information on existing fundamentals (e.g. in light of the staff's inflation forecasts).

Our own GPT prompts go further in the direction of the following layers of information:

– We identify the tonality for three fundamentals separately, but we also identify topics within the fundamentals. We see this elsewhere as well, e.g. *Evdokimova et al.* (*2023*) identify forward guidance and quantitative easing components in the case of the MPOL fundamental and specify labour market activity within real activity. We go further than this, identifying seven topics for the REAL fundamental, six for MPOL and four for INFLA.

– We determine which geographical unit the fundamental information relates to (it matters whether a central bank is talking about its own or global growth prospects).

– We highlight the dynamics of the fundamentals (often, human and machine annotations are confused by contradictory information about levels and changes: e.g. 'unemployment rose moderately but remains at historically low levels').

– We attempt to identify temporal information (whether the tonality of the fundamental refers to the past, present or future). An important contribution in this regard is *Byrne et al.* (*2023*), which documents in detail that temporal information significantly explains surprises in yields.

– Separation of facts/surprises/expectations and upside/downside risks within expectations.

– Finally, for tonality, we ask not only for signs but also for different intensities in the prompt (on a scale from –3 to +3), as many others do.

Table 4 shows the more detailed output of our GPT prompts by the GPT-5 model for the three FOMC sentences in the sample of *Gorodnichenko et al.* (*2023*).

Table 4

More detailed outputs of the GPT prompt for selected sentences

Sentence	Topic code	Topic text	GEO	Tone text	Tone score	Actual v expected	Dynamics	Time frame
The Committee will maintain the target range for the federal funds rate at 0 to 1/4 per cent and continues to anticipate that economic conditions are likely to warrant exceptionally low levels of the federal funds rate for an extended period.	MPOL_RATE	federal funds rate	United States	range unchanged	0	OBSERV	CHANGE	CURRENT
	MPOL_RATE	federal funds rate	United States	0 to 1/4 per cent	−3	OBSERV	LEVEL	CURRENT
	MPOL_FG	forward guidance	United States	low rates extended period	−2	EXPECT	LEVEL	FUTURE
	REAL_CYCLE	economic conditions	United States	weak economic conditions	−2	EXPECT	LEVEL	FUTURE
Although inflation pressures seem likely to moderate over time, the high level of resource utilisation has the potential to sustain those pressures.	REAL_CYCLE	resource utilisation	current country	high level of resource utilisation	2	OBSERV	LEVEL	CURRENT
	INFLA_CPI	inflation pressures	current country	likely to moderate	−2	EXPECT	CHANGE	FUTURE
	INFLA_CPI	inflation pressures	current country	sustain those pressures	2	EXPECT_POSRISK	LEVEL	FUTURE
Although economic activity is likely to remain weak for a time, the Committee continues to anticipate that policy actions to stabilise financial markets and institutions, fiscal and monetary stimulus, and market forces will contribute to a gradual resumption of sustainable economic growth in a context of price stability.	MPOL_GEN	monetary stimulus	current country	monetary stimulus	−2	OBSERV	LEVEL	CURRENT
	REAL_GDP	economic activity	current country	likely to remain weak	−2	EXPECT	LEVEL	MedFUTURE
	REAL_GDP	economic growth	current country	gradual resumption	2	EXPECT	CHANGE	MedFUTURE
	REAL_GDP	economic growth	current country	sustainable	2	EXPECT	LEVEL	MedFUTURE
	INFLA_CPI	price stability	current country	price stability	0	EXPECT	LEVEL	FUTURE

Note: The table shows the results of the GPT-5 model's more detailed outputs (topic, geographical location, tonality, fact/expectation, dynamics: level/change, time frame) based on three selected Fed FOMC statement sentences.

Source: Authors' calculations

Extracting such diverse information is not feasible for either rule-based (the rule system would be too complex) or BERT-type methods (it would require a huge human-annotated sample to ensure that there are enough elements for each of the many possible value categories); therefore, generative models working with prompts may be the way forward in this area.

Another direction that we consider promising and that is also mentioned in the literature (e.g. *Geiger et al. 2025*) is to use annotations from generative large language models instead of/in addition to costly human annotations for fine-tuning BERT-type models. Based on our previous results, BERT-type models can only deliver truly accurate classification performance if they are specifically fine-tuned to the texts of a given central bank. Since obtaining human annotations can be time-consuming and costly, it may sometimes be easier to perform labelling with a more powerful online generative model (e.g. OpenAI's large GPT models). BERT-type models trained on a few hundred/thousand sentences can then be run faster than GPT models and without subscription costs to evaluate a broader text database.

5. Conclusions

Our study aims to contribute to the growing body of literature on central bank text analysis by comparing the different characteristics of three model families (rule-based, BERT-type and GPT models) in terms of three macroeconomic fundamentals, using the texts of five central banks. Based on the results, although there are significant differences in their classification performance, all three model families may be justified for use depending on the human, IT and financial resources and time constraints of the given task at hand.

The significantly weaker classification performance of rule-based methods can sometimes be compensated for by the speed (an order of magnitude better than BERT-type models and two orders of magnitude better than GPT models), low cost (no human annotations required, low hardware requirements) and transparency of the methods (no black box nature).

In line with the results in the literature, BERT-type models, with appropriate human annotation, outperform even the most powerful GPT models. BERT-type models are also significantly faster, can be run offline and therefore do not require a subscription. Human-annotated training samples tailored to the specific central bank text is important for the outstanding performance of these models (they lose their advantage over GPT when used on central bank texts other than they were trained on), and they have larger hardware requirements to run than the other two model families.

GPT models perform depending on their size and series, with newer, larger models providing better classification performance at higher execution costs and longer runtimes. A significant advantage of GPT models is that they do not require human annotation, and prompts can be used flexibly, especially in newer reasoning models, to extract a wide range of information from the text. Furthermore, if a newer, better-performing model appears, it can be more easily integrated into our existing processes.

In some cases, it may be advisable to use combinations of model families. For example, it may be worthwhile to use more expensive and slower large GPT models to create smaller annotation samples, which can then be used to train BERT-type models to analyse larger databases more quickly and cost-effectively.

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Annex

Table 5												
Detailed results for the test sample (REAL fundamental, observations by category)												
	Positive			Neutral			Negative			No fundamentals		
	TP	FP	FN	TP	FP	FN	TP	FP	FN	TP	FP	FN
Evdokimova et al. (2023)	160	115	62	0	2	75	122	74	91	1,182	162	125
Mátrai-Pitz – Siket (2023)	127	78	95	7	36	68	96	44	117	1,227	202	80
Fulop – Kocsis (2023)	112	82	110	8	16	67	87	32	126	1,242	238	65
Picault – Renault (2017)	114	370	108	0	11	75	143	618	70	488	73	819
Huang et al. (2022)	199	26	23	41	17	34	197	35	16	1,270	32	37
Gössi et al. (2023)	199	33	23	39	19	36	195	58	18	1,248	26	59
Pfeifer – Marohl (2023)	197	30	25	39	21	36	200	51	13	1,257	22	50
Gambacorta et al. (2024)	206	43	16	39	16	36	195	45	18	1,249	24	58
GPT-4.1-nano	184	163	38	17	101	58	127	48	86	1,147	30	160
GPT-5-nano	133	45	89	9	8	66	157	26	56	1,276	163	31
GPT-4.1-mini	187	66	35	22	21	53	167	40	46	1,251	63	56
GPT-5-mini	207	62	15	23	34	52	192	48	21	1,223	28	84
GPT-4.1	183	56	39	19	21	56	168	52	45	1,242	76	65
GPT-5	206	50	16	26	15	49	184	42	29	1,250	44	57

Note: The table provides a more detailed, case-based presentation of the results in Sub-sections 3.1 and 3.2. For the REAL fundamental, we present the positive counts (TP: true positive), type I errors (FP: false positive, 'false alarm' cases) and type II errors (FN: false negatives, 'missed detection') for each value category (positive, neutral, negative, no fundamentals). The sample contains 1,817 elements (this filters out cases where human annotations do not match from the 2,384-element test sample). For easier interpretation, higher element counts for TP are shown in darker shades of green, while higher element counts for FP and FN are represented with darker shades of red.

Source: Authors' calculations

Table 6

Detailed results for the test sample (INFLA fundamental, observations by category)

	Positive			Neutral			Negative			No fundamentals		
	TP	FP	FN	TP	FP	FN	TP	FP	FN	TP	FP	FN
Evdokimova et al. (2023)	118	97	58	0	0	107	89	55	54	1,361	151	84
Mátrai-Pitz – Siket (2023)	104	52	72	5	27	102	93	46	50	1,395	149	50
Fulop – Kocsis (2023)	99	51	77	4	15	103	77	36	66	1,407	182	38
Picault – Renault (2017)	–	–	–	–	–	–	–	–	–	–	–	–
Huang et al. (2022)	157	48	19	77	40	30	119	32	24	1,389	9	56
Gössi et al. (2023)	154	53	22	62	34	45	123	43	20	1,391	11	54
Pfeifer – Marohl (2023)	157	46	19	73	34	34	120	27	23	1,405	9	40
Gambacorta et al. (2024)	155	52	21	66	33	41	121	32	22	1,400	12	45
GPT-4.1-nano	127	73	49	55	121	52	71	32	72	1,359	33	86
GPT-5-nano	105	21	71	8	19	99	87	21	56	1,425	185	20
GPT-4.1-mini	146	89	30	31	31	76	110	46	33	1,371	47	74
GPT-5-mini	150	62	26	38	39	69	126	58	17	1,368	30	77
GPT-4.1	124	49	52	31	31	76	102	49	41	1,394	91	51
GPT-5	206	50	16	26	15	49	184	42	29	1,250	44	57

Note: The table provides a more detailed, case-based presentation of the results in Sub-sections 3.1 and 3.2. For the INFLA fundamental, we present the positive counts (TP: true positive), type I errors (FP: false positive, 'false alarm' cases) and type II errors (FN: false negatives, 'missed detection') for each value category (positive, neutral, negative, no fundamentals). The sample contains 1,871 elements (this filters out cases where human annotations do not match from the 2,384-element test sample). For easier interpretation, higher element counts for TP are shown in darker shades of green, while higher element counts for FP and FN are represented with darker shades of red. Source: Authors' calculations

Table 7

Detailed results for the test sample (MPOL fundamental, observations by category)

	Positive			Neutral			Negative			No fundamentals		
	TP	FP	FN	TP	FP	FN	TP	FP	FN	TP	FP	FN
Evdokimova et al. (2023)	48	164	64	1	4	88	61	190	90	1,202	165	281
Mátrai-Pitz – Siket (2023)	–	–	–	–	–	–	–	–	–	–	–	–
Fulop – Kocsis (2023)	7	50	105	1	2	88	0	38	151	1,480	257	3
Picault – Renault (2017)	13	219	99	1	10	88	112	832	39	571	77	912
Huang et al. (2022)	92	29	20	47	33	42	132	39	19	1,448	15	35
Gössi et al. (2023)	79	20	33	49	35	40	123	55	28	1,446	28	37
Pfeifer – Marohl (2023)	87	31	25	46	33	43	132	44	19	1,448	14	35
Gambacorta et al. (2024)	75	16	37	40	21	49	129	61	22	1,457	36	26
GPT-4.1-nano	40	27	72	48	185	41	65	111	86	1,319	40	164
GPT-5-nano	58	34	54	9	13	80	85	15	66	1,441	180	42
GPT-4.1-mini	95	47	17	31	63	58	129	36	22	1,391	43	92
GPT-5-mini	99	45	13	21	24	68	131	46	20	1,422	47	61
GPT-4.1	92	47	20	22	25	67	132	54	19	1,422	41	61
GPT-5	96	43	16	25	20	64	132	43	19	1,424	52	59

Note: The table provides a more detailed, case-based presentation of the results in Sub-sections 3.1 and 3.2. For the MPOL fundamental, we present the positive counts (TP: true positive), type I errors (FP: false positive, 'false alarm' cases) and type II errors (FN: false negatives, 'missed detection') for each value category (positive, neutral, negative, no fundamentals). The sample contains 1,835 elements (this filters out cases where human annotations do not match from the 2,384-element test sample). For easier interpretation, higher element counts for TP are shown in darker shades of green, while higher element counts for FP and FN are represented with darker shades of red. Source: Authors' calculations

Inflation and Perception: Drivers of Hungarian Households' Expectations*

Tímea Várnai ⬤ *– Áron Szakály* ⬤

This study analyses the evolution of the Hungarian households' inflation expectations in the period between 2015 and 2025 based on household questionnaire data, using an error correction model framework. The waves of inflation experienced in the early 2020s resulted in a change in the formation of inflation expectations. The anchoring of expectations during the period of high inflation increased in importance: households became more forward-looking, and the role of inflation perception in the formation of expectations decreased. As regards instantaneous effects, it is apparent that food price fluctuations, EUR/HUF exchange rate changes, volatility – which reflects economic uncertainty among other factors – and households' decreasing confidence in the economy amplified fears of inflation more than they did during the low-inflation period of 2015–2019. The impact of inflation forecasts on households' inflation expectations increased. Exchange rate stability became a key factor in anchoring households' expectations. The effects and their changes, as identified by our analyses, are robust to the highlighted socio-demographic groups as well.

Journal of Economic Literature (JEL) codes: D12, D84, E1, E31, E71, C83, C32

Keywords: household behaviour, inflation expectations, perceived inflation, questionnaire-based survey

1. Introduction – motivation and links to literature

The early 2020s was a period of overlapping waves of inflation. Most countries worldwide were affected and the European Union and its eastern Member States were particularly hard hit by supply and demand frictions in the wake of the coronavirus pandemic, by the energy crisis and by the Russian–Ukrainian war.

In Hungary, inflation crossed the 20-per cent threshold in September 2022, and it took 13 months of concerted effort to bring it back into the single-digit range by October 2023. The country-specific causes of Hungary's inflation trajectory – which was record-setting in the European Union – are analysed by *Balatoni and Quittner* (*2024*). As in Hungary, households' inflation expectations remained high in several European countries even in the wake of the rapid disinflation, showing the persistent effect of high inflation peaks on expectations (*De Fiore et al. 2025*). With the permanently high expectations, inflation in Hungary started to rise again during the last months of the previous year, highlighting how important the anchoring of household inflation expectations is.

The aim of our analyses is to identify what relevant macroeconomic factors affect Hungarian households' inflation expectations in the short and medium term, and to find out whether those expectations are anchored or not. The expression "short term" denotes the instantaneous effects of macroeconomic variables, while "medium term" denotes the effect in the long-term component of error correction equations.

Understanding the factors that influence household inflation expectations is particularly important for macroeconomic stability and monetary policy considerations. Consumer behaviour is profoundly affected by household inflation expectations. On the one hand, they influence households' consumption and savings decisions (*Andrade et al. 2023*; *Burke – Ozdagli 2023*; *D'Acunto et al. 2022*): if households expect prices to rise, they may bring forward their purchases, which will generate stronger demand and thus drive inflation higher. On the other hand, expectations also influence wage bargaining, as demand for higher salaries will raise the costs of businesses and impact their pricing decisions, easily leading to higher inflation again. The effects of household inflation expectations on inflation were empirically proven based on US survey data by *Brandão-Marques et al.* (*2023*) and *Goodspeed* (*2025*) and on Hungarian data by *Gábriel* (*2010*).

The role of household inflation expectations is treated as one of the most important factors by central banks' theoretical models when modelling monetary policy transmission; however, macroeconomic forecasts are, for the most part, in practice, based on expectations derived from surveys conducted by professional forecasters and market participants (*ECB 2021*). In the research on household expectations, the emphasis is mostly on qualitative expectations (*Gábriel et al. 2013; D'Acunto et al. 2024; Menz – Poppitz 2013; Anesti et al. 2025*)*,* but there are also cases which assess quantitative expectations (*Meyler – Reiche 2021*).

The nature of slowly diminishing inflation expectations was already examined after the global financial crisis of 2009 (*Łyziak – Paloviita 2017*; *Berge 2018*), but in the wake of the inflation shocks in the early 2020s, central bankers and researchers have, in recent years, been growing increasingly interested in the evolution of households' inflation expectations. *D'Acunto et al.* (*2024*) argue that households' inflation expectations may deviate from the inflation target both in the medium and long term, while in the short term, they are dominated by news on inflation, in contrast to experts' forecasts.

The role of psychological factors has been highlighted with the spread of behavioural economics. The pioneers of behavioural economics – *Kahneman* (often referred to as the "master of irrationality") *and Tversky* (*1973, 1979, 1982*) – recognised the innate nature of intuitive beliefs and choices, i.e. that people are prone to cognitive distortion, which results in so-called bounded rationality in their decisions. *Sirakovova* (*2024*) gives a comprehensive overview of the role of behavioural economics in understanding inflation expectations. She concludes that the prospect theory of *Kahneman and Tversky* (*1979*) – arguing that individuals evaluate changes around them in a relative way, from their own individual perspectives – applies to inflation expectations as well. Rationality is often sidelined in complex, uncertain and risky situations. Inflation expectations can also be demonstrated to be potentially affected by emotions, experience and fears. People holding less favourable views of the economy as a whole tend to have higher inflation expectations (*Meyler – Reiche 2021*).

People express their opinion on inflation primarily based on their own day-to-day individual shopping habits and experiences, i.e. based on the price levels they are confronted with when it comes to buying food, fuel or paying utility bills. People find these events easy to remember, and therefore they contribute to asymmetric price perception (*Sirakovova 2024*). The correlation between energy prices and inflation expectations is emphasised by *Binder* (*2015*), *Coibion and Gorodnichenko* (*2015*) and *Vatsa et al.* (*2025*). *Jo and Klopack* (*2025*) concluded from US data – taking advantage of the different regulatory environment – that inflation expectations are affected not only by actual gas prices, but also by announcements of prospective gas price cuts. *Berge* (*2018*) emphasised the role of food inflation as well, besides trends in energy prices. *Brassil et al.* (*2024*) found fuel prices to be "salient" prices, while *Anesti et al.* (*2025*) identified food prices as such, i.e. as prices affecting inflation expectations more than justified by their share in the consumer basket. Additionally, *Anesti et al.* (*2025*) also argue that food prices affect households' inflation expectations significantly more than any other factor, even energy, and that disregarding food price inflation results in overestimation of the importance of energy prices.

D'Acunto et al. (*2019, 2021*) found that the composition of the individual consumer basket does not affect inflation expectations as substantially as the frequency of buying specific products and the fact that prices are rising. *Angelico and Di Giacomo* (*2019*) also emphasise the importance of shopping frequency, along with that of extreme price changes, past inflation and food prices. Our analysis of Hungarian data revealed that the impact of food inflation on household inflation expectations has outgrown the 18-per cent weight of foodstuffs in the consumer basket. This trend may have been driven, in part, by the higher-than-average fluctuation in food prices, based on the findings of *D'Acunto et al.* (*2019, 2021*) and *Angelico and Di Giacomo* (*2019*).

In addition to the individual's experiences regarding changes in prices, inflation expectations are also driven by economic news and exchange rate changes as well as confidence in the general economic situation, the economic policy and the central bank, all of which are also taken into account in our analyses. Announced inflation expectations may rise during times of economic uncertainty. A major inflation shock – such as the energy and food price hike in 2022–2023 – may trigger a temporary loss of confidence and thereby de-anchor expectations. *Dräger et al.* (*2025*) and *Afunts et al.* (*2024*) demonstrate the effects of the Russian–Ukrainian war on household inflation expectations.

People's opinion is easily shaped by news generating fears of inflation as well as by strong optimistic or pessimistic messages, which may also be reflected by exchange rate fluctuations. Such news affects the inflation expectations of households in heterogeneous and asymmetric ways, which is partly explained by lower-income households' being less able to adjust their expenditures. As a consequence of this, they can benefit less from information on future inflation, including information communicated by the central bank, and hence, they pay less attention to such information (*Ichiue et al. 2024*). In addition, high-inflation news changes expectations more than low-inflation news (*Chahrour et al. 2025*). *Ehrmann et al.* (*2017*) argue that an increase in media coverage of inflation decreases the distortion of the expectations of households with higher-than-average inflation expectations more than those of the average household. The tone of the news also matters. Negative news has a stronger impact (*Lamla – Lein 2014*; *Dräger 2014*), but different news consumption patterns (newspapers vs. television) may also affect households' inflation expectations (*Menz – Poppitz 2013*; *Conrad et al. 2021*). Although we did not undertake to scrutinise the direct effects of news, in our analysis we did investigate exchange rate movements, which also partially reflect the impacts.

The credibility of monetary policy, the central bank's communication and price-limiting economic policy measures can help elevated expectations return to a level

consistent with the central bank's inflation target. Based on Dutch household data from 2015, *Christelis et al.* (*2020*) found that inflation expectations and uncertainties regarding inflation were significantly lower among households with higher confidence in the central bank; *D'Acunto et al.* (*2022*) reached a similar conclusion based on US data. Monetary policy measures help to anchor inflation expectations (*Kamada et al. 2015*), in particular expectations that are less firmly anchored (*Doh et al. 2025*). Messages on the central bank's inflation target do influence households' inflation expectations (*Binder – Rodrigue 2018*), but they are significantly less effective if they come through the media (*Coibion et al. 2019*). We analyse the role of confidence and demonstrate that consumer confidence measured by GKI Gazdaságkutatóintézet (an economic research institute) influenced household inflation expectations and that this influence increased during the period of higher inflation rates.

Central banks around the world make special efforts to anchor inflation expectations, in order to achieve inflation targets and maintain economic stability (*Easaw et al. 2012*; *ECB 2021*; *Carvalho et al. 2023*, *Kamada et al. 2015*; *Lin – Li 2025*). The most important lesson from the economic policy failure in the stagflationary period of the 1970s, is that central banks are best able to stabilise the medium-term inflation rate by anchoring expectations at the target levels, due to the logic of inflation targeting. Anchoring inflation expectations makes it possible, after an inflationary period, for inflation to return to a level ensuring price stability at the lowest possible cost to the real economy. For this reason, the anchoring of inflation expectations is one of the key aspects of our study.

If expectations are stable or anchored, fluctuations in inflation will remain transient, and a decrease in inflation will come without major social costs. However, if inflation expectations start rising after a one-off shock, there is a risk of the economy getting stuck with higher prices, which may then result in the possibility of persistent failure to meet the inflation target and of monetary policy losing credibility (*Figure 1*). Expectations are not necessarily anchored; the inflation rate does not necessarily returns to the central bank's target; and inflation expectations can only be stabilised through credible measures. International experience shows that only in about one-quarter of cases was it possible to bring inflation back down to the single-digit range within a year after it surged above 20 per cent (*Spéder – Vonnák 2023*). A strong, credible and disciplined monetary policy was the common factor in all cases of successful disinflation.

Figure 1
Duration and level of an inflation shock with unanchored expectations (left-hand panel) and anchored expectations (right-hand panel)

Source: Magyar Nemzeti Bank (Central Bank of Hungary, MNB)
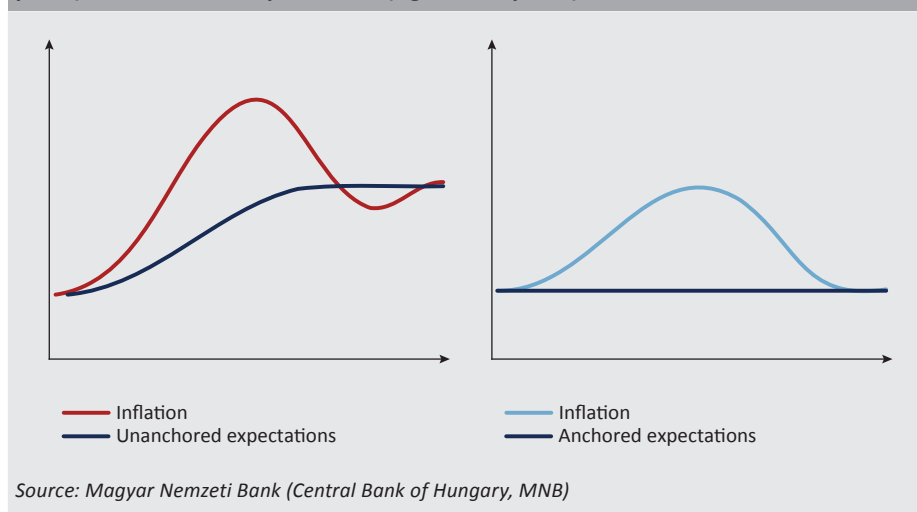
From the aspect of monetary policy, it is important that the economy behaves differently in a high-inflation environment and in a low-inflation environment. *Borio et al.* (*2023*) demonstrated that inflation tends to stabilise itself in a low-inflation regime, but this ability vanishes as inflation rises. Indeed, a variety of self-reinforcing developments emerge during the transition to a high-inflation regime. Therefore, monetary policy must respond decisively and in time when a shift to a high-inflation regime is imminent. As soon as inflation exceeds a certain level, both employees and companies tend to pay increased attention to price changes and that raises the likelihood of a wage-price spiral developing. Likewise, *Gobbi et al.* (*2025*) also argue that during severe and protracted shocks, central banks must be attentive to a more sensitive response in inflation expectations and the degree of wage indexation. The results reported by *Goodspeed* (*2025*) also confirm the different behaviour of households' inflation expectations: during periods of low inflation, consumers do not pay attention to changes in inflation, but in periods of high inflation, they do, predicting its trends more accurately.

Analysing Hungarian data, this study scrutinises how factors determining inflation expectations changed between the low-inflation period before 2020 and the high-inflation period of the 2020s. We contribute to the literature on inflation expectations in that we identify a wide range of factors determining quantitative inflation expectations based on Hungarian data, as well as distinguishing their effects in low- and high-inflation regimes. In view of the work of *Easaw et al.* (*2012, 2013*), in this study we take into account the fact that households' inflation expectations may be either anchored or unanchored, households update their expectations both

in the short term and the long term. The analysis was carried out on the basis of households' quantitative inflation expectation, as did *Meyler and Reiche* (*2021*) as well as *Hayo and Méon* (*2023*). Unlike *Szyszko and Kliber* (*2025*), who analysed the effects of oil prices on inflation expectations in Hungary among other countries, we identify the effects of a wider range of factors on the Hungarian data.

In *Section 2* and *Section 3* of the study, we present the data used and the methodology of our analysis, respectively. *Section 4* shows our estimated results, while finally, *Section 5* is the summary of our conclusions.

2. Data

2.1. Household inflation perceptions and expectations

Households' inflation expectations and current inflation perceptions are measured by monthly representative consumer surveys conducted by GKI Gazdaságkutató Zrt. on samples of 1,000 respondents. The survey is based on answers to qualitative and quantitative questions. The qualitative questions are based on pre-defined categories (such as: prices will *"increase more rapidly", "increase at the same rate", "increase at a slower rate", "stay about the same" and "fall slightly"*), reflecting perceptions regarding the direction and rate of the current and expected inflation. By contrast, quantitative questions ask about consumer price changes in terms of numbers:

- *By how many per cent do you think that consumer prices have gone up/down over the past 12 months?*

- *By how many per cent do you expect consumer prices to go up/down in the next 12 months?*

One advantage of the quantitative answers is that they can be compared directly to the official inflation statistics, and they are also comparable over time, making them suitable for data-based analyses. They can be used for analysing the trends and volatility of inflation expectations, as well as responses in inflation expectations to various economic events. However, the drawbacks of the quantitative method are that the answers depend on the way the questions are asked, that some answers provide extreme (outlier) values and that respondents often provide rounded figures (such as 0 or 10 per cent). Another negative factor is that respondents with lower education may have difficulties in giving numerical answers, which may result in distortions.

Conversely, the understanding of qualitative questions may vary by person or over time; therefore, the aggregation of individual responses is not straightforward. Balance indicators calculated from results derived from surveys are necessarily based on arbitrary weighting. Indeed, qualitative expectations cannot be directly compared with actual data, since qualitative surveys of inflation expectations essentially differ from the evolution of the consumer price index. The techniques

generating quantitative indicators from qualitative responses for comparisons to official indices are highly dependent on the assumptions underlying the methodology used (see, for instance, *Arioli et al. 2017*).

The qualitative survey used in our analysis took place during the 127-month period between January 2015 and July 2025; therefore, the database holds a total of 127,000 observations. The database is of the *repeated cross-sectional* type; in other words, different households participated in the different monthly surveys. Consequently, it is only possible to examine average trends in the whole population or various socio-demographic groups, not individual dynamics. The data thus gathered were adjusted through further steps, and responses to qualitative questions were used for eliminating inconsistent numerical answers. The criteria used and the treatment applied to numerical answers are presented in *Table 1.*

Table 1		
Criteria applied to the quantitative inflation expectations recorded in the survey		
	Criterion (condition)	**Treatment (quantitative response)**
i.	Qualitative response (expectation/perception) = "prices will stay about the same/prices have stayed about the same"	To be considered as 0%.
ii.	Qualitative response (perception) ≠ "prices have stayed about the same", but quantitative response = 0%	To be considered as invalid.
iii.	Qualitative response (expectation) = "prices will increase more rapidly", but quantitative response for expectation < quantitative response for perception	To be considered as invalid.
iv.	Qualitative response (expectation) = "prices will increase at a slower rate", but quantitative response for expectation > quantitative response for perception	To be considered as invalid.
v.	Qualitative response (perception) = "prices have fallen", and (expectation) = "prices will increase at the same rate"	To be considered as invalid.
vi.	Qualitative response (perception) = "prices have stayed about the same", and (expectations) = "prices will increase at the same rate"	To be considered as invalid.
vii.	Qualitative response (expectation) = "prices will increase at the same rate", but the absolute difference between expected and perceived inflation is ≥ 15 percentage points	To be considered as invalid.

Up to the early 2020s, Hungarian households' inflation perception was typically higher than actual inflation, but changed in close correlation with actual inflation (*Figure 2*). However, the waves of inflation seen in the new decade following the low-inflation environment of the 2010s increased the distance between the two indicators. Inflation varied within the range of 0 per cent to 3 per cent from 2015 to 2019 (averaging 1.8 per cent), while the average for inflation expectations was as high as 9.5 per cent. Expectations followed not the actual, but rather the perceived inflation (of around 8 per cent) during that time. The close correlation between perceived inflation and expectations lasted until the inflation wave observed in

the first half of the 2020s. From 2021, the trajectory of the two indicators has diverged. With an increase in perceived inflation, no material break was observed in inflation expectations in mid-2021, indicating that expectations were anchored to a certain degree. After the outbreak of the war between Russia and Ukraine, from March 2022 on, both perceptions and expectations began to rise steeply and simultaneously. However, from August 2022, the increase in expectations no longer followed the continued steep rise in perceived inflation. Nevertheless, expectations cannot be regarded as being fully anchored in the household sector since both the expected and the perceived rise of prices have, since mid-2024, stabilised above the level preceding the earlier waves of inflation, and then began to decrease slightly.

Figure 2
Changes in household inflation perceptions, expectations and actual inflation
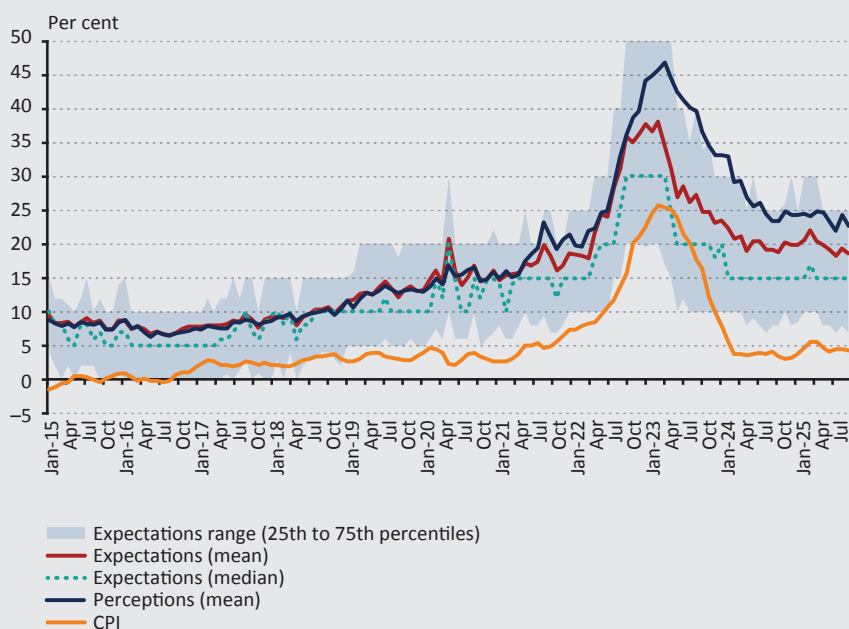
Note: Data adjusted by the MNB.
Source: Hungarian Central Statistical Office (HCSO), GKI, European Commission (EC), MNB

2.2. Socio-demographic composition of households' inflation expectations

Different socio-demographic groups are characterised by different household inflation expectations (*Table 2*). The total sample's average expectation is 15.6 per cent, while its median is 10 per cent. The raw average rates show that women's inflation expectations are 2.3 percentage points higher than those of men. Higher expected inflation rates have generally been found among women (for instance, *Easaw et al. 2013*; *Meyler – Reiche 2021*; *D'Acunto et al. 2021*). The rate of estimated future price rise increases with age up to the age group of 50–64,

and then it declines again among people over 65 (a similar pattern is described by *Meyler – Reiche 2021*). This heterogeneity by age may be explained by differences in experience relating to inflation during the different lifetimes of the various cohorts (*Malmendier – Nagel 2016*). As regards educational attainment, in the raw average, respondents with primary school education expect lower rates of inflation than those with secondary or tertiary qualifications do. In terms of occupation categories, white-collar employees reported the lowest inflation expectations.

These categories are, of course, not independent of one another: women's higher average inflation expectations are partly related to their group's different composition in terms of age and qualifications. The results presented in the last two columns of *Table 2* are simultaneously controlled for socio-demographic characteristics, thereby separating the effects of the various factors. The estimation equation of the applied linear regression:

$$E_{it}^h(\pi_{t+12}) = \alpha + \sum_k \beta_k D_{kit} + \gamma_t + u_{it} \tag{1}$$

where E^h means households' expectation, $E_{it}^h(\pi_{t+12})$ denotes a 12-month forward-looking inflation expectation of household i at the date t, D_{kit} are dummy variables describing socio-demographic characteristics (gender, age group, education, employment), β_k is the related coefficient measuring the difference from the reference group. The specification in the last but one column of *Table 2* does not include time fixed effects (γ_t), while the estimates presented in the last column of the same includes the monthly fixed effects as well, eliminating the effects of changes in the macroeconomic environment.

The results of our estimates show that socio-demographic factors have a significant and robust impact on inflation expectations. Women's expectations are statistically significantly higher, by 3.0 percentage points, than men's, even after controlling for age, educational attainment and occupation. The youngest (18–29-year-old) and the oldest (over-64-year-old) age groups have significantly lower inflation expectations than the other – middle age – groups. According to specification (2) people with tertiary qualifications have the lowest inflation expectations. *Easaw et al.* (*2013*), *Ehrmann et al.* (*2017*) and *Meyler and Reiche* (*2021*) also observed that inflation expectations are also lower with higher levels of education. It should be noted that, in the case of the specification without time fixed effects (1), the highest inflation expectations are observed among people with tertiary education. One of the reasons for this is that people in this group expected higher inflation rates typically during high-inflation periods. Another reason – which is more of a technical nature – is that the number of respondents with not more than primary education tended to be smaller in the sample during such periods. In terms of employment, pensioners expect the highest rates of inflation in the future. They are followed by economically inactive people making up the "other" category and blue-collar workers.

Table 2
Socio-demographic composition of households' inflation expectations

	Number of obs.	Share (%)	Mean	Std. Dev.	Median	p25	p75	Percentage point deviation from the reference group	
								(1)	(2)
Gender									
Male	45,793	48.1	14.4	16.1	10	5	20		
Female	49,442	51.9	16.7	18.5	10	5	20	2.741***	3.016***
Age									
18–29	16,094	17.2	14.7	18.6	10	4	20	−1.767***	−1.626***
30–49	33,868	36.2	15.7	18	10	5	20		
50–64	26,402	28.2	16.5	17.3	12	5	20	0.901***	0.239
65+	17,186	18.4	15.3	15.6	10	5	20	−0.475	−1.948***
Education									
Primary education or less	10,130	10.6	13.1	15.2	10	4	20	−3.441***	−0.423*
Upper secondary	59,659	62.6	15.9	17.9	10	5	20		
Tertiary	25,446	26.7	15.9	17.1	10	5	20	0.305*	−1.749***
Employment									
Other	9,571	12.6	20.2	22.7	15	6	30	5.134***	2.242***
Blue collar	12,710	16.7	17	17.9	12	6	20	1.677***	1.828***
Pensioner	19,509	25.7	17.6	17.3	15	7	21	1.892***	2.348***
White collar	25,998	34.2	16.4	17.3	12	5	20		
Self-employed, manager	8,187	10.8	17.4	18.9	14	6	20	1.537***	−0.345
Full sample									
	95,235	100	15.6	17.4	10	5	20		

Note: The aggregated numbers of elements in the various socio-demographic groups may differ from the corresponding numbers of elements as a consequence of the elimination of the "Do not know / Do not answer" values. The "other" category includes unemployed people, those fulfilling domestic task and other inactive earners, dependants, students and other economically inactive people. The average of the reference group (α=15.6) is the inflation expectation of male respondents aged 30–49, with secondary education in white collar jobs.

The equation of the OLS regression marked (1):

$$E_{it}^{h}(\pi_{t+12}) = \alpha + \sum_{k} \beta_k D_{kit} + u_{it}.$$

The equation of the OLS regression marked (2) includes the γ_t month's fixed effects as well:

$$E_{it}^{h}(\pi_{t+12}) = \alpha + \sum_{k} \beta_k D_{kit} + \gamma_t + u_{it}.$$

*The significance levels are: *** p<0.01, ** p<0.05, * p<0.1. Robust (White's) standard errors for the regression estimates.*

Source: MNB based on GKI, EC

The heterogeneity of the formation of inflation expectations may entail important macroeconomic consequences, and monetary policy messages may be perceived by different groups of society in different ways. Therefore, the robustness of the results was tested for certain highlighted socio-demographic characteristics.

2.3. Macroeconomic factors and their effect mechanisms

Household inflation expectations are partly anchored and partly retrospective, i.e. they are affected by recent experience and inflation perception. The extent to which inflation expectations are anchored is important for monetary policy, because an inflation target can only be sustainably achieved if expectations are anchored not necessarily to the inflation target, but at least at a level that is consistent with the inflation expectations. The degree of anchoring can be altered in the short run by major shocks or unexpected events. Such significant impacts may include the substantial exchange rate movements observed in recent years, the energy and food price increase experienced in 2022 and 2023, or even the impact of the coronavirus pandemic on economic confidence. Of the (measurable) factors affecting inflation expectations, in our study we highlighted the perception of inflation, actual inflation, the inflation of prioritised groups in the consumer basket, the inflation forecasts of macroeconomic professionals and consumer confidence, as well as the change and the degree of fluctuation in the EUR/HUF exchange rate.

On the one hand, certain factors may have an immediate effect on inflation expectations, such as when expectations react quickly to certain news or events (e.g. an increase in the volatility of the exchange rate). On the other hand, other factors shape inflation expectations slowly and gradually (e.g. a persistently high-inflation environment). Also factored in are the direct impacts of macroeconomic factors on inflation expectations as well as the fact that macroeconomic factors may also have a major indirect impact on expectations via households' perception of inflation. The role of the factors influencing inflation expectations are discussed below.

We examined how the perception of inflation is affected by prioritised groups in the consumer basket by also analysing the changes in the prices of the main groups in the inflation basket (market services, traded goods, food, market energy, items with administered prices, alcohol and tobacco). Household inflation perceptions are most affected by changes in the prices of goods and services that the households buy frequently and directly, and inflation perceptions have a strong impact on inflation expectations. In 2024, the shares of food and fuels in the consumer basket were 18 per cent and 7 per cent, respectively, but their psychological weight in inflation perceptions may have been much higher, as their prices show higher-than-average volatility, and many households believe that the cost of daily shopping reflects general inflation. Households are particularly sensitive to fuel, energy and food price changes. Owing to the government's measures (fuel price cap, reduction in public utility charges), Hungarian households were significantly less exposed to energy

and food price increases than businesses during the examined period. However, in the European Union, it was Hungary where the rise in food prices exceeded core inflation excluding processed food by the largest degree in the period 2020–2024.

The inflation forecasts of professionals indirectly shape household inflation expectations, primarily through the media and economic news. Changes in market consensus may affect expectations regarding future price changes, even if consumers' experiences relating to current price changes remain unchanged. Monetary policy and the central bank's communication are also reflected by professional forecasts. For inflation forecasting, we collected the median of the Consensus Economics forecasts for the next six and twelve months.

The consumer confidence index measures people's confidence in the economic situation and their financial optimism. In times of uncertainty or pessimism (in conjunction with low consumer confidence levels), people tend to have concerns about higher inflation. There is an interaction between the level of trust in the economy by households and high inflation. On the one hand, high inflation creates uncertainty among households, because of the diminishing purchasing power of their disposable income. On the other hand, if households are less confident about the economic outlook, they are more likely to expect further price increases. This expectation can be self-fulfilling: it drives demand for higher salaries, and consumers bring forward their purchases, to which companies may respond by raising prices. Therefore, weakening confidence may indirectly contribute to more persistent inflationary pressures. However, if confidence starts to grow, this could lower inflation expectations, contributing to stability. The main factors shaping confidence include, primarily, inflation-related factors, along with income and labour market expectations, general uncertainty, economic security and predictability, as well as economic policy. While not examining consumer confidence itself, *Chen et al.* (*2025*) analysed uncertainty, which may be part of confidence, and found no evidence of changes in inflation affecting short-term uncertainty, despite the fact that macroeconomic and financial variables have a profound impact on inflationary uncertainty.

To reduce the endogeneity between confidence and inflation expectations, we approached consumer confidence using the GKI's consumer confidence index, the value of which is determined by four factors that do not include households' inflation perception or expectation.

• the perception of households' financial position in the past twelve months,

• expected changes in households' financial position in the coming twelve months,

• expected changes in Hungary's economic situation in the coming twelve months, and

• prospects for purchases of high-value consumer goods in the next twelve months.

Hungary is a small, open economy, where the EUR/HUF exchange rate changes feed through relatively quickly to domestic prices and hence inflation expectations, as a consequence of the high proportion of imports. Rapid exchange rate changes may reflect an increase in economic uncertainty. The effect of exchange rate changes can shape household inflation expectations not only through the perception of current price changes, but also regarding the future. Households may perceive a major weakening of the exchange rate as an inflation risk and may thus incorporate it directly into their inflation expectations. In times of economic uncertainty, higher volatility in the EUR/HUF exchange rate may amplify the effect of exchange rate changes: with larger and more frequent exchange rate changes, higher costs will be more quickly built into prices by companies.

3. Methodology

We identify short-term and long-term correlations between inflation expectations and macroeconomic factors with the help of the error correction model (ECM), as discussed in the study by *Easaw et al.* (*2013*).

Based on the theory of rational expectations, we assume that households' expectations are, in part, forward-looking (rational) – which we express with the median projection by Consensus Economics – and partly backward-looking (adaptive), i.e. governed by perceived inflation and actual inflation. This dual mechanism can be formalised in the following cointegration equation:

$$E_t^h(\pi_{t+12}) = \alpha_0 + \underbrace{\alpha_R E_t^C(\pi_{t+6})}_{rational\ component} + \underbrace{\alpha_A \pi_t^P}_{adaptive\ component} + e_t \tag{2}$$

where $E_t^h(\pi_{t+12})$ is the 12-month forward-looking household inflation expectation, $E_t^C(\pi_{t+6})$ is the 6-month forward-looking analyst expectation (due to lack of data, we use the median of professionals' 6-month forward-looking projections as a proxy variable instead of the 12-month figure), π_t^P is inflation as perceived by households, and e_t is the difference from the equilibrium level in the short term. The weights of rational and adaptive expectations are α_R and α_A, respectively, for which, α_R, α_A>0 and $\alpha_R + \alpha_A$=1. In the case of α_A=1, we refer to as fully backward-looking expectations and, in the case of α_R=1, as fully rational expectations. In our analysis, we allow a bias in inflation expectations, the extent of which is expressed by α_0. However, this bias is presumed to remain unchanged over time. The existence of cointegration between the variables is shown in *Table 5* and was checked with the stationarity of the residual.

In the short run, expectations may be shifted from the equilibrium by macroeconomic factors, which can be described with the following specification:

$$\Delta E_t^h(\pi_{t+12}) = \beta_0 + \beta_1 \Delta \pi_t^P + \beta_2 (E_t^C(\pi_{t+6}) - \pi_t) + \beta_3 \Delta CCI_t + \beta_4 \Delta FX_{t-1} + \varphi e_{t-1} + u_t \quad (3)$$

where π_t is actual inflation, $(E_t^C(\pi_{t+6}) - \pi_t)$ is the shift of inflation expected by analysts in the next six months, ΔCCI_t is the change in consumer confidence, ΔFX_{t-1} is the percentage change in the previous month's EUR/HUF rate (if positive, it shows a weakening of the forint), and e_{t-1} is the error correction term. The latter's coefficient $-1 < \varphi < 0$ measures the speed of adjustment: the extent to which households' expectation drops (increases) in the next period, having risen above (dropped below) the equilibrium. The above two equations can be combined, as follows:

$$\begin{aligned} \Delta E_t^h(\pi_{t+12}) = &\beta_0^* + \beta_1 \Delta \pi_t^P + \beta_2 (E_t^C(\pi_{t+6}) - \pi_t) + \beta_3 \Delta CCI_t + \beta_4 \Delta FX_{t-1} \\ &+ \varphi \left[E_{t-1}^h(\pi_{t+11}) - \alpha_R E_{t-1}^C(\pi_{t+5}) - \alpha_A \pi_{t-1}^P \right] + u_t \end{aligned} \quad (4)$$

where $\beta_0^* = (\beta_0 - \varphi \alpha_0)$ includes the expectations bias.

Because of the role of perceived inflation in shaping expectations, we examine the factors affecting households' perception of the rate of a price increase. An error correction model is used, in which it is assumed that, in the long run, perceived inflation moves together with actual inflation:

$$\pi_t^P = \gamma_0 + \gamma_1 \pi_t + v_t \quad (5)$$

where the γ_1 coefficient is fixed at 1. Our assumption is that the shocks in the second half of the examined period were so severe that they moved households' perceptions far away from actual movements in prices. Due to the limited availability of data, the examined period does not cover a whole business cycle. By fixing the coefficient, we avoid capturing short-term effects with the long-term relationship. In estimating the equation, we observed that the estimated error correction residuals do not show any substantial autocorrelation ($DW = 2.05$), which confirms our choice. In our analysis, we allow a distortion of inflation perception, the extent of which is expressed by γ_0. However, this distortion is presumed to remain unchanged over time. The short-term dynamics capture rapidly changing factors that affect perception:

$$\Delta \pi_t^P = \delta_0 + \delta_1 \Delta \pi_t^F + \delta_2 \sigma_{t-1}^{FX} + \delta_3 \Delta CCI_t + \rho v_{t-1} + u_t, \quad (6)$$

where $\Delta\pi_t^F$ denotes the change in food inflation, σ_t^{FX} is the relative standard deviation of the EUR/HUF rate, and υ_{t-1} is the error correction term. By substituting equation (5) into equation (6), we obtain:

$$\Delta\pi_t^P = \delta_0^* + \delta_1\Delta\pi_t^F + \delta_2\sigma_{t-1}^{FX} + \delta_3\Delta CCI_t + \rho(\pi_{t-1}^P - \gamma_1\pi_{t-1}) + u_t \,, \tag{7}$$

where δ_0^* includes the degree of bias. Error correction equations (4) and (7) are estimated in one step. The variables determining long-term correlations are integrated of order one (see *Annex*, *Table 4*). The estimated parameters – the anchoring of household inflation expectation and the short-term effect of macroeconomic factors – are presented in the following section.

4. Results

4.1. Estimate results

Our estimates indicate that in the early 2020s a change occurred in the way inflation expectations are formed. The predominantly low, stable inflation environment in the 2010s was followed by a period of higher, more volatile inflation, and households could expect a persistently higher inflation risk for the future. The focus shifted to the role of anchored expectations. In the uncertain, higher inflation environment of the new decade, the role of inflation expectations, consumer confidence and exchange rate developments increased, while that of inflation perceptions diminished. Further analyses will be required to find out how people's confidence in the economy and how their inflation expectations were affected by the Hungarian central bank's communication, the domestic economic policy and Hungarian media. The changes taking place in the formation of inflation expectations as a consequence of the different characteristics in the new decade are in line with the findings of studies that emphasised the regime-dependent nature of expectations formation (*Borio et al. 2023*; *Goodspeed 2025*; *Gobbi et al. 2025*; *Lin – Li 2025*). We describe these effects in more detail below.

The inflation expectations of Hungarian households were almost purely backward-looking during the low-inflation period. Between 2015 and 2019, households' inflation perception was fully integrated into expectations in both the short and the long term. This effect has diminished during the past five years, and since 2020, a 1-percentage point rise in inflation perception has increased household expectations only by 0.68 percentage point simultaneously and by 0.45 percentage point in the medium term (*Table 3*). As the current perceived price increase is becoming less and less indicative of the future expectation, other factors have emerged in the current more uncertain environment.

Table 3

**Factors affecting inflation perceptions and expectations**

	2015–May 2025		2015–2019		2020–May 2025	
	Change in inflation perceptions	*Change in inflation expectations*	*Change in inflation perceptions*	*Change in inflation expectations*	*Change in inflation perceptions*	*Change in inflation expectations*
Change in inflation perceptions		0.719***		1.055***		0.681***
		(0.070)		(0.081)		(0.088)
Direction of market consensus		0.131***		−0.005		0.188***
		(0.045)		(0.063)		(0.058)
Change in food inflation	0.286***		0.122		0.287***	
	(0.051)		(0.136)		(0.068)	
Change in consumer confidence	−0.057***	−0.107***	−0.063**	0.014	−0.048+	−0.103***
	(0.021)	(0.018)	(0.027)	(0.017)	(0.030)	(0.023)
EUR/HUF exchange rate change (−1)		0.205***		0.027		0.249***
		(0.059)		(0.046)		(0.080)
Relative std. dev. of exchange rate (−1)	0.686**		−0.046		0.625+	
	(0.278)		(0.403)		(0.428)	
Error correction term (−1)	−0.037**	−0.315***	−0.098*	−0.822***	−0.077*	−0.599***
	(0.017)	(0.063)	(0.052)	(0.142)	(0.039)	(0.111)
Actual inflation level (−1)	1.000		1.000		1.000	
	(−)		(−)		(−)	
Perceived inflation level (−1)		0.626***		0.991***		0.451***
		(0.046)		(0.038)		(0.050)
Market consensus level (−1)		0.374		0.009		0.549
		(−)		(−)		(−)
Constant	0.078	0.915***	0.816**	0.226	0.922	3.899***
	(0.254)	(0.252)	(0.389)	(0.240)	(0.838)	(0.909)
Adjusted R^2	0.367	0.682	0.101	0.787	0.403	0.747
Durbin–Watson-statistics	2.05	2.23	2.35	1.82	2.01	2.08
F-statistics	18.794***	44.613***	2.622**	36.053***	11.822***	32.527***

Note: The significance levels are: *** $p<0.01$, ** $p<0.05$, * $p<0.1$, + $p<0.15$. The standard errors appear in brackets under the estimated parameters. Based on theoretical considerations, the actual inflation coefficient's parameter for long-term inflation perception is fixed at 1. In the long-term inflation expectation, the sum of the market consensus and the perceived inflation parameters is set to 1, based on theoretical considerations.

Source: MNB calculation based on GKI and EC data

During the high-inflation period, households became more forward-looking, and market expectations had a significant impact on their inflation expectations (*Table 3*). On average since 2020, the 1-percentage point decrease in the inflation forecast of professionals simultaneously reduced household inflation expectations by 0.19 percentage point and by 0.55 percentage point in the medium term. During the preceding low-inflation period, this effect was nearly zero and insignificant. In the low-inflation environment, households probably did not pay much attention to inflation prospects, but in periods of high inflation, people focus more on inflation and respond more sensitively to information in the media regarding developments of relevance to the price index (*Goodspeed 2025*). Our moving window estimate shows that the role of inflation perception has gradually decreased during the past ten years, and we have not seen a break in the effect (*Figure 3*).

Figure 3
Changes in the impacts of different factors on inflation expectations over time
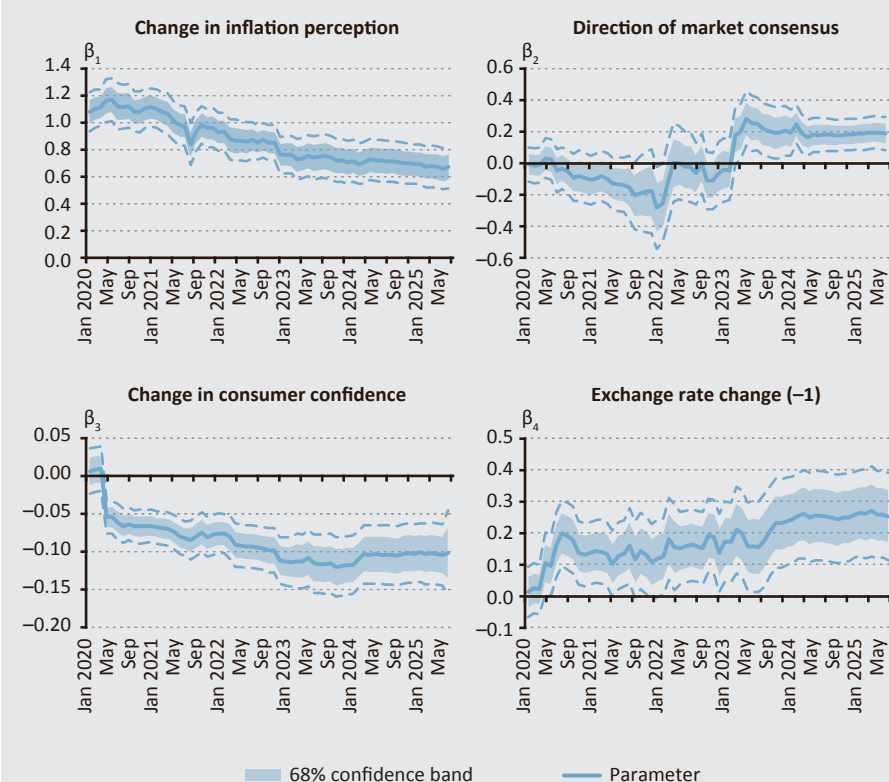
Note: 5-year rolling window estimates of error-correction models. The dates relate to the end of each period. The light blue band shows the 1-standard deviation (68-per cent) confidence interval for the parameter estimate, while the dashed line indicates the 90-per cent confidence interval.
Source: MNB based on GKI data

Since 2020, the structure of inflation has demonstrably dominated inflation perceptions and, indirectly, expectations as well, which may have been caused by larger fluctuations in food prices, in addition to the frequency of purchases. After 2020, a 10-percentage point rise in food inflation was followed by an average 2.9-percentage point increase in households' average inflation perception and thus, indirectly, by a 2.0-percentage point rise in households' average expectation as well (*Table 3*). The rolling-window analysis shows that a remarkable, significant increase in the effect occurred when food prices surged (*Figure 4*). Food inflation has traditionally been a volatile component of inflation in Hungary, but it reached very high levels (even above 40 per cent) in 2022. The larger-than-average fluctuation in the price of this product group may have contributed significantly to the (psychological) impact of food inflation rising significantly above its 18-per cent weight in the consumer basket and to a surge in households' inflation expectations.

Figure 4
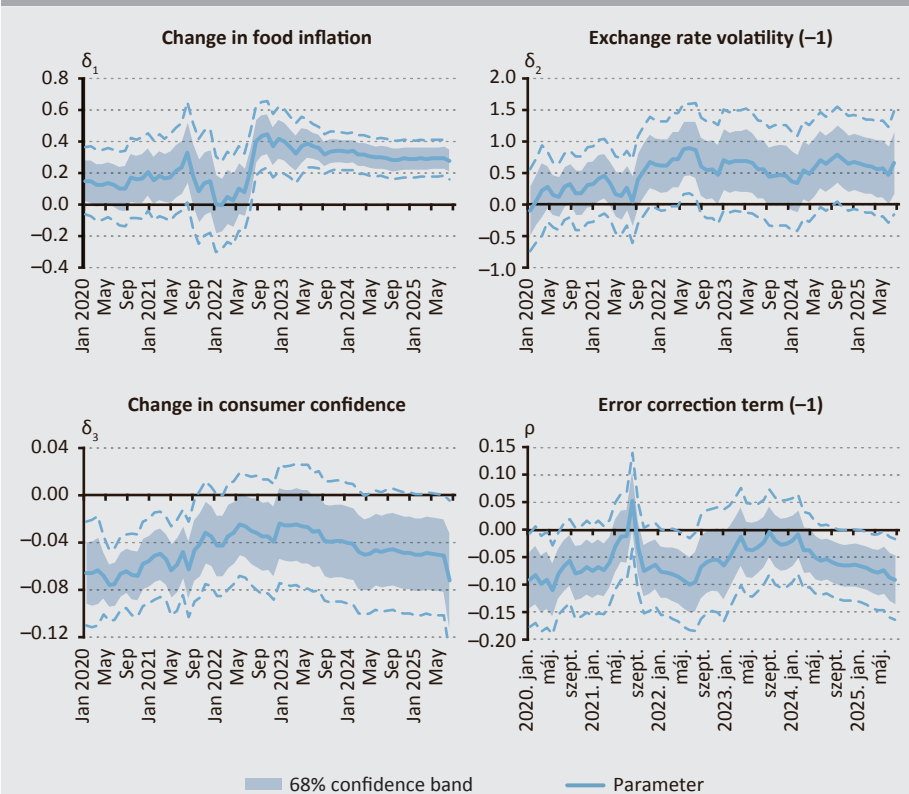**Changes in the impact of different factors on inflation perceptions over time**

Note: 5-year rolling window estimates of error-correction models. The dates relate to the end of each period. The light blue band shows the 1-standard deviation (68-per cent) confidence interval for the parameter estimate, while the dashed line indicates the 90-per cent confidence interval.

Source: MNB based on GKI data

The increase in food inflation affects nominal developments in the economy through second-round impacts as well: when people are faced with a steady, rapid increase in food prices, they expect all other items to also become more expensive. Our results relating to the dominant role of food inflation are added to the empirical findings highlighting the impact of direct purchasing experiences and the frequency of shopping on the formation of opinions on inflation (*Angelico – Di Giacomo 2019*; *D'Acunto et al. 2019, 2021*; *Anesti et al. 2025*).

No significant correlation was found between energy prices and expectations (as well as perception), which may have resulted from the still regulated public utility charges of households and the fuel price cap introduced for the period of the oil price increase. As a consequence of these measures, households did not perceive the energy price rise, or they perceived only a fraction of the market price increase; therefore, they did not increase their expectation any further (*Annex, Table 6*).

The impact of household confidence on expectations increased overall between the two periods, despite the fact that the indirect impact decreased through perception and became insignificant at a 10-per cent significance level (we note that the Granger causality was tested in order to eliminate the endogeneity problem relating to confidence, and at a 10-per cent significance level neither inflation perception nor inflation expectation was found to be a Granger cause of the confidence variable used in the estimation – with p-values of 0.588 and 0.120 per cent, respectively, including four lags). Household inflation expectations were practically not influenced by confidence between 2015 and 2019, but in the early 2020s, this direct impact had grown to be measurable. The impact of household confidence on perception was quite similar in the two examined periods, while the immediate impact of perceptions on expectations decreased by one-third. Since 2020, a 1-percentage point loss of confidence raised average inflation expectations by 0.10 percentage point directly, on average (*Table 3*) and – by factoring in the indirect impacts through perception as well – by a total of 0.14 percentage point (before 2020, the direct effect was practically 0 percentage point, while the total effect was 0.05 percentage point). The increase in the role played by confidence is consistent with findings from behavioural economics: due to negative experiences and uncertainty, people tend to place more weight on potential negative (high inflation) future outcomes (*Kahneman – Tversky 1973, 1979, 1982*; *Meyler – Reiche 2021*). Rolling window estimates show that the direct impact of confidence on household inflation expectations increased dramatically during the coronavirus

pandemic and continued to increase gradually thereafter in a high-inflation regime (*Figure 3*).

As well as the inflation forecasts of professionals, the EUR/HUF exchange rate can also have a direct impact on people's future price expectations. Households responded to exchange rate changes more sensitively in the period 2020–2024. A 1-per cent weakening of exchange rate experienced one month earlier drove households' expectations by an average of 0.25 percentage point in 2020–2024 – when controlled for changes in inflation perception and food prices – whereas the exchange rate had no significant effect in the 2015–2019 period. Even the effect of the (relative) standard deviation of the EUR/HUF rate was practically zero in 2015–2019, but grew stronger for the period after 2020. During the period of significant depreciations of the forint from 2018 on, the impact on inflation perceptions temporarily increased and became significant, remaining around the 10-per cent significance level for the entire period of the 2020s. The role of the changes in the exchange rate in the evolution of perception was also examined, but it was not found to have had a significant explanatory power, controlling for other variables. This may indicate that not only the weakening of the exchange rate but its uncertain movements may also affect peoples' perception of inflation, which points to the role of exchange rate stability. This phenomenon may also be related to the fact that Hungarian forint witnessed considerably more major depreciations than appreciations (corrections) during the examined period. Additional analyses need to be carried out regarding the role of monetary policy in anchoring inflation expectations by attenuating exchange rate fluctuations (more stable exchange rate).

4.2. Robustness analysis based on demographic characteristics

The robustness of our results was tested in relation to Hungarian households' socio-demographic characteristics. Due to the longitudinal cross-sectional structure of the household survey, the estimation of equations (4) and (7) was carried out and compared over time, using the average of the sub-groups featuring the given demographic characteristics. We highlighted the following groups: 1) women, 2) men, 3) the 18–64-year age group (adults of working age), 4) active population, 5) people with secondary and tertiary qualifications, and 6) white-collar workers and entrepreneurs.

Figure 5
Estimated parameters of factors affecting inflation expectations, in various socio-demographic groups
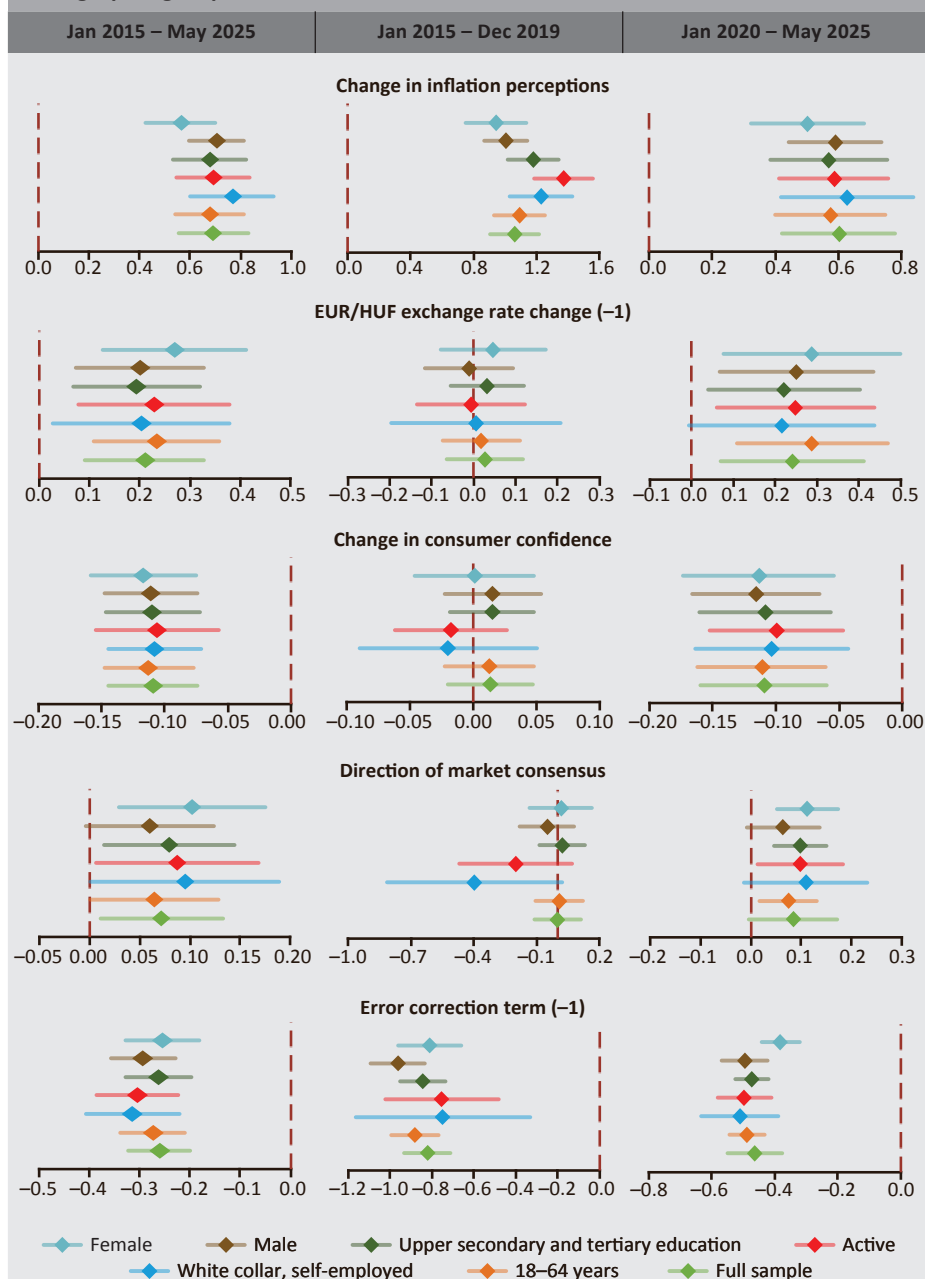
Note: The marking points (diamonds) indicate the parameters' point estimates, while the horizontal lines indicate the 95-per cent confidence interval.

Source: MNB estimate

The effects and their changes between the two periods, as identified by our analyses, applied to the highlighted socio-demographic groups as well. The direction and magnitude of the effects estimated for the above sub-groups are similar to those estimated for the entire population, and the significance of the effects also changes only in a few cases (*Figures 5* and *6*). Of the factors affecting inflation perception, special mention is made of food inflation, the impact of which is particularly robust, significant and consistently positive in a wide range of segments,

Figure 6
Estimated parameters of factors affecting inflation perception, in various socio-demographic groups
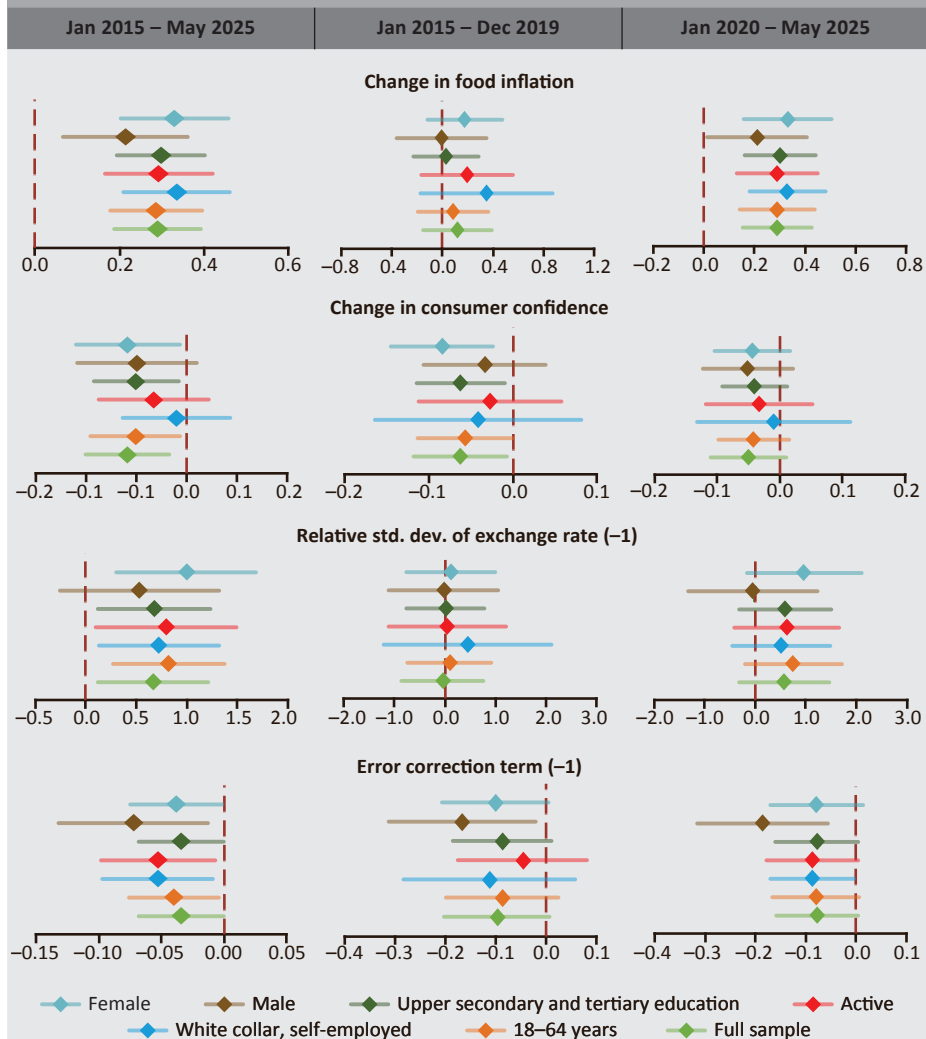

Note: The marking points (diamonds) indicate the parameters' point estimates, while the horizontal lines indicate the 95-per cent confidence interval.

Source: MNB estimate

in all periods reviewed (*Figure 6*). In 2015–2019, expectations were only driven by perceived inflation, by approximately 1 percentage point, somewhat more in the group of economically active people. No significant heterogeneity is found in the magnitude of the effects of macroeconomic factors during the years after 2020 (*Figure 5*).

Our robustness analyses show that macroeconomic factors have a relevant impact on household inflation perception and the formation of expectations even in the groups of different socio-demographic characteristics. Therefore, in high-inflation regimes, economic policy measures that are aimed at anchoring expectations and boosting household confidence may be widely effective even without demographic targeting.

5. Summary

We provided an overview of trends in Hungarian households' inflation expectations over the past 10-year period, pointing out changes in the formation of expectations triggered by the shocks and waves of inflation in the early 2020s. Hungarian households' inflation perception and expectations have both been higher than the actual rates of inflation, and the two moved closely together until 2019. However, the waves of inflation increases reduced the comovement in the 2020s. The process of disinflation of 2023 brought about a faster decrease in expectations and a less marked decrease in inflation perception.

The predominantly low, stable inflation environment in the 2010s was followed by a period of higher, more volatile inflation, and households could expect a persistently higher inflation risk for the future. During the low-inflation period in 2015–2019, Hungarian households' inflation expectations were practically purely backward-looking. In the more uncertain period of high inflation in the 2020s, people consider the "currently" perceived price increase less and less indicative of the future expectation. Households became more forward-looking by one-third, highlighting the role of anchored expectations.

Regarding instantaneous effects, the role of food price inflation, macroeconomic forecasts and exchange rate movements, along with exchange rate volatility that also reflects uncertainty, as well as confidence in the general economic situation increased in the short term. We observed signs that, based on findings in the literature, may indicate that the role of psychological factors intensified in the high-inflation environment in Hungary. The larger-than-average fluctuation in food prices may have contributed to the psychological impact of food inflation rising significantly above its 18-per cent weight in the consumer basket, although this requires further analysis. We found no significant impact of energy and fuel prices, perhaps due to the regulated public utility charges applied since 2013 and

the price cap introduced for the period of the fuel price increase. The role played by household confidence rose in the early 2020s, which is consistent with findings from behavioural economics: due to negative experiences and uncertainty, people tend to place more weight on potential negative (high inflation) future outcomes. Households reacted more sensitively not only to changes in the exchange rate but also to its volatility, partly reflecting economic uncertainty. Both the inflation forecasts of professionals and the EUR/HUF exchange rate can have a direct impact on households' price expectations. Uncertain exchange rate movements may also affect inflation perceptions, highlighting the importance of exchange rate stability. Additional analyses need to be carried out regarding the role of monetary policy in anchoring inflation expectations by attenuating exchange rate fluctuations (more stable exchange rate) on the one hand, and also the possible roles of the various communication channels in dampening inflation expectations, on the other.

Our results are robust regarding Hungarian households' socio-demographic characteristics. Macroeconomic factors (and consequently inflation regimes) have a significant impact on households' inflation perception and expectations even considering different socio-demographic characteristics.

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Annex

Table 4

Integration test of the variables covered by our analyses (between January 2015 and May 2025)

	ADF-test (p-value)		Phillips–Perron-test (p-value)		Order of integration (p=0.05)	
	H0: I(1)	H0: I(2)	H0: I(1)	H0: I(2)	ADF	PP
Inflation expectations	0.662	0.000	0.562	0.000	1	1
Inflation perceptions	0.431	0.013	0.640	0.000	1	1
Actual inflation	0.093	0.009	0.295	0.000	1	1
Consensus (6-month ahead)	0.078	0.001	0.252	0.000	1	1

Note: Estimation period: Jan 2015 – May 2025.
Source: MNB calculation based on GKI and EC

Table 5

Cointegration correlations

	Inflation expectations Equation (2)		Inflation perceptions Equation (5)	
	Without parameter restriction	With parameter restriction	Without parameter restriction	With parameter restriction
Inflation expectations	1	1 (norm.)	–	–
Consensus (6-month)	0.301*** (0.091)	(1–0.536***) (–)	–	–
Inflation perceptions	0.609*** (0.037)	0.536*** (0.038)	1	1
Actual inflation	–	–	1.625*** (0.145)	1
Constant	3.437*** (0.445)	4.008*** (0.584)	9.425*** (1.186)	12.660*** (0.537)
Residual stationarity test (p-value)				
ADF	0.005	0.004	0.139	0.319
PP	0.000	0.000	0.098	0.352

*Note: Cointegration equations. The significance levels are: *** p<0.01, ** p<0.05, * p<0.1. The standard errors appear in brackets under the estimated parameters. Estimation period: Jan 2015 – July 2025.*
Source: MNB calculation based on GKI and EC data

Table 6

Factors affecting inflation perceptions (between January 2015 and May 2025)

	2015–May 2025		2015–2019		2020–May 2025	
	Change in inflation perceptions	Change in inflation perceptions	Change in inflation perceptions	Change in inflation perceptions	Change in inflation perceptions	Change in inflation perceptions
Change in food inflation	0.294***	0.294***	0.142	0.130	0.294	0.295***
	(0.052)	(0.051)	(0.154)	(0.145)	(0.069)	(0.067)
Change in consumer confidence	−0.056**	−0.055***	−0.067**	−0.062**	−0.048[+]	−0.047[+]
	(0.022)	(0.021)	(0.03)	(0.028)	(0.033)	(0.030)
Exchange rate volatility (−1)	0.733**	0.736***	0.051	−0.012	0.708[+]	0.707[+]
	(0.283)	(0.279)	(0.484)	(0.455)	(0.439)	(0.430)
Change in fuel prices	0.000		0.001		0.001	
	(0.016)		(0.021)		(0.023)	
Change in fuel prices (−1)	0.025[+]	0.025*	0.006	0.004	0.026	0.026
	(0.017)	(0.014)	(0.025)	(0.020)	(0.023)	(0.020)
Change in fuel prices (−2)	0.002		−0.005		0.001	
	(0.016)		(0.024)		(0.024)	
Error correction term (−1)	−0.035**	−0.035**	−0.087	−0.092[+]	−0.067[+]	−0.067*
	(0.018)	(0.017)	(0.06)	(0.056)	(0.041)	(0.04)
Actual inflation level (−1)	1	1	1	1	1	1
	(−)	(−)	(−)	(−)	(−)	(−)
Constant	0.035	0.022	0.699[+]	0.757*	0.665	0.673
	(0.257)	(0.254)	(0.444)	(0.420)	(0.880)	(0.854)
Adjusted R^2	0.373	0.382	0.030	0.067	0.390	0.411
Durbin–Watson-statistics	2.11	2.1	2.38	2.36	2.06	2.06
F-statistics	11.298***	16.059***	1.251	1.818[+]	6.844***	9.917***

Note: The significance levels are: *** p<0.01, ** p<0.05, * p<0.1, [+] p<0.15. The standard errors appear in brackets under the estimated parameters. Based on theoretical considerations, the actual inflation coefficient's parameter for long-term inflation perception is fixed at 1. In long-term inflation expectation, the sum of the market consensus and the perceived inflation parameters is set to 1, based on theoretical considerations. Source: MNB calculation based on GKI and EC data

The Relationship between ESG Factors and Corporate Credit Risk: Research Trends from a Bibliometric Perspective*

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The study reviews the literature analysing the relationship between ESG factors and corporate credit risk using bibliometric and systematic literature review methods, processing scientific publications published between 2020 and 2024. Of these, 61 relevant studies are identified and examined in detail, focusing primarily on research trends and empirical results. Due to stricter regulations and market interest, the number of articles focusing on ESG and credit risk has increased significantly. According to the majority of publications, better ESG performance reduces credit risk. Our analysis revealed several research gaps: the examination of the relationship between ESG and credit risk in the small and medium-sized enterprise sector, the impact of climate risks on corporate credit risk and credit portfolios, region-specific analyses, and the application of innovative artificial intelligence and machine learning-based methodological frameworks are areas that could generate significant added value in both academic and market contexts.

1. Introduction

The consideration of ESG (Environmental, Social, Governance) factors in the analysis of corporate credit risks has come to the fore in recent years. Numerous international rules and guidelines have encouraged financial sector players to integrate sustainability considerations into their credit risk management frameworks.

UN initiatives[1] have also had a major impact on exerting stronger pressure through financial intermediaries to achieve sustainability goals. During this period, international recognition of the framework supporting climate-related disclosures (Task Force on Climate-related Financial Disclosures[2] – TCFD) has grown stronger. In the European context, the 2019 European Green Deal,[3] the EU Taxonomy Regulation[4] (Regulation (EU) 2020/852) and the Sustainable Finance Disclosure Regulation (Regulation (EU) 2019/2088,[5] SFDR) are particularly noteworthy. EU and Hungarian regulations specifically applicable to credit institutions and financial enterprises – such as EBA/GL/2025/01, the European Banking Authority's[6] (EBA) guideline on ESG risk management, and Magyar Nemzeti Bank (The Central Bank of Hungary) Recommendation No. 7/2025 (VI. 23.)[7] – clearly stipulate that financial institutions must integrate ESG factors into their credit risk management processes. As a result, the relationship between sustainability (ESG) factors and credit risk indicators has received increased attention since 2020.

It is also worth noting that, not only in the banking system and lending but also in general, investor interest in ESG considerations has grown significantly in recent years, as evidenced by the global rise of sustainable investments and the widespread adoption of responsible capital market practices (*PRI;[8] OECD 2021*). The European Union's sustainable finance framework – in particular, the Taxonomy Regulation and the SFDR – further encourages the integration of ESG factors into investment decisions, which also influences the assessment of corporate credit risk. In addition, studies (e.g. *Amel-Zadeh – Serafeim 2018; Ahmad et al. 2024*; *Li et al. 2025*) also point out that ESG considerations are playing an increasingly important role in business and investment decision-making. Sustainability performance is no longer just a matter of reputation, but directly influences financing conditions, capital market perception and investor confidence.

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[1] 2006 Principles for Responsible Investment and 2019 Principles for Responsible Banking.

[2] The TCFD is an international organisation supported by the United Nations that aims to standardise the disclosure of climate risks (*TCFD 2017*).

[3] A comprehensive programme launched by the European Union in 2019 with the aim of achieving climate neutrality by 2050 (*European Commission 2019*).

[4] Defines which economic activities may be considered sustainable (https://eur-lex.europa.eu/eli/reg/2020/852/oj/eng).

[5] Requires financial institutions to disclose ESG risks and impacts (https://eur-lex.europa.eu/eli/reg/2019/2088/oj/eng).

[6] EBA issues guidelines on prudent operation and ESG risk management for EU credit institutions (https://www.eba.europa.eu/sites/default/files/2025-01/fb22982a-d69d-42cc-9d62-1023497ad58a/Final%20Guidelines%20on%20the%20management%20of%20ESG%20risks.pdf).

[7] https://www.mnb.hu/letoltes/7-2025-esg-kerdoiv-ajanlas.pdf (in Hungarian)

[8] https://www.unpri.org/.

This study explores the research trends and patterns that can be observed in scientific publications dealing with the relationship between ESG and credit risk as a result of increasing regulatory requirements and growing investor interest in sustainability. To this end, we process publications analysing the relationship between ESG and credit risk based on keywords, and we present and systematise current research focuses and scientific results. Based on this, we also identify research gaps that could serve as a basis for further empirical analyses.

In our study, we conducted a systematic literature review and bibliometric analysis to explore the relationship between ESG and corporate credit risk. We used the Elsevier Scopus[9] and Web of Science[10] (WoS) databases for the analysis, which was performed with the Python programming language. We examined English-language publications published between 2020 and 2024 and identified 61 relevant studies. By analysing these, we identified publication trends and possible directions for further research.

To the best of our knowledge, there has been no comprehensive, structured literature review that specifically examines the relationship between ESG factors and corporate credit risk management using a systematic literature review methodology. This study aims to fill this gap.

Our article is structured as follows. Following the introduction, *Section 2* presents the methodology used in the research, while *Section 3* presents the results in three sub-sections. *Sub-Section 3.1* focuses on research trends, changes over time, the geographical relevance of the research and journals, and identifies the main research topics and areas of focus. *Sub-Section 3.2* details publications analysing the relationship between ESG and credit risk, with a particular focus on ESG components (E, S, G, disclosure) and credit risk indicators (e.g. credit rating, CDS spread, probability of default). In *Sub-Section 3.3*, we summarise the results and methods of the most influential research in the field as well as the variables examined. Finally, in *Section 4*, we formulate our most important conclusions.

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[9] https://www.scopus.com.
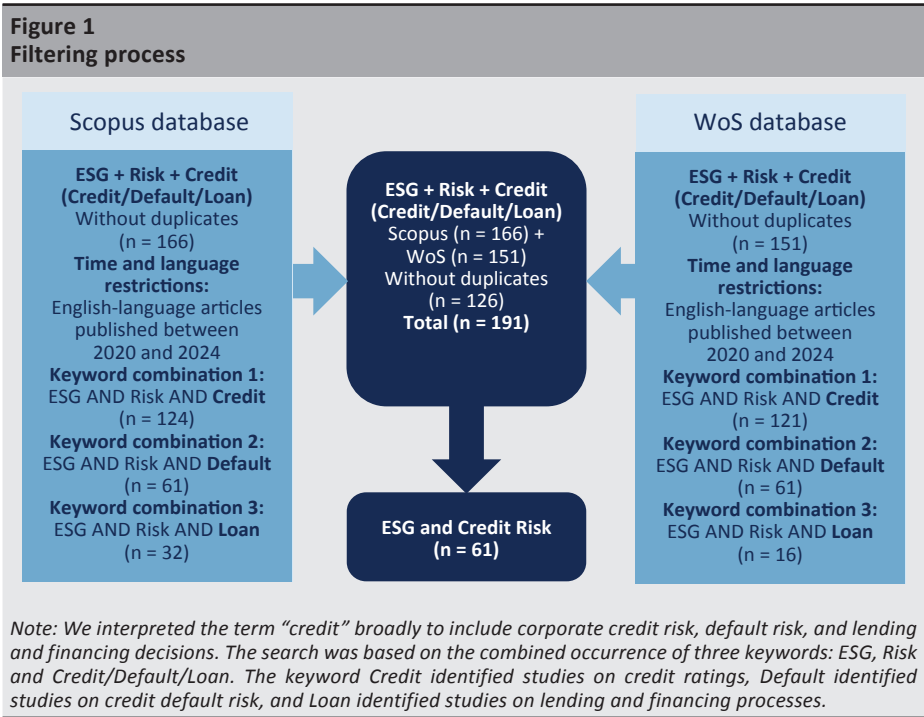[10] https://www.webofscience.com.

2. Methodology

We used systematic literature search and bibliometric analysis in this study. We took publications found in the Elsevier Scopus and Web of Science (WoS) databases as our data sources. The analysis was performed using the Python programming language. The search covered publication titles, abstracts and keywords. In addition, we applied further restrictions: we only considered English-language, "article" type publications published between 2020 and 2024. The chosen time interval was justified by the fact that the number of scientific publications analysing the relationship between ESG and corporate credit risk has increased significantly since 2020 (see *Figure 3*).

One important step was selecting the appropriate keywords, which we determined based on our primary research question and a preliminary review of the literature on the subject. In the course of our research, we narrowed down the range of relevant publications in two search and filtering cycles. First, we searched for publications examining the relationship between sustainability and risk using the keywords "ESG AND Risk". As a second step, we narrowed down the "ESG AND Risk" search even further and ran three targeted queries that focused on exploring the relationship between ESG + Risk + Credit, Default, Loan. We interpreted the concept of credit in a broad sense in this context, using several keywords, as it encompasses both corporate credit risk and default risk as well as lending and financing processes (Loan). Accordingly, the search examined the co-occurrence of the three keywords in three rounds, with the third keyword containing three different expressions:

• "ESG AND Risk AND Credit" – we used the keyword "Credit" to identify studies focusing on credit ratings, credit markets in general and credit premiums;

• "ESG AND Risk AND Default" – the keyword "Default" covers research examining the probability of default, bankruptcy risk or PD indicators;

• "ESG AND Risk AND Loan" – the keyword "Loan" typically captures studies related to lending conditions, credit supply and financing decisions.

Finally, we systematically reviewed and categorised the results of the three keyword searches, in order to identify articles dealing with the relationship between ESG and credit risk. This step allowed us to filter out publications that touched on the topics of "ESG", "Credit" and "Risk" but did not directly address the correlations between ESG and credit risk, which is the focus of our research.

Figure 1
Filtering process

Scopus database	ESG + Risk + Credit (Credit/Default/Loan) Scopus (n = 166) + WoS (n = 151) Without duplicates (n = 126) **Total (n = 191)**	WoS database
ESG + Risk + Credit (Credit/Default/Loan) Without duplicates (n = 166) **Time and language restrictions:** English-language articles published between 2020 and 2024 **Keyword combination 1:** ESG AND Risk AND **Credit** (n = 124) **Keyword combination 2:** ESG AND Risk AND **Default** (n = 61) **Keyword combination 3:** ESG AND Risk AND **Loan** (n = 32)	**ESG and Credit Risk (n = 61)**	**ESG + Risk + Credit (Credit/Default/Loan)** Without duplicates (n = 151) **Time and language restrictions:** English-language articles published between 2020 and 2024 **Keyword combination 1:** ESG AND Risk AND **Credit** (n = 121) **Keyword combination 2:** ESG AND Risk AND **Default** (n = 61) **Keyword combination 3:** ESG AND Risk AND **Loan** (n = 16)

Note: We interpreted the term "credit" broadly to include corporate credit risk, default risk, and lending and financing decisions. The search was based on the combined occurrence of three keywords: ESG, Risk and Credit/Default/Loan. The keyword Credit identified studies on credit ratings, Default identified studies on credit default risk, and Loan identified studies on lending and financing processes.

Using the filtering criteria shown in *Figure 1*, we identified 191 relevant studies from the Scopus and Web of Science databases based on combinations of the keywords ESG + Risk + Credit, Default, Loan.

In the course of our research (*Figure 2*), we categorised the articles according to several criteria; the results are presented accordingly.

Figure 2
Research process according to the Sections discussing the results

Overview of the research structure and the content of the examined sub-sections		
ESG + Risk + Credit (Credit/Default/Loan) (n = 191)	**Examination of the relationship between ESG and credit risk indicators** (n = 61)	
3.1. Bibliometric analysis	3.2. Systematic review	3.3. Summary
Research trends, temporal patterns, geographical distribution, journals, citation metrics, and thematic areas.	ESG components (E, S, G, Disclosure) and credit risk indicators (Credit ratings, CDS spread, PD), Empirical methodologies.	Summary of the most influential publications in the field.

We first analysed the entire set of results (191 publications) based on a bibliometric analysis according to temporal and geographical (affiliation and research area) criteria, journals and main research topics. We then paid particular attention to the correlations between ESG components (E, S, G and ESG disclosure), credit risk and credit risk indicators (61 publications), to the main research results in this sub-area, and to the classification and analysis according to the methodologies used.

It should be noted that our study only collected English-language publications corresponding to the keywords, as the filtering of the Scopus and Web of Science databases does not include publications published in Hungarian-language journals, books or study volumes; therefore, these are not included in the analysis. At the same time, we found several Hungarian-language or Hungarian-origin studies that are closely related to the topic in a given subfield, such as climate risk or green finance, but these were not included in the search results. For example, *Ritter* (*2022*) analyses the impact of climate risks on the credit exposure of banks and bank branches operating in Hungary. *Várgedő* (*2022*) presents the methodology and results of a climate risk stress test conducted on Hungarian credit institutions. *Tamásné Vőneki – Lamanda* (*2020*) provide a comprehensive discussion of how ESG and climate risks manifest in the financial intermediary system. *Hajnal et al.* (*2022*) examine the risk correlations between energy certificates and housing loans. Finally, it is important to note that we are also aware of a systematic literature review in English that covers research trends in green finance and climate risks (*Muchiri et al. 2022*): it examines areas related to our research, but was published using different keywords, as well as relevant bibliometric and science history research that is not available in the form of journal articles (*Sárvári 2024*). We return to this when presenting the limitations of our study.

3. Results

The results are presented in three sub-sections, narrowing the focus of the research in parallel (*Figure 2*). In *Sub-Section 3.1*, based on articles filtered by ESG + Risk + Credit, Default, Loan, we analyse research trends, changes over time, geographical distribution and journals, and we present the main thematic areas and research focuses. *Sub-Section 3.2* discusses research examining the relationship between ESG and its components and credit risk indicators, supplemented by an analysis of methodological approaches. Finally, in *Sub-Section 3.3*, we summarise the most influential and most cited articles analysing the relationship between ESG and credit risk.

3.1. Research trends and thematic areas

Based on keyword research, the topic of ESG was already present in the academic discourse before 2011. However, until 2020, only about 20 to 50 publications were produced each year that focused on the relationship between sustainability and risk. After 2020, in parallel with the strengthening of regulatory requirements, the number of publications on this topic began to increase dramatically, which is why we chose 2020 as the starting point for our systematic analysis (*Figure 3*).

Figure 3
Number and growth trend of scientific publications on ESG and risk between 2015 and 2024
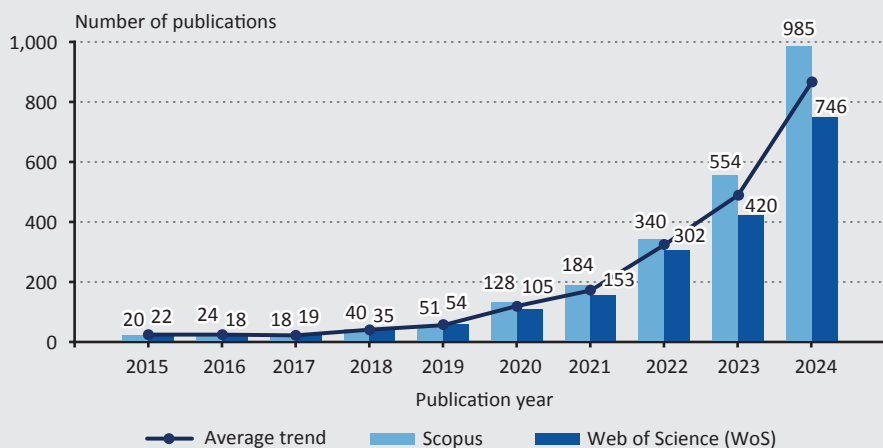
Source: Compiled based on Scopus and Web of Science

Within the ESG and risk topic, relatively few studies have specifically addressed the issue of credit risk management. However, the number of such studies rose dynamically between 2020 and 2024 (*Figure 4*), which clearly shows that the relationship between ESG and credit risk is becoming an increasingly important area of research in the financial literature. The increase of scientific interest essentially coincides with the entry into force of the sustainability regulations presented earlier and the change in market attitudes.

In the following, we only analyse studies published from 2020 onwards on the topic of ESG + Risk + Credit, Default, Loan.

Based on author affiliation, it can be established that 85 per cent of publications in the examined period can be linked to ten countries, meaning that a significant proportion of global publication activity is concentrated in a few larger countries. More than one-half of the publications come from researchers in Asian countries, with China standing out in particular.

Looking at the geographical focus of the studies, we found that most of the research has a global focus (52 articles). Among the regional analyses, Asia (63 articles) and Europe (37 articles) are the most frequently studied regions, with a significant number of articles also focusing on the Americas (32 articles). In terms of countries, China (21 articles) and the United States (27 articles) stand out, but there were also a smaller number of studies on Latin America (5 articles), India, Malaysia, Kazakhstan, Thailand, Ukraine, Russia, and Arab and African countries (1–3 articles). It can be concluded that advanced economies continue to dominate ESG credit risk research, but scientific interest in emerging or developing markets is now almost equally significant. We found a total of 7 articles on the Central and Eastern Europe (CEE) region and individual countries (4 on Poland, 1 on the Czech Republic, 1 on Ukraine and 1 on Romania), which indicates a gap in research. Research conducted on the entire CEE region, but specifically on the Hungarian corporate market, can provide significant added value for a deeper understanding of the interrelationships and for exploring region-specific characteristics, problems and risks.

The 191 publications examined may also be analysed thematically. Based on research focus, we identified the following thematic areas: ESG and credit risk; ESG and bonds; ESG and financial performance; ESG and regulation, disclosure and green finance; ESG and integration and methodology. *Figure 4* shows the dynamics of these thematic areas and the significant increase in the proportion of studies directly examining the relationship between ESG and credit risk.

Figure 4
Trends in the number of scientific publications on ESG + Risk + Credit, Default, Loan and changes in the proportion of main research topics between 2020 and 2024
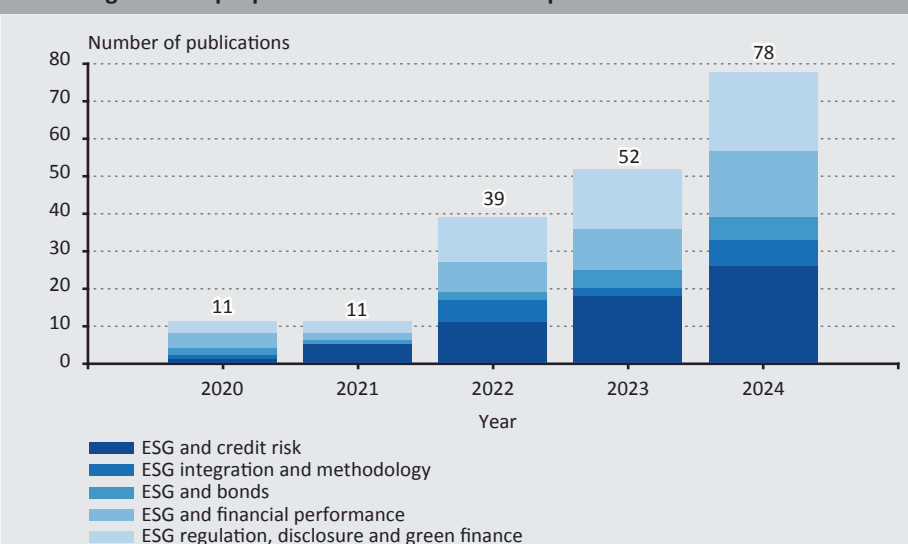

Note: n=191
Source: Compiled based on Scopus and Web of Science

Looking at the examined five years (2020–2024), the largest thematic area overall (61 studies) examined the direct relationship between *"ESG factors and credit risk"*. The central question in these articles is whether high ESG performance reduces the probability of default and improves credit ratings. These studies are presented in more detail in *Sub-Section 3.2* below. The second most significant topic area is *"ESG regulation, disclosure and green finance"*, which comprises 55 studies. These studies examined the role of sustainability requirements, reporting obligations and green finance instruments, with a particular focus on market integration, the risks of so-called "greenwashing",[11] and the impact of ESG factors on credit and bond market risks. The 43 studies analysing the relationship between *"ESG and financial performance"* discussed the relationship between ESG performance and corporate profitability, valuation and risk profile, examining whether sustainable practices represent a financial advantage or a cost for companies. 16 studies analysed the relationship between *"ESG and bonds"*, and bond markets, presenting the impact of ESG factors on bond yields, risk premiums and funding costs. 16 studies also addressed the topic of *"ESG integration and methodology"*. These studies developed new models, assessment frameworks and risk estimation methods for the systematic integration of ESG considerations into investment and credit decision-making. The aim of these studies was to improve the measurability of ESG factors and integrate them into quantitative models, thereby facilitating the objective assessment of ESG considerations in risk management.

Figure 5 shows the distribution of articles published by the journals with the most publications on the subject and their publishers, broken down by topic. Looking at the journals, a significant proportion of the articles appeared in journals focusing on finance, economics and sustainability, and the role of journals focusing on business ethics and corporate governance issues is also significant, reflecting the interdisciplinary nature of the relationship between ESG and credit risk. The journals with the most publications are: "Sustainability" (13 articles) and "Finance Research Letters" (11 articles). The former tends to integrate sustainability aspects into economic analyses, while the latter approaches the topic from a financial and investment perspective. "International Review of Economics and Finance" (6 articles) also has a significant share as an economics journal that has published several articles on the topic. According to the SCImago Journal Rank classification, the journals with the most publications belong to the categories of "Economics", "Econometrics" and "Finance", which confirms the financial and economic focus of the topic.

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[11] "Greenwashing" is a deceptive practice whereby a company presents its sustainability performance as better than it actually is for marketing or communication purposes (*European Parliament Think Tank 2022*).

Figure 5
Top 10 journals and the number of publications published in different thematic areas
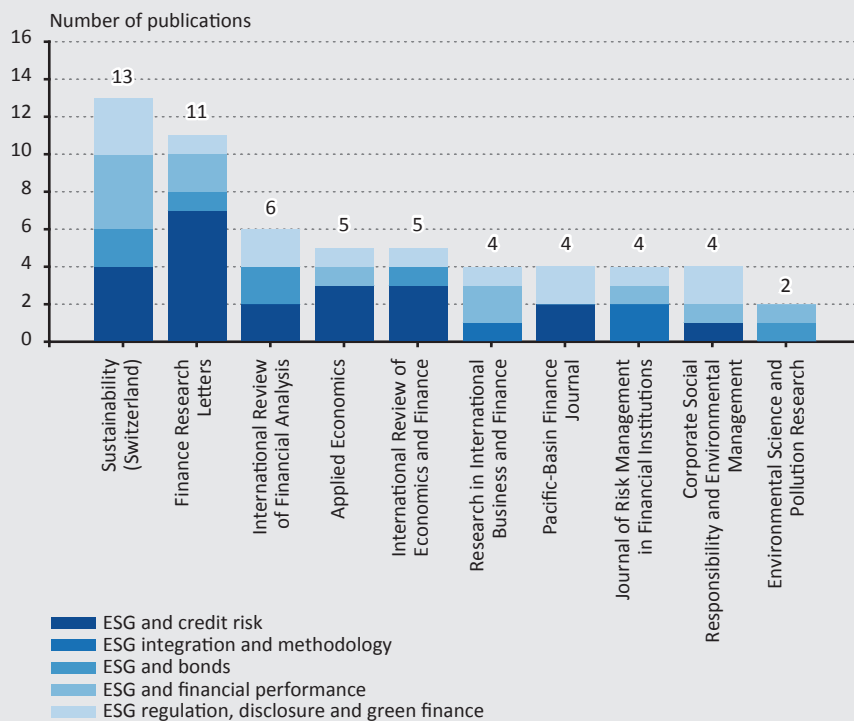
Source: Compiled based on Scopus and Web of Science

3.2. Examining the relationship between ESG and credit risk indicators, and methodologies

In the following sub-section, we further narrow down the research related to ESG, Risk and Credit, analysing 61 studies that specifically examine the relationship between ESG and corporate credit risk. As a first step, we show what types of credit risk indicators the studies examined used to measure credit risk and how they integrated ESG factors (as an aggregate indicator or as separate E, S or G components) into their research. Based on this, we were able to identify research gaps. At the end of the sub-section, we grouped the publications based on the methodology used.

Table 1 summarises the analysis based on credit risk indicators and ESG dimensions.

Table 1

Grouping of publications based on the credit risk indicators and ESG factors examined (n = 61)

Credit risk indicators / ESG factors	E	ESG	Total
(1) Structural / modelled credit risk indicators	4	25	29
(2) Credit rating-based indicators	3	13	16
(3) Market-based risk indicators	2	7	9
(4) Financing / bank-based risk indicators	1	6	7
Total	10	51	61

Note: The colouring of non-summing cells containing numbers indicates frequency of occurrence; darker shades indicate higher frequency, lighter shades indicate lower frequency.

Source: Compiled based on Scopus and Web of Science

When examining ESG factors, studies examining environmental factors (E) typically drew conclusions through the analysis of carbon dioxide emissions, environmental performance indices and climate exposure. Among these, several studies (e.g. *Palmieri et al. 2023; Danisman – Tarazi 2024; Wadhwani 2022; Ginglinger – Moreau 2023; Kim – Kim 2024; Schult et al. 2024; van der Walt et al. 2024*) showed that better environmental performance and lower carbon intensity had a positive impact on credit risk indicators, while high emissions or climate exposure increased risk. Only five of the studies specifically addressed the impact of climate or climate policy risk on credit risk (*Liu et al. 2023; Sun et al. 2024; Kim – Kim 2024; Hrazdil et al. 2024; Penikas – Vasilyeva 2023*).

The research most often focused on evaluating the relationship between overall ESG performance and credit risk (48 articles). None of the studies focused exclusively on the social (S) or corporate governance (G) pillars. However, according to *Hua Fan – Michalski* (*2020*) and *Al Mutairi – Bakar* (*2023*), strong governance structures and high transparency have a risk-reducing effect. The analysis of social (S) factors focused on the effects of CSR activities and ethical violations (Corporate Social Irresponsibility – CSI). *Fauser – Gruener* (*2020*)*, Quang Trinh et al.* (*2023*)*, Ngamvilaikorn et al.* (*2024*) and *Ubeda et al.* (*2024*) all found in respect of this topic that responsible operation is associated with lower bankruptcy and reputational risk, while social irresponsibility is associated with higher risk in this regard.

Looking at the other dimension, the credit risk indicators examined can be divided into four main categories. The use of *(1) structural or modelled credit risk indicators* is the most common (29 articles). These include risk measures based on internal financial and accounting data that examine the financial stability and probability of default of companies. These include indicators such as Probability of Default (PD),[12]

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[12] Probability of default: the chance that a debtor will fail to meet their payment obligations within a given period. It is a key indicator of bank risk management, also used in the Basel framework (*Bessis 2015*; Basel Committee on Banking Supervision (*BCBS 2006*)).

Expected Default Frequency (EDF),[13] the Altman Z-score[14] and the Merton model.[15] The results of these studies showed that higher ESG performance was typically associated with lower PD and a more favourable Z-score, i.e. better sustainability performance of companies was accompanied by lower credit risk (see, for example, *Atif – Ali 2021; Brogi et al. 2022*). The second most common category is *(2) credit rating-based indicators* (16 publications). These studies were based on ratings assigned by credit rating agencies (e.g. S&P, Moody's, Fitch) and changes in those ratings. Most of the studies concluded that higher ESG ratings – especially the corporate governance (G) component – had a positive impact on credit ratings, reducing the likelihood of downgrades and funding costs (*Jeon 2021; Chodnicka-Jaworska 2021*). The third category consists of *(3) market-based risk indicators* (9 publications). These include indicators derived from investor pricing, such as bond yields and Credit Default Swap (CDS)[16] spreads. These indicators directly reflect the credit risk perceived by the market and respond well to changes in ESG performance. Numerous empirical studies have shown that better ESG performance significantly reduces CDS spreads and bond market risk premiums, indicating a lower level of risk perceived by investors (*Jang et al. 2020; Barth et al. 2022; Lian et al. 2023; Bannier et al. 2022*). Finally, the fourth group includes *(4) financing and bank-based risk indicators* (7 publications). These studies examined companies' access to credit, their tax financing costs or the ratio of non-performing loans[17] (NPL) as indirect manifestations of credit risk. The results showed that companies with higher ESG ratings were viewed more favourably by banks, which led to better credit terms and lower funding costs (*Luo et al. 2023; Quang Trinh et al. 2023*).

Based on the ESG factors and credit risk indicators examined, a number of research gaps emerge. Most of the studies analysed focused on the large enterprise segment, while small and medium-sized enterprises (SMEs) are key players in terms of economic value added and employment.[18] Since sustainability goals cannot be achieved without the involvement of this sector, it would be justified and useful to expand research on the ESG activities and risk profiles of the SME sector. In our opinion, such studies could promote the development of practical guidelines and processes that could help smaller businesses achieve sustainable operations.

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[13] The probability of default estimated by Moody's KMV model, which determines the expected frequency of default based on the market value of the company's assets and the ratio of liabilities (*Kealhofer 1995*).

[14] A discriminant analysis model based on the company's financial ratios, which predicts the probability of insolvency (*Altman 1968*).

[15] A structural credit risk approach that treats the value of a company as an option and signals bankruptcy when the value of assets falls below liabilities (*Merton 1974*).

[16] Credit risk premium, which shows how much it costs to buy insurance against a debtor's default; one of the main indicators of risk perceived by market participants (*Hull et al. 2004*).

[17] Non-performing loan, where the debtor has not paid interest or principal for more than 90 days; a category defined by the European Central Bank guidelines (*ECB 2017*).

[18] According to data published by the European Commission (*European Commission 2022*), the importance of small and medium-sized enterprises: in 2019, micro and small enterprises (employing fewer than 50 persons) accounted for 99.8 per cent of all enterprises in the EU non-financial business sector, SMEs accounted for nearly 64 per cent of total employment, while SMEs (including micro-enterprises) generated around 52 per cent of total value added.

Second, the vast majority of studies examined aggregate ESG indicators, while analysis of the independent impact of the social (S) and governance (G) components is practically absent, even though the literature emphasises their potential risk-reducing role. Third, the examination of financing and bank-based indicators is also underrepresented, even though these are key to exploring the impact of ESG factors on financial stability. Finally, the integration of climate risk into credit risk models may also be a promising area of research.

Table 2 shows the classification of the above articles based on the methodology. In addition to panel and cross-sectional econometric analyses, approaches based on machine learning, natural language processing and quasi-experimental designs are also becoming increasingly common.

Table 2		
Methodological distribution based on ESG and credit risk research		
Methodological category	**Description / content**	**Number of studies**
Empirical econometrics – cross-section	Static regressions based on a given point in time or a short period; snapshot analysis of the relationship between ESG and credit risk.	23
Empirical econometrics – panel	Fixed or random effects models covering multiple periods; they enable the analysis of temporal dynamics and company-specific effects.	16
Theoretical and synthesising (SLR/policy)	Literature reviews, studies presenting theoretical frameworks or policy concepts that do not perform empirical analysis.	16
Machine learning / text analysis	AI- and NLP-based methods that reveal non-linear patterns by processing unstructured data (e.g. ESG reports, news).	2
Questionnaire-based / qualitative	Research based on interviews, questionnaires or case studies that examines management practices and the institutional side of ESG integration.	2
Quasi-experimental / event-based	Natural experiments, event studies or difference-in-differences analyses that examine causal effects (e.g. crises, regulatory shocks).	2

Note: n=61, Systematic Literature Review: SLR
Source: Compiled based on Scopus and Web of Science

Empirical econometrics studies may use cross-sectional and panel data. *Cross-sectional studies* (e.g. *Kanno 2023; Wu – Xie 2024*) examined whether higher ESG performance improves the creditworthiness of companies over a given period. These studies clearly demonstrate the relationship, but do not show how it develops over time. *Panel-based analyses*, however, are capable of examining dynamic processes and taking hidden corporate characteristics into account. *Li et al.* (*2022*), for example, showed that higher ESG scores are associated with lower bankruptcy risk, while *Luo et al.* (*2023*) found that better ESG results increased the likelihood

of obtaining trade credit and reduced information asymmetry. The findings of *Habermann and Fischer* (*2023*) also pointed out that social performance increases costs in the short term, but leads to more sustainable operations in the longer term. The *theoretical and synthesising* studies (16 in total) focused primarily on reviewing the literature, developing conceptual frameworks and policy recommendations, without empirical analysis. These works placed ESG as a risk dimension in theoretical models of financial stability and corporate financing, contributing to the conceptualisation of the research area. In recent years, more advanced approaches based on *machine learning and text mining* have also emerged, revealing new patterns through the analysis of unstructured data. *Bonacorsi et al.* (*2024*) used LASSO and Random Forest algorithms to predict credit risk, while *Hajek et al.* (*2024*) used natural language processing (NLP) to estimate corporate credit ratings from the text of ESG reports. These methods complement traditional econometric models by revealing non-linear relationships, but their use still lags far behind that of conventional econometric models. *Qualitative and questionnaire-based* research is rare but provides additional insight. *Gumerov and Rizvanova* (*2023*) analysed the ESG integration of the Russian banking system through a case study, demonstrating how ESG considerations can be incorporated into risk management. Finally, *quasi-experimental* and event-based studies represent a new direction in exploring causal effects. *Tang et al.* (*2024*) used the Kyoto Protocol, and *Danisman – Tarazi* (*2024*) used financial crises as natural experiments, and their results show that companies with higher ESG performance are more resilient in crisis situations. *Chodnicka-Jaworska* (*2021*) also found a positive relationship between ESG improvement and credit ratings. Therefore, these methods allow for a more accurate examination of the causal relationships between ESG and credit risk.

Based on the methodological pattern, another research gap also emerges. The vast majority of the studies examined used a traditional econometric approach, while the proportion of machine learning, text analysis and quasi-experimental methods was extremely low. This suggests that the exploration of the relationship between ESG and credit risk is still primarily based on linear, static models, which are of limited use in capturing complex, non-linear relationships. Few studies have examined ESG effects in a causal framework to determine whether improvements in ESG performance actually cause a reduction in risk or merely correlate with it.

3.3. Summary, key research in the field

In summary, we analysed the ten most influential studies from the group of articles discussing the relationship between ESG and credit risk, ranked by their average annual citations. *Table 3* summarises the focus, methodology and key findings of each study.

Table 3

Most cited studies on the relationship between ESG and credit risk

Article	Citations (annual average)	Focus	Data source, sample and period	Methodology	Main results / conclusions
Luo et al. (2023)	44.0	Impact of ESG on corporate access to trade credit	Panel data on companies listed on the Chinese stock exchange, 2011–2019	Empirical econometrics – cross-section	ESG performance increases companies' access to trade credit.
Li et al. (2022)	38.3	Impact of ESG practices on the credit risk of Chinese listed companies	ESG ratings and financial data of Chinese listed companies, 2010s	Empirical econometrics – panel	Higher ESG ratings reduce companies' credit risk.
Atif – Ali (2021)	35.3	Relationship between ESG disclosure and credit risk	Data from US non-financial companies, 2006–2017	Empirical econometrics – cross-section	ESG disclosure is positively correlated with "Merton's distance to default" value and negatively correlated with "credit default swap spreads", indicating lower credit risk.
Habermann – Fischer (2023)	34.5	Integration of ESG considerations into bank risk management	USA Refinitiv ESG database, 6,696 firm-years of observation, 2010–2019	Empirical econometrics – panel	During an upturn, an increase in CSP raises the probability of default.
Cohen (2023)	27.5	Correlations between ESG dimensions and financial risks	USA – S&P500 companies, 2019–2021	Empirical econometrics – cross-section	E and S risks increase the probability of default, G is not significant.
Li et al. (2023)	24.5	Role of ESG indicators in estimating corporate default risk	Panel data from Chinese A-share companies, 2010s	Empirical econometrics – panel	CPU increases bankruptcy risk, but better ESG and greater corporate governance mitigate it.
Anwer et al. (2023)	23.0	Correlations between ESG dimensions and financial risks	Global: 158 energy companies in 16 countries, 2010–2021	Empirical econometrics – panel	Inverted U-shape: low ESG is associated with higher risk, while high ESG is associated with lower risk.
Meles et al. (2023)	22.5	Examining the relationship between green innovation and credit risk	Europe: 26,904 firm-years of observations across 35 European countries, 2003–2019	Empirical econometrics – panel	Green innovation reduces corporate credit risk, especially in market-oriented countries, but not significantly for IPO companies.
Bannier et al. (2022)	21.3	Examining the relationship between corporate social responsibility and credit risk	USA and Europe: corporate panel data, 2003–2018	Theoretical / synthesising (SLR/policy)	In the United States, only environmental aspects are negatively associated with credit risk, while in Europe, both environmental and social aspects are negatively associated with credit risk.
Tian – Tian (2022)	17.0	Impact of corporate sustainability on trade credit financing	ESG and financial data of Chinese listed companies, 2009–2020	Theoretical / synthesising (SLR/policy)	Better ESG performance is associated with lower information and operational risks, which increases corporate trade credit financing.

Note: Corporate Social Performance: CSP, Climate Policy Uncertainty: CPU, Initial Public Offering: IPO

Source: Compiled based on data from Scopus and Web of Science

These studies show methodological diversity, as along with the predominance of panel and cross-sectional econometric models, we also find theoretical models and synthesising approaches. Empirical studies have generally shown a significant and typically negative relationship between ESG values and credit risk. Their results consistently suggest that higher ESG performance contributes to the financial stability of companies, resulting in lower bankruptcy risk, more favourable credit ratings and lower funding costs.

4. Conclusion

Our analysis shows that the relationship between ESG and corporate credit risk has become a rapidly expanding area of research during the examined period (2020–2024). The surge in the number of publications coincides with the emergence of sustainability regulations and supervisory guidelines, particularly the strengthening of European initiatives and banking supervisory expectations, which has significantly encouraged the inclusion of this thematic area on the academic and practical agenda.

The vast majority of the research found in the course of our search is global, focusing on Asia and the US; there are fewer analyses on Europe, and the Central and Eastern European region is underrepresented, even though sustainability requirements also have a significant impact on these regions. The measurement basis of the selected studies typically relies on large corporate databases; SMEs are rarely examined, and although this certainly poses measurement difficulties, analysing them would be of particular importance in terms of economic value added.

Most empirical studies link the aggregate (total) ESG dimension to structural/ modelled credit risk indicators (e.g. PD), credit ratings and market-based indicators (e.g. CDS spread). The methodological toolkit consists predominantly of cross-sectional and panel econometrics procedures, supplemented to a lesser extent by text mining, machine learning and quasi-experimental approaches. Overall, the most influential articles indicate a significant association: better ESG performance is generally associated with lower bankruptcy risk, more favourable credit ratings and lower risk premiums, although the independent effects of individual dimensions (particularly "S" and "G" or, within "E", climate risk) are less well explored.

The research gaps identified offer several directions for further exploration: (i) Targeted research on ESG measurement and credit risk correlations in the mid-cap sector and SMEs in general would fill a gap and could provide direct input for banking practice. (ii) Regionally embedded studies are needed in the CEE region, including systematic exploration of local-language research, taking into account regulatory, market and data-specific characteristics. (iii) The causal mechanisms linking financing and bank-based indicators (e.g. NPL ratios) and ESG have been

researched to a minor extent, even though they are also key to commercial banks' credit risk measurement practices. (iv) A promising but under-researched area is the integration of climate risk into credit risk models, as well as (v) the wider use of AI, quasi-experimental and event study methods that better capture non-linear effects.

Our study has limitations. We analysed only English-language article-type publications published in scientific journals between 2020 and 2024, and the search relied on two databases (Scopus, Web of Science) and predefined keywords. These filters necessarily limit the comprehensiveness of the study and may contribute to certain geographical and thematic biases.

Overall, our results confirm that ESG factors provide meaningful information on corporate credit risk and that the systematic integration of ESG considerations into risk management, lending and pricing practices is justified, especially in the context of increasing regulatory requirements. Future research should give greater emphasis to analyses focusing on the medium-sized enterprise segment and the CEE region, models incorporating climate risk channels, and frameworks that are suitable for identifying causality between ESG and credit risk and are based on newer, advanced data analysis techniques.

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International Crises, Geopolitical Risks and the Hungarian Stock Market*

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The authors examined the impacts of 108 international crises since 1991 on the share price index of the Budapest Stock Exchange with the event window and cross-sectional regression techniques, using the MSCI Emerging Markets Index as a basis of comparison. The results show that the average cumulative abnormal returns are, for the most part, negative, and statistically significant impacts can be observed primarily during a brief (0–10-trading day) period following the event. Market responses grew stronger after the 2000s, and the Hungarian stock market responds more sensitively to crises than developing markets do. Over the longer run, peaceful crises trigger more marked negative responses but these are temporary, while more severe crises have longer negative effects. In a regional breakdown, European events have proven to be the most sensitive. Cross-sectional regression analyses show that abnormal returns in the stock market are predominantly related to global volatility (VIX) and the BUX index's return environment preceding the event, while domestic macroeconomic fundamentals and confidence indicators only show a weaker and less certain relationship.

1. Introduction

Capital market dynamics are driven primarily by geopolitical risks. It is consistently pointed out in the literature that increased geopolitical uncertainty is accompanied by lower stock returns and higher volatility (*Smales 2021; Lamine – Zribi 2024*). These are not homogeneous impacts: they differ by country, region, time period and sector. Emerging markets are profoundly affected, while developed markets

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respond less dramatically (*Nasouri 2025; Salisu et al. 2022*). Sectoral studies have found that the financial, the energy and the defence sectors are the most exposed, while other industries tend to show asymmetric reactions (*Chatziantoniou et al. 2025; Choudhury 2024*). Geographical proximity is another profound determinant, i.e. markets closer to a crisis respond significantly more remarkably than those at larger distances (*Nygaard – Sørensen 2024; Grinius – Baležentis 2025*).

The above studies reveal that international crises not only cause short-term shocks, they also structurally influence risk management, investment strategies and portfolio diversification. Accordingly, we found it important to explore how the Hungarian stock market responds to geopolitical events. We are looking for an answer to the question of whether significant abnormal returns can be identified on the BUX index, relative to the MSCI Emerging Markets Index, along with how the types, severity and geographical locations of crises affect market reactions. Finally, we also examine whether the abnormal returns associated with crises are explained by global uncertainty indicators, domestic macroeconomic fundamentals or investors' confidence indicators.

In our study, we analyse 108 international crises in the International Crisis Behaviour (ICB) database and sort the events on the basis of five dimensions (degree of violence, severity of the crisis, involvement of superpowers, level of tension and geographical location), for the periods 1991–2021, 2000–2021 and 2010–2021. Our study relies on the event window methodology, with the help of which we identify abnormal returns and then also analyse the strongest market responses with the technique of cross-sectional regression (using 22 explanatory variables).

2. Literature review

Earlier studies show that that asset returns and volatility are strongly influenced by macroeconomic announcements (*Elder et al. 2012*), global economic events (*Berkman et al. 2011*) and the tone of news appearing in the media (*Manela – Moreira 2017*). *Caldara and Iacoviello* (*2022*) were the first to create a geopolitical risk index (GPR), interpreting geopolitical risks regarding wars, terrorist attacks and tensions between states, for studying geopolitical events. Most studies in the literature use this index, along with econometric methods (such as OLS, VAR, quantile regression) to identify relationships. Another major approach in the literature studies actual events with the help of the event window technique.

The GPR index is based on a study by *Lamine and Zribi* (*2024*), in which they examined the impacts of geopolitical risks with a focus on the G7 and the BRICS stock markets and found that while the impact on returns diminishes over time, volatility displays a persistently rising trend. *Demiralay et al.* (*2024*) analysed the impacts of threats and actions besides those of geopolitical risks, to find that returns

exhibit a positive response to the GPR in a rising stock market environment and a negative response in a declining environment, while volatility tends to respond positively, especially in the case of geopolitical actions.

Based on data from 40 countries, *Rafi and Ali* (*2025*) developed a new framework to measure geopolitical risk exposure (GRE), in the form of three factors (geopolitical risk, action and threat), using the index introduced by *Caldara and Iacoviello* (*2022*). Their results indicate that the geopolitical threat factor has the strongest predictive capability. Based on daily data, *Smales* (*2021*) demonstrated that an increase in geopolitical risk drives oil prices up, but depresses returns on stocks, while keeping volatility persistently high. *Denie et al.* (*2024*) made similar observations from their studies of the relationships between oil, gold and US dollar indices, as well as stock markets.

Studies based on GPR indices were also conducted to analyse the impacts of geopolitical risk in developing countries. *Nasouri* (*2025*) argues that volatility on developing countries' stock markets and financial stress respond much more vigorously to an increase in GPR, while in developed economies the corresponding impacts are observed more in the stock markets. *Salisu et al.* (*2022*) focused only on emerging markets and concluded that the index of geopolitical events is a better predictive factor than threats. The conclusions of *Wijaya et al.* (*2024*) supplement the above: they found that the GPR has different impacts on different countries.

Geopolitical risks have asymmetric impacts not only in different countries, but also at a sectoral level within the stock market. *Chatziantoniou et al.* (*2025*) found that geopolitical risks have significant, heavily sector-dependent impacts and that sectors respond more markedly to threats of terrorist attacks than to actual attacks themselves, while the escalation of war triggers more extreme volatility than threats or outbreaks of wars. *Choudhury* (*2024*) concluded the US financial sector is the most hard-hit by geopolitical risks, with the raw material and energy sectors also showing significant exposure. In line with the above, *Boungou and Urom* (*2025*) noted that the degree to which geopolitical risk affects returns in the G20 countries' banking sectors depends on market performance, the period in which the conflict occurs and the geographical locations of the banking systems.

Another avenue of research explores actually occurring events instead of geopolitical risk indices, using the event study method in most cases. Analysing the impacts on twelve stock markets of the war that broke out between Russia and Ukraine in 2022, *Grinius and Baležentis* (*2025*) identified the proximity effect as the key factor, with Poland showing the strongest price response, while markets outside Europe remained, for the most part, unresponsive. Using the event study method, *Goyal and Soni* (*2024*) described the impacts of the Israeli-Palestinian conflict that erupted in October 2023 on the stock markets of 47 countries. Emerging markets

and the global stock markets were found to have responded negatively, while the developed markets proved to be more resilient. Other studies have highlighted how armed conflicts in the Middle East affect oil companies' stock returns (*Khalifa et al. 2017*), how closely the 1973 Arab–Israeli war (Yom Kippur War) was related to changes in oil prices (*Nygaard – Sørensen 2024*) and how changes in the relationship between North and South Korea affected the stock returns of companies involved in the economic cooperation concerned (*Pyo 2021*). Moreover, the 1997 Asian financial crisis, the 2008 global financial crisis and the Covid–19 pandemic enhanced the US stock market's global return transmission function, which was also affected by geopolitical risks (*Tran – Vo 2023*).

Studies on the impacts of geopolitical risks on the domestic economy, particularly in terms of capital market correlations, are limited at present. However, country-specific and sectoral asymmetries that have also been identified in international results may also warrant empirical analyses of the Hungarian market. A number of studies on the Hungarian capital markets yielded results in relation to matters of asset pricing that are in line with the findings of international studies. For example, *Lakatos* (*2016*), analysing the phenomenon of overreaction, and *Rádóczy – Tóth-Pajor* (*2021*), studying responses to extreme market events, obtained results comparable to those to be found in the international literature. Additional similar results come from studies of seasonality (*Kégl – Petróczy 2024; Neszveda – Simon 2021*), the momentum effect (*Csillag – Neszveda 2020*), price drifting (*Csillag – Neszveda 2022; Nagy – Ulbert 2007*), stock market anomalies (*Bidló – Szabó 2024*) and the trading strategy of liquidity provision (*Neszveda – Vágó 2021*). Results that are different from the trends observed in international markets have also been produced; for instance, in the applicability of company valuation methods (*Takács 2007*), in financial behaviour phenomena (*Molnár 2005*) and in capital market performance indicators (*Koszorús 2019*).

Grébel and Pesuth (*2023, 2024*) noted in relation to the domestic capital market that the role of geopolitical risks has grown in importance in both theory and practice. Our analysis shows that geopolitical tensions generally exert a negative influence on stock market returns, particularly in emerging markets and in the Central and Eastern European region. Moreover, geopolitical risks were found to play a remarkable role in the stock markets and also in the trends appearing in domestic economic outlooks. For instance, *Horváth and Molnár* (*2025*) noted that the persistently subdued external environment (the Russian–Ukrainian war, the US customs tariff threats) has caused profound uncertainty in the Hungarian economy, thwarting economic growth, and future perspectives also carry substantial risks.

Overall, the literature highlights that geopolitical risks impact stock market returns and volatility asymmetrically – globally, across regions and across sectors.

3. Data and methodology

In our event study analysis, we use the daily closing prices of the Budapest Stock Exchange index for the period from 2 January 1991 to 31 December 2021. Although BUX index data are available for the subsequent period as well, the last event in the ICB database[1] of crisis data was recorded for 20 September 2021; therefore, we processed the BUX index data accordingly.

The MSCI Emerging Markets (MSCI EM) Index – representing a wide range of developing market shares and evolving in closer coordination with the BUX index than other alternative indices – was used as the benchmark in calculating the abnormal return in the event window analysis. Daily log return data of the BUX and MSCI EM indices were used, which were calculated in the estimation window as detailed below:

$$R_t = 100 * (lnP_t - lnP_{t-1}). \tag{1}$$

Based on the Augmented Dickey–Fuller-test, the series were found to be stationary. The expected return was calculated with the linear regression model, in the following form:

$$R_{i,t} = \propto_i + \beta_i R_{m,t} + \varepsilon_{i,t}, \tag{2}$$

where:

• $R_{i,t}$: the daily log return of the BUX index as at *t* time,

• $R_{m,t}$: the daily log return of the MSCI EM index as at *t* time,

• β_i: the coefficient describing sensitiveness to market returns.

The model was aligned to the period between days 130 and 10 before the event (estimation window); thereafter, the abnormal returns were calculated for the period around the actual event. The abnormal return is defined as the difference between the actual return and the expected return:

$$AR_{i,t} = R_{i,t} - E(R_{i,t}), \tag{3}$$


[1] https://sites.duke.edu/icbdata/

where:

• $R_{i,t}$: is the BUX index's log return on day t around event i,

• $E(R_{i,t})$: the expected log return estimated on the basis of the estimation period's regression coefficient.

The abnormal returns calculated as described above were aggregated for the period of the event concerned, on the basis of the following formula:

$$CAR_i(T_1, T_2) = \sum_{t=T_1}^{T_2} AR_{i,t}. \tag{4}$$

Understanding the event window analysis is facilitated by *Figure 1*, where the T_0–T_1 period is the estimating period between the 10th and the 130th day preceding the event, and the T_1–T_2 period constitutes the event window.

Figure 1
Illustration of the event study's time window
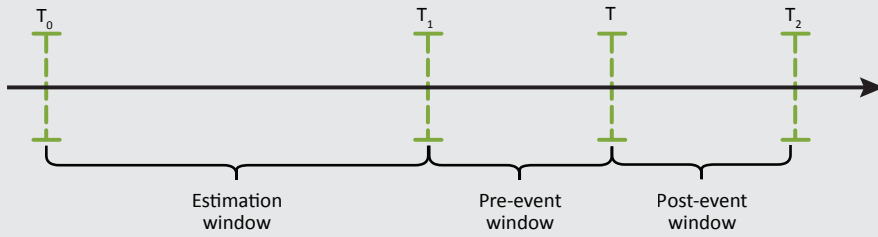
Note: The figure shows the event window where T_0 and T_1 are the starting and ending days of the estimation period, T is the day of the event and T_2 is the last day of the event window.

In the event window analysis, we used both a symmetric window (−30/+30, −15/+15, −2/+2, −1/+1 days) and an asymmetric window (0–2, 0–3, 0–5, 0–10, 0–20 and 0–30 days), with the latter exclusively covering the post-event period. The length of each window was determined in view of recommendations found in the literature (*MacKinlay 1997; Azzimonti 2018; Kiss et al. 2024; Rappai 2011)*.

The robustness of the results was tested with an alternative estimation method, the so-called average return technique, in which the expected return was replaced with the average return calculated in the estimation window. Moreover, the results were compared to the S&P 500 global share price index and, to enable regional comparison, to the WIG20 (Polish) and the PX (Czech) indices. Both t-tests and z-tests were used for significance testing, in observance of methodology guidelines

on event study, commonly found in the literature (*MacKinlay 1997; Fűrész – Rappai 2022; Rádóczy – Tóth-Pajor 2021*).

In the event studies, the starting points of geopolitical crises were determined on the basis of the event dates (Trigger Dates) found in the ICB database. A trigger date marks the officially recognised date of the outbreak of a crisis. In 33 of the 108 events studied, the event date fell on a non-trading date (weekends, in most cases). Those were replaced with the nearest available trading dates (typically Mondays).

In addition to the event window analysis, our research also aimed to examine the extent to which global uncertainty indicators, domestic macroeconomic factors, and investor and business confidence indicators can explain the cumulative abnormal returns associated with geopolitical events. To do so, we collected 22 variables from the categories of global and domestic economic policy uncertainty, geopolitical risks, investor sentiment, global capital market volatility, consumer and business confidence, domestic macroeconomic indicators and the technical indicators of the BUX index (*Annex, Table 4*), on the basis of our review of the relevant literature and our intuitive and empirical considerations. In the first step of our analysis, with the help of the event window analysis method, as well as z-tests and t-tests, we identified the period in which the cumulative abnormal returns (*CAR*) gave the most salient response to the events. The most pronounced time window (the [0,10] window, which proved to be the most significant) was selected for further analyses. A 5-per cent winsorisation was performed on the *CAR* value associated with the various events. In the cross-sectional regression analysis, the macroeconomic and uncertainty variables of the month preceding, the month of and the month following each event were assigned to its *CAR* value. To pre-screen the variables, each explanatory variable was examined in a separate regression analysis with the cumulative abnormal return being used as dependent variable, making it possible to identify the factors which were, even in themselves, related to the stock market reaction.

After estimating the individual regressions, we grouped the explanatory variables into thematic blocks and employed four different model specifications to identify which sets of variables best explain the patterns in abnormal returns. The final specifications included factors that showed stable and relatively strong relationships with the cumulative abnormal returns in the individual regressions. The model (5) based on global uncertainty indicators comprised the VIX (capital market volatility), the *GEPU_current* (global economic policy uncertainty), the *GPR* (geopolitical risk) and the *WUI* (world uncertainty) indicators. The model focusing on domestic macroeconomic factors (6) comprised the inflation rate, unemployment rate, retail sales and industrial production, supplemented with the domestic uncertainty

indicator (*WUI_HUN*) and the domestic geopolitical risk index (*GPRC_HUN*). The model based on confidence indicators (7) comprised domestic consumer and business confidence indices as well as the Baker–Wurgler investor sentiment index. Finally, the model combining global volatility with the market performance of the BUX (8) comprised the effects of the VIX and the monthly BUX return.

$$CAR_i^w = \alpha + \beta_1 VIX_i^{-1m} + \beta_2 GEPU\_current_i^{-1m} + \beta_3 GPR_i^{-1m} + \beta_4 WUI\_global_i^{-1m} + \epsilon \quad (5)$$

$$CAR_i^w = \alpha + \beta_1 CPI\_HUNyy_i^{-1m} + \beta_2 Unemp\_HUN_i^{-1m} + \beta_3 Retail\_HUNyy_i^{-1m}$$
$$+ \beta_4 Prod\_HUNyy_i^{-1m} + \beta_4 WUI\_HUN_i^{-1m} + \beta_5 GPRC\_HUN_i^{-1m} + \epsilon \quad (6)$$

$$CAR_i^w = \alpha + \beta_1 CCI\_HUN_i^{-1m} + \beta_2 BCI\_HUN_i^{-1m} + \beta_3 BWSENT_i^{-1m} + \epsilon \quad (7)$$

$$CAR_i^w = \alpha + \beta_1 VIX_i^{-1m} + \beta_2 BUXreturn_i^{-1m} + \epsilon \quad (8)$$

The dependent variable is the winsorised cumulative abnormal return (CAR_i^w), while the explanatory variables marked with "−1m" refer to their values in the month preceding the event. In all inference calculations, we rely on heteroskedasticity-robust (HC1) standard errors.

4. Description of international crises

Our study relied on the International Crisis Behaviour (ICB) database (*Brecher – Wilkenfeld 1997; Brecher et al. 2025*), documenting 512 international crises that occurred between 1918 and 2021, which enables structured comparisons between crises in terms of 81 pre-defined quantitative and qualitative dimensions. Our analysis focused on 108 events that occurred in the 1991–2021 period, taking into account that this is the period in which the Hungarian stock market and the ICB database overlap. Although the database also contains information on the Russian–Ukrainian war, the event date has not been determined yet; therefore, that particular event is not covered by this analysis.

To develop a more profound understanding of the characteristics of the events, a number of different variables were used in our study. The degree of violence of the various crises was assessed with the help of the *VIOL* (violence) variable, which encodes the degree of violence occurring in the course of the various events. The values of the variable range from 1 to 4, where 1 represents a completely peaceful event, while 4 represents a full-scale war. Events were *VIOL* < 2 were considered as "peaceful", whole those with VIOL ≥ 2 were regarded as "armed". The severity of a crisis was defined in terms of the *GRAVCR* (Gravity of Value Threatened) variable, showing the weight of the value (e.g. economic interest, political regime, existence of a state) threatened during the crisis. The higher values on a scale of 0 to 6 indicate

more severe threats; in our analysis, we separated severe (*GRAVCR* > 3) crises. Superpower involvement is measured by the *POWINV* (Superpower Involvement in Crisis) variable, which indicates the degree of the involvement of the United States of America and/or of the Soviet Union (now Russia). The scale extends from 1 to 7, and where the *POWINV* > 0, at least one of the two played some role in the conflict. The change in international tension as a consequence of a crisis is expressed by the *OUTESR* (Outcome of Escalation or Reduction of Tension) variable, arranging events into three categories: 1=tension eased, 2=status quo remained unchanged, 3=tension grew. (*OUTESR*=1) events where tensions eased and (*OUTESR*=2) events with no change were analysed separately in our study. *OUTESR*=3 (escalation) events were not analysed because of their small number. The geographical location of a crisis is indicated by its *GEOG* (Geographic Location of Crisis) variable, on the basis of which analyses were also carried out in regional breakdowns.

5. Empirical results of the event effects

The complete sample – i.e. the results for the period between 1991 and 2021 – shows that the average cumulative abnormal return (average *CAR*) was negative in most of the time windows used (in 8 out of 10 event windows), but it also shows that it is only the 5-trading-day window following the event in which a statistically significant effect can be identified with the help of t-testing. Z-test-based significance was identified in the case of the [−15,15], [0,2] and [0,10] day windows (*Table 1*).

Table 1
Average cumulative abnormal returns of the event windows between 1991 and 2021

Event window	Number of cases	Average CAR	t-statistics	Positive ratio	z-statistics
[−30,30]	108	0.464	0.309	0.48	−0.385
[−15,15]	108	−0.409	−0.385	0.42	−1.732*
[−1,1]	108	−0.351	−1.348	0.49	−0.192
[−2,2]	108	0.009	0.032	0.49	−0.192
[0,2]	108	−0.337	−1.589	0.38	−2.502**
[0,3]	108	−0.422	−1.641	0.46	−0.77
[0,5]	108	−0.671	−2.205**	0.44	−1.347
[0,10]	108	−0.341	−0.462	0.41	−1.925*
[0,20]	108	−0.042	−0.042	0.47	−0.577
[0,30]	108	−0.282	−0.217	0.45	−0.962

Note: The table shows the average cumulative abnormal returns (CAR) calculated for the whole period and for all events, along with the corresponding t-statistics and z-statistics for various event windows. The "Positive ratio" column indicates the percentage rates of the events with positive CAR values. The figures marked * and ** indicate 10-per cent and 5-per cent significance levels, respectively (p < 0.10; p < 0.05).

The following partial periods were analysed: 1991–2000 (32 events), 2000–2021 (76 events) and 2010–2021 (48 events). The analysis of the 2000–2021 partial period instead of the 2000–2010 period is justified by the fact that the Hungarian capital market was more advanced and more liquid in those years and that a larger number (n=76) of events were available, resulting in more robust significance estimates. Our analysis of the partial periods shows that during the 1991–2000 period the average *CAR* was positive in several time windows, without being statistically significant in any of the cases (*Annex, Tale 5*). By contrast, the average CAR was persistently negative in each reviewed event window during the 2000–2021 period, apart from the [−30,30] day interval. The t-test identified significant negative effects in the [0,5] and [0,10] day windows, while the z-test found statistically significant differences in the [0,1] and [0,2] day windows. Similar results were obtained for the 2010–2021 period (48 cases). Negative average cumulative abnormal returns were measured in each of the time windows, barring the [−30,30] day slot. Significant effects were found in the [0,10] and [0,2] day windows even by t-testing, while significant differences were also found by z-testing in additional shorter windows (*Annex, Table 5*).

No capital market effect on the BUX index could be statistically found to have been caused by the crises between 1991 and 2000. By contrast, significant effects were identified in several event windows after 2000; therefore, we examined the average cumulative abnormal return in 1-day steps for that period (76 events). As illustrated in *Figure 2*, the results show that the strongest significant effect was identified in the [0,10] trading day event window (*CAR*=−1.12; $p < 0.05$). Statistically significant negative effect can also be identified on the basis of the test results, in the 4th to 11th day post-event period. Each of the windows between [0,4] and [0,11] is significant at least at the 10-per cent level, while some of them are significant even at 5 per cent. These results indicate that a steady negative market reaction follows the events during the first two weeks, during which the BUX index underperforms the MSCI Emerging Markets Index. Thereafter, this effect gradually wanes and starting from the [0,12] day period no statistically significant difference can be detected. The analyses of the partial periods have shown that the effects are not homogeneously distributed over time. While in the period between 1991 and 2000, no statistically significant average *CAR* could be identified, in the 2000s, it was possible to find negative reactions in several event windows, and this trend gained momentum after 2010.
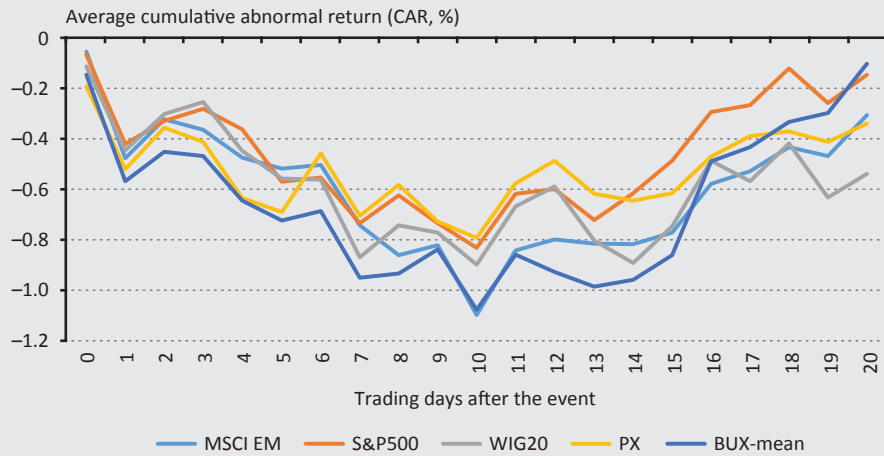
Figure 2
Changes in the average CAR in different event windows

Average cumulative abnormal return (CAR, %)
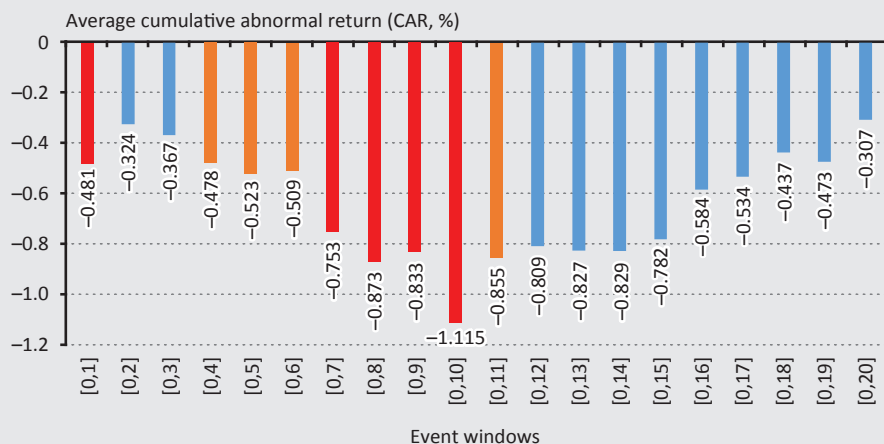
Note: The chart shows the post-event average abnormal returns in event windows formed with a 1-trading-day step span. The red bars and the orange bars indicate significant negative effect at 5 per cent (p < 0.05) and at 10 per cent (p < 0.10), respectively, while in the case of the blue bars the effect is not statistically significant according to t-testing.

The results for the 1991–2000 period may also be caused by reasons of methodology, because in the 1991–1996 period, the explanatory power of the market model (R^2) was extremely small (below 5 per cent in all cases) during the estimation period, making the reliability of the expected returns estimated by regression questionable. An alternative approach was also applied to correct these, and the expected return was substituted with the estimation period's average return, but even this method failed to show a significant abnormal return for the 1991–2000 period. However, in the 2000–2021 period, a statistically significant negative abnormal return was observed for the [0,2] and [0,5] event windows; i.e. the BUX index underperformed relative to both its own pre-event average return and the benchmarks (MSCI EM, S&P 500, WIG20, PX). The results of the basic model are also confirmed by the robustness tests: the negative abnormal return persists, only to return to its highest absolute value by the 10th trading day after the event (*Figure 3*).

Figure 3
Changes in the average CAR with different benchmarks

Average cumulative abnormal return (CAR, %)

Trading days after the event

— MSCI EM — S&P500 — WIG20 — PX — BUX-mean

Note: The figure illustrates the cumulative abnormal returns calculated on the basis of a variety benchmarks (MSCI EM, S&P 500, WIG20, PX) and the previous average return of the BUX (BUX-mean).

Having completed the analysis of the various periods, the results were also separated on the basis of the dimensions discussed in *Section 4*. Sorting the events into categories of "armed" and "peaceful" (*VIOL* variable), we found regarding the entire period that although in the case of the events associated with armed conflicts (n=80) the average *CAR* was negative for the most time, none of the applied statistical tests produced significant results (*Annex, Table 6*). By contrast, in the case of peaceful conflicts (n=28) the average CAR is statistically significantly negative in the short run, in the [0,5] event window, and thereafter, it turns positive, but the effect is not significant (*Figure 4*).

A breakdown by GRAVCR – the variable indicating the severity of the crisis – shows a pattern consistent with peaceful conflicts. Over the entire period (n=41), events associated with more severe crises (*GRAVCR > 3*) showed a statistically significant negative average CAR in the short term, in the [−1,1] and [0,2] day windows. However, thereafter, the abnormal return turns positive, but the effect is no longer significant. This negative and significant market reaction was confirmed – also in several event windows ([−1,1], [0,2], [0,20]) during the 2000–2021 partial period (n=27). On the other hand, no material difference could be identified on the basis of the *POWINV* variable – reflecting the involvement of the superpowers – in the effects of events on the stock exchange, because no event occurred during the examined period without the involvement of at least one of the superpowers.

In 51 of the 108 events covered by the study, the tension was found to have eased, when examined on the basis of the *OUTESR* variable, after the outbreak of the crisis, no change took place in the external participants' crisis perception in 47 cases, and the tension grew in 10 cases. The results of the analysis showed that no statistically significant abnormal return could be established in the cases when the tensions eased (*OUTESR*=1), and the events unfolded similarly to peaceful conflicts (*Figure 4*). By contrast, during events when the status quo remained unchanged (*OUTESR*=2), negative and significant *CAR* values could be observed in several time windows. Significant results were found, for instance, regarding the [–1,1], [0,2], [0,3] and [0,5] windows. The market reactions to the events are summarised in *Figure 4.* The results are consistent with intuitive expectations, in that persistent underperformance can be observed in the case of armed conflicts and crises with unchanged tensions, while the effects of severe, peaceful or declining tensions proved to be short-lived.

Figure 4
Abnormal returns by type of event
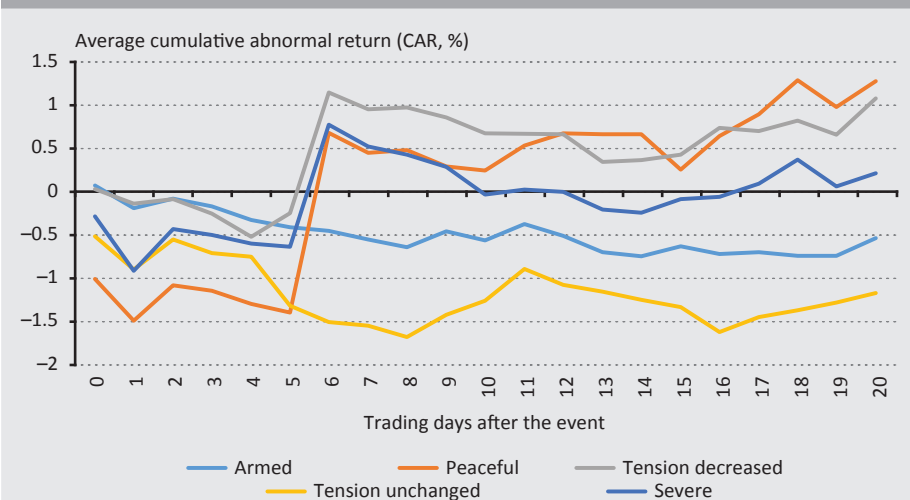
Note: The figure presents the average cumulative abnormal returns associated with armed (VIOL ≥ 2) and peaceful (VIOL < 2) crises, as well as events characterised by decreasing tension (OUTESR=1), unchanged tension (OUTESR=2), and high crisis severity (GRAVCR > 3), over the 20 trading days following the event.

From a breakdown of the sample by region, it can be seen that the events relate to Africa (23 cases), Asia (50 cases), Europe (7 cases) and the Middle East (26 cases). However, in most of the regions, no statistically significant correlation can be found between the events and abnormal stock market returns (*Annex, Table 7*). Some cases are exceptions to the above. In the case of the events in Africa, the average *CAR* is –1.6 in the [0,10] window, with a t=–1.975 statistical value, which

is regarded as nearly significant. In the case of the events that took place in Asia, negative and significant cumulative abnormal returns were found in the [−1,1], [0,2] and [0,3] windows (*Figure 5*). Negative average *CAR* figures were identified in 23 of a total of 40 region and time window combinations during the entire time period, in 5 of which we found statistically significant results. Most non-negative average *CAR* values were associated with events relating to the Middle East, where the average *CAR* was positive in 7 of the 10 event windows reviewed. From *Figure 5*, it can be concluded that while the events that took place in the Middle East were accompanied by positive price reactions, the crises in Africa and Europe consistently resulted in negative abnormal returns. The effects of events in Asia are modest and show no clear direction. The generalisability of the results, however, is limited by the fact that in most of the time windows the abnormal returns are not significant.

Figure 5
Cumulative abnormal returns by region

Note: The figure shows the average cumulative abnormal returns associated with events in different regions (Middle East, Asia, Africa, Europe) over the first 20 trading days following the event, on the entire sample.
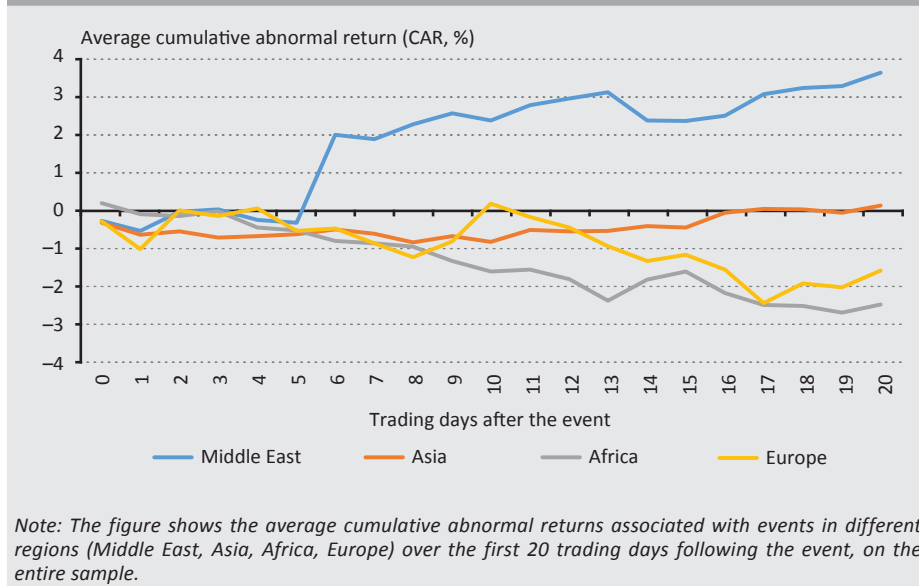
The number of events in which statistically significant negative abnormal returns could be identified increased after the 2000s. Having analysed as many as 40 region and time window combinations, we found 28 cases with negative average *CAR* figures, in 8 of which we found statistically significant results. In the 2000–2021 period, the positive average *CAR* is no longer associated with the Middle East but with Africa, where a positive average *CAR* can be observed in 7 cases. Mention should be made in particular of the crises relating to the European region, in the case of which significant negative effects were observed even in the case of the lowest average *CAR*, bearing out the hypothesis that geographical proximity

enhances the market's reaction to geopolitical events. Nevertheless, the small number of cases (4 events) should also be taken into account in the interpretation of the results, as it limits the generalisability of the conclusions. It should also be noted that although the ICB database distinguishes between 21 sub-regions under the *GEOG* variable within the four regions examined (Africa, Asia, Europe, Middle East), a detailed analysis of these failed to provide any additional information to the above results, i.e. no subregion can be identified where significant effects are more observable, and the interpretability of the results is limited the small number of cases in the case of a number of subregions.

6. The effects of global, domestic and other uncertainty factors on the CAR values

On the basis of the above analysis, the *CAR* values belonging to the event window [0,10] were used as the dependent variable of the cross-sectional regression for the entire period, because that particular period was found to have the strongest statistical power. The distribution of winsorised cumulative abnormal returns (*CAR*) does not deviate significantly from normality according to the Shapiro–Wilk test (W=0.982, p=0.44).

Three factors appear to be dominant in view of the univariate cross-sectional regression analyses. Of the global uncertainty indicators, the VIX index showed significant positive correlation with the cumulative abnormal returns, indicating that with higher prior-month market volatility, the stock market reactions may be less negative and may even be more favourable. The *BUXrec* variable, which is of a more technical nature, also indicated a positive correlation, showing that when the BUX index is below the 12-month moving average (in a trend of decrease), the market reacts less markedly to geopolitical events than when it is on the upswing. The above conclusions are also confirmed by two additional variables (*BUXmedian* and *BUXreturn*) relating to the BUX index return. Reactions to geopolitical events are dampened by prior-month stock market returns below the median and by more pronounced stock market downturns. In the case of the business confidence index (*BCI_HUN*), the negative coefficient shows that cumulative abnormal returns are higher when confidence indices are lower; in other words, the market tends to react more favourably in a pessimistic economic environment, presumably because negative outlooks have already been factored in by investors (*Table 2*). Of the variables examined simultaneously with the occurrence of the events only the ones associated with the BUX index (*BUXmedian* and *BUXreturn*) show a correlation; however, the nature of the relationship is reversed in this case, and the less dramatic price reactions identified during an event are linked to higher stock market returns and to higher-than-median performance levels. The post-event 1-month correlations of the variables reviewed in our study are also consistent with

the above – they are supplemented with a negative correlation with the domestic geopolitical risk (*GPRC_HUN*) and uncertainty (*WUI_HUN*) indicators, i.e. the marked price reaction (negative *CAR*) is accompanied by increasing uncertainty (increasing indicator value) in the following month. It should be noted in particular that the uncertainty (*WUI_RUS*) and geopolitical risks relating to Russia (*GPR_RUS*) show no significant correlations with the reactions shown on the Hungarian stock market.

Table 2

Cross-sectional regression results for the CAR values

Variable	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Period	1 month before		Concurrently		1 month after	
GEPU_current	−0.001	0.747	−0.001	0.826	−0.002	0.661
GEPU_ppp	−0.001	0.704	0.000	0.899	−0.002	0.666
US_EPU	0.001	0.811	0.001	0.878	0.003	0.531
GPR	0.002	0.796	0.008	0.437	0.008	0.499
GPRT	0.002	0.856	−0.001	0.954	−0.001	0.942
GPRA	0.001	0.806	0.007	0.210	0.007	0.304
GPRC_HUN	9.830	0.601	3.567	0.859	−21.863*	0.048
BWSENT	0.413	0.500	0.020	0.975	−0.239	0.674
VIX	0.115**	0.007	0.046	0.305	0.030	0.496
CCI_HUN	−0.122	0.517	−0.137	0.461	−0.148	0.419
BCI_HUN	−0.254	0.090	−0.271	0.080	−0.241	0.145
BUXrec	1.511*	0.029	−0.110	0.878	−0.571	0.410
CPI_HUNyy	0.128	0.347	0.104	0.467	0.127	0.395
Unemp_HUN	0.029	0.832	0.028	0.841	0.040	0.770
Retail_HUNyy	0.013	0.859	0.026	0.728	−0.011	0.873
Prod_HUNyy	−0.045	0.207	0.038	0.223	−0.033	0.415
WUI_global	0.000	0.510	0.000	0.858	0.000	0.239
WUI_HUN	2.227	0.369	−2.094	0.374	−6.632*	0.019
BUXmedian	1.530*	0.016	−1.488*	0.020	−1.599*	0.014
BUXreturn	−12.837*	0.030	19.317**	0.000	12.504*	0.030
WUI_RUS	2.240	0.378	2.509	0.221	−2.170	0.330
GPR_RUS	−0.466	0.648	0.178	0.846	−1.101	0.234

*Note: The data in the table show the results of cross-sectional regression analyses on winsorised cumulative abnormal returns (CAR). The three columns indicate the effects of the explanatory variables during the month preceding, simultaneously with and following the event. HC1 robust (heteroskedasticity-robust) standard deviations were used for inference. The significance levels are marked: ** $p < 0.01$; * $p < 0.05$.*

In the global model presented in *Table 3*, the VIX index showed a significant positive effect for the *CAR* values (β=0.175, p < 0.01), while the *GEPU_current*, the *GPR* and the *WUI_global* did not prove to be significant. The model's alignment is considered low (*adjusted R²*=0.10). Diagnostic tests show that the model is reliable because multicollinearity is low (*VIF* < 1.5), the Shapiro–Wilk test did not reject the normal distribution of residuals (p=0.996), and the Breusch–Pagan test indicated no heteroscedasticity (p=0.90).

None of the variables in the domestic macroeconomic and uncertainty models reached the significance level. Alignment is weak (negative *adjusted R²*), showing that the domestic fundamentals do not contribute to a substantial explanation of the *CAR*. In the model of confidence indices, neither the consumer indicator, the business confidence indicator, nor the Baker–Wurgler investor sentiment index showed any significant correlation with the *CAR* values. Alignment is weak (negative *adjusted R²*=0.00) again, i.e. these indicators do not explain the changes in returns.

In the final model, the VIX showed a significant positive impact on the *CAR* values (β=0.097, p < 0.05). The effect of the monthly return of the BUX was negative (β=–9.25), which proved to be weakly significant with robust errors (p=0.09). The model has weak explanatory power (*adjusted R²*=0.11). Based on the diagnostic tests, the model's estimate may be regarded as reliable. Multicollinearity is not a problem (*VIF*=1.08 in the case of both variables). The hypothesis of normal distribution of residuals was not rejected by the Shapiro–Wilk test (p=0.81), and no significant heteroscedasticity was indicated by the Breusch–Pagan test (p=0.79).

Among the models, only the global uncertainty model, and within that, the VIX index, showed a significant correlation with *CAR* values. The domestic fundamentals and confidence indicators provided no additional information. The results provided by the final model confirm, on the whole, that the abnormal returns in the domestic stock market were related primarily to the prior month's global volatility (VIX), while the domestic market performance (*BUXreturn*) showed a weaker and more uncertain correlation. Accordingly, the results suggest that negative reactions are more moderate (higher *CAR*) after periods characterised by higher capital market risks and that reactions are similarly moderate even when the BUX index's return in the previous month is low. It is concluded from the above that the market had already partially factored in the unfavourable outlook prior to the events, and that investors view geopolitical developments as minor surprises during this period of increased uncertainty.

Table 3

Cross-sectional regression results for the CAR values

Variable	Global (5)	Domestic macros (6)	Confidence indices (7)	Final model (8)
Constant	−6.785*	−2.607	20.452	−2.647**
VIX	0.175**			0.097*
GEPU_current	−0.002			
GPR	0.033			
WUI_global	0			
CPI_HUNyy		0.087		
Unemp_HUN		0.064		
Retail_HUNyy		0.008		
Prod_HUNyy		−0.064		
WUI_HUN		1.828		
GPRC_HUN		32.54		
CCI_HUN			0.057	
BCI_HUN			−0.271	
BWSENT			0.306	
BUXreturn				−9.245
R^2	0.169	0.101	0.047	0.136
Adjusted R2	0.096	−0.024	0.003	0.11

*Note: The data in the table show the results of cross-sectional regression analyses on winsorised cumulative abnormal returns (CAR) on the basis of the equations – (5), (6), (7) and (8) – discussed in Chapter 3. HC1 robust (heteroskedasticity-robust) standard deviations were used in the estimates. The significance levels are marked: ** $p < 0.01$; * $p < 0.05$.*

7. Discussion

Our conclusions are consistent with the international literature, in that the negative short-term reactions of the BUX index primarily lead to diminishing stock returns (*Smales 2021; Lamine – Zribi 2024*). The enhanced market sensitivity observed since 2000 may be related to the fact that the market has become more developed and liquid, thereby amplifying the impact of geopolitical shocks (*Grinius – Baležentis 2025*). The significant negative abnormal returns associated with peaceful events, identified in the [0,5] day event window, may at first appear to be in contrast to the expectations, but they are in line with findings that the persistence of threats and uncertainty triggers stronger market reactions than the violent escalation itself (*Rafi – Ali 2025*). It was also in line with this that we demonstrated how we observed similar reactions in events characterised by preservation of the status quo. This

indicates that the market often aligns its reactions not to the actions themselves, but rather to the persistence of lasting uncertainties and threats. The impact of geographical proximity is also borne out by the results in a regional breakdown. The European events caused greater underperformance on the part of the BUX index, which is in line with the proximity effect hypothesis (*Grinius – Baležentis 2025; Nygaard – Sørensen 2024*).

Cross-sectional regression analyses found that the global risk indicators (VIX) and the stock market's prior performance play a significant role, while the domestic macroeconomic factors and confidence indicators do not substantially explain the cumulative abnormal returns. This is consistent with the findings of international studies, which show that the extent of the effect depends on the level of stock market performance (*Demiralay et al. 2024*).

8. Conclusion

Our study explored the Hungarian capital market's short-term reactions in relation to international crises. The results for the period between 1991 and 2021 showed negative average cumulative abnormal return values in the majority of the event windows, but the t-testing found significant effects only in the [0,5] day window, while z-testing found such effects in the [−15,15], [0,2] and [0,1] windows. In the partial period between 2000 and 2021, an increase in significant effects was observed along with stronger and more persistent negative market reaction, particularly in the windows between [0,1] and [0,11], where the lowest average abnormal return was found in the [0,10] window. All of this goes to show that the BUX index not only reacts negatively to international crises compared to its own past performance, but also underperforms relative to benchmarks representing developing and developed markets – the MSCI Emerging Markets, S&P 500, the WIG20 and the PX indices – meaning that the Hungarian market reacts more sensitively and strongly to geopolitical events.

The crises were also grouped by various dimensions (e.g. by severity or by geographical location). The results show that although the average abnormal return tends to be negative during events related to armed conflicts, the effects of such events are not statistically significant. On the other hand, in the case of peaceful events, significant negative reactions can be observed in the short term, in the [0,5] day event window, which, however, is a temporary phenomenon, as returns rebound in subsequent periods, although the effect is no longer statistically significant. In the case of events accompanied by eased tensions, the market's reaction shows a pattern similar to those of peaceful conflicts: negative in the short term, then turning positive later, but the effect is only significant in the short term.

On the other hand, events indicating continuation of the status quo, i.e. prolongation of the crisis and uncertainty, result in negative and statistically significant cumulative abnormal returns in several time windows. When we categorised crisis events in terms of severity, events related to more severe crises during the period between 2000 and 2021 resulted in significantly negative abnormal returns in several of the event windows examined.

In a breakdown by geographical region, the results show that the Hungarian stock market is most sensitive to European crises, which resulted in significantly negative abnormal returns. The effects of events taking place in Africa were mostly negative but insignificant, while events in the Middle East were accompanied by moderately positive exchange rate reactions. The effects of events in Asia are moderate and short-term, suggesting in general that geographical proximity increases the intensity of the Hungarian market's response to international crises.

Cross-sectional regression analyses found that cumulative abnormal returns are primarily explained by global uncertainty factors and the past performance of the Hungarian stock market. The preceding month's VIX index showed significant positive correlation with *CAR* values, indicating that an increase in global market volatility prior to an event moderates the negative reactions (higher *CAR*) of the Hungarian stock exchange to crises. Investors tend to become more risk-averse in such situations even before the crisis; thus, when the crisis hits, the selling pressure is less intense, because some of the increased risks have already been factored in.

Similar correlations are found in the case of technical indicators related to the BUX (*BUXrec, BUXmedian, BUXreturn*): in the month preceding the event, the downward trend (*BUXrec*), monthly returns below the median (*BUXmedian*) or low monthly returns (*BUXreturn*) dampened the market reaction (higher CAR). This suggests that investors had already factored in the unfavourable outlook to some extent ahead of the event; therefore, the actual effect of the crisis was not as dramatic as it might have been. Conversely, domestic macroeconomic factors (inflation, unemployment, industrial production, consumer confidence) showed no significant correlation with cumulative abnormal returns.

The general applicability of the conclusions is limited by the fact that abnormal returns were not statistically significant in many event windows, indicating that the market impacts of crises were often temporary or relatively weak.

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Annex

Table 4		
Variable descriptions		
Variable	**Category**	**Brief description / Source**
GEPU_current	Global economic policy uncertainty	The Global Economic Policy Uncertainty Index is a text-based, news-based, GDP-weighted indicator, based on current price GDP (*Baker et al. 2016*).
GEPU_ppp	Global economic policy uncertainty	The Global Economic Policy Uncertainty Index is a text-based, news-based, purchasing power parity-weighted indicator (*Baker et al. 2016*).
US_EPU	US economic policy uncertainty	The Economic Policy Uncertainty Index is a text-based, news-based indicator, United States of America (*Baker et al. 2016*).
GPR	Global geopolitical uncertainty	The Geopolitical Risk Index is a global aggregated, text-based and news-based indicator (*Caldara – Iacoviello 2022*).
GPRT	Global geopolitical uncertainty	The Geopolitical Threat Index (threat) is a text-based and news-based indicator (*Caldara – Iacoviello 2022*).
GPRA	Global geopolitical uncertainty	The Geopolitical Act Index (actual acts) is a text-based and news-based indicator (*Caldara – Iacoviello 2022*).
GPRC_HUN	Hungarian geopolitical uncertainty	A Hungary-specific geopolitical risk index (*Caldara – Iacoviello 2022*)
BWSENT	Investor sentiment indicator	Baker–Wurgler investor sentiment index (*Baker – Wurgler 2006, 2007*)
VIX	Global capital market uncertainty	Volatility index (implied volatility of S&P500 options). Source: CBOE
CCI_HUN	Hungarian consumer confidence	Consumer Confidence Index (domestic consumer confidence index). Source: OECD
BCI_HUN	Hungarian business confidence	Business Confidence Index (domestic business confidence index). Source: OECD
CPI_HUNyy	Hungarian macroeconomic variable	Inflation (consumer price index, annual change). Source: HCSO
Unemp_HUN	Hungarian macroeconomic variable	Unemployment rate (%). Source: HCSO
Retail_HUNyy	Hungarian macroeconomic variable	Retail sales, annual change (%). Source: HCSO
Prod_HUNyy	Hungarian macroeconomic variable	Industrial production, annual change (%). Source: HCSO
WUI_global	Global uncertainty indicator	World Uncertainty Index (global average, GDP-weighted) (*Ahir et al. 2022*)
WUI_HUN	Hungarian uncertainty indicator	World Uncertainty Index – Hungary (*Ahir et al. 2022*)
BUXmedian	Technical market indicator	It equals 1, if the BUX index return is below the median, otherwise it equals 0.
BUXreturn	Technical market indicator	The monthly return of the BUX index
BUXrec	Technical market indicator	It equals 1, if the BUX is below the previous 12-month moving average, otherwise it equals 0.
WUI_RUS	Uncertainty indicator	World Uncertainty Index – Russia (*Ahir et al. 2022*)
GPR_RUS	Geopolitical uncertainty	Russia-specific geopolitical risk index (*Caldara – Iacoviello 2022*)

Table 5

Results of the cumulative abnormal returns of the event windows, in a breakdown by period

Period	Event window	Number of cases	Average CAR	t-statistics	Positive ratio	z-statistics
1991–2000	[−30,30]	32	0.584	0.13	0.53	0.354
1991–2000	[−15,15]	32	−0.365	−0.117	0.40	−1.061
1991–2000	[−1,1]	32	−0.253	−0.393	0.56	0.707
1991–2000	[−2,2]	32	0.394	0.554	0.56	0.707
1991–2000	[0,2]	32	−0.37	−0.717	0.38	−1.414
1991–2000	[0,3]	32	−0.555	−0.909	0.44	−0.707
1991–2000	[0,5]	32	−1.024	−1.265	0.47	−0.354
1991–2000	[0,10]	32	1.496	0.679	0.44	−0.707
1991–2000	[0,20]	32	0.588	0.195	0.59	1.061
1991–2000	[0,30]	32	0.517	0.129	0.56	0.707
2000–2021	[−30,30]	76	0.414	0.401	0.46	−0.688
2000–2021	[−15,15]	76	−0.427	−0.554	0.42	−1.376
2000–2021	[−1,1]	76	−0.392	−1.534	0.46	−0.688
2000–2021	[−2,2]	76	−0.152	−0.53	0.46	−0.688
2000–2021	[0,2]	76	−0.324	−1.523	0.38	−2.065**
2000–2021	[0,3]	76	−0.367	−1.392	0.47	−0.459
2000–2021	[0,5]	76	−0.523	−1.937*	0.42	−1.376
2000–2021	[0,10]	76	−1.115	−2.306**	0.39	−1.835*
2000–2021	[0,20]	76	−0.307	−0.493	0.42	−1.376
2000–2021	[0,30]	76	−0.619	−0.767	0.40	−1.606
2010–2021	[−30,30]	48	0.509	0.408	0.43	−0.866
2010–2021	[−15,15]	48	−0.844	−0.899	0.38	−1.732*
2010–2021	[−1,1]	48	−0.373	−1.622	0.46	−0.577
2010–2021	[−2,2]	48	−0.197	−0.588	0.48	−0.289
2010–2021	[0,2]	48	−0.422	−1.624	0.37	−1.732*
2010–2021	[0,3]	48	−0.275	−0.839	0.52	0.289
2010–2021	[0,5]	48	−0.445	−1.333	0.45	−0.577
2010–2021	[0,10]	48	−1.499	−2.511**	0.35	−2.021**
2010–2021	[0,20]	48	−1.309	−1.935*	0.37	−1.732*
2010–2021	[0,30]	48	−1.194	−1.375	0.35	−2.021**

Note: The table shows the average cumulative abnormal returns (CAR) calculated for all events, along with the corresponding t-statistics and z-statistics for various event windows. The "Positive ratio" column indicates the percentage rates of the events with positive CAR values. The asterisks mark statistical significance: * p < 0.10; ** p < 0.05.

Table 6

Results of event windows, in the case of peaceful and armed conflicts

Event window	Number of cases	Average CAR	t-statistics	Positive ratio	z-statistics
Peaceful crisis					
[−30,30]	28	1.399	0.454	0.5	0
[−15,15]	28	−1.06	−0.371	0.29	−2.268**
[−1,1]	28	−1.435	−2.128**	0.32	−1.89*
[−2,2]	28	−1.098	−1.632	0.36	−1.512
[0,2]	28	−1.112	−2.467**	0.32	−1.89*
[0,3]	28	−1.177	−1.962**	0.32	−1.89*
[0,5]	28	−1.441	−1.793*	0.36	−1.512
[0,10]	28	0.268	0.111	0.21	−3.024**
[0,20]	28	1.346	0.546	0.36	−1.512
[0,30]	28	1.987	0.738	0.46	−0.378
Armed crisis					
[−30,30]	80	0.137	0.079	0.48	−0.447
[−15,15]	80	−0.181	−0.174	0.46	−0.671
[−1,1]	80	0.028	0.113	0.55	0.894
[−2,2]	80	0.397	1.299	0.54	0.671
[0,2]	80	−0.066	−0.282	0.4	−1.789*
[0,3]	80	−0.158	−0.58	0.51	0.224
[0,5]	80	−0.402	−1.35	0.46	−0.671
[0,10]	80	−0.555	−1.014	0.48	−0.447
[0,20]	80	−0.527	−0.518	0.51	0.224
[0,30]	80	−1.077	−0.725	0.45	−0.894

Note: The table shows the average cumulative abnormal returns (CAR) calculated for the whole period and for all events, along with the corresponding t-statistics and z-statistics in a breakdown by armed (VIOL ≥ 2) and peaceful (VIOL < 2) conflicts. The "Positive ratio" column indicates the percentage rates of the events with positive CAR values. The figures marked * and ** indicate 10-per cent (p < 0.10) and 5-per cent significance levels, respectively (p<0.05).

Table 7

Results of the event windows in the case of conflicts broken down by region

Period	Event window	Number of cases	Average CAR	t-statistics	Positive ratio	z-statistics	Region
1991–2021	[0,10]	23	−1.609	−1.975**	0.35	−1.46	Africa
1991–2021	[−1,1]	50	−0.632	−1.782*	0.4	−1.414	Africa
1991–2021	[0,2]	50	−0.559	−1.998**	0.36	−1.98**	Asia
1991–2021	[0,3]	50	−0.713	−1.989**	0.42	−1.131	Asia
1991–2021	[0,10]	50	−0.832	−1.519	0.36	−1.98**	Asia
2000–2021	[−1,1]	17	0.669	2.097**	0.76	2.183**	Africa
2000–2021	[−1,1]	39	−0.787	−1.839*	0.35	−1.761*	Asia
2000–2021	[0,2]	39	−0.618	−1.985**	0.33	−2.082**	Asia
2000–2021	[0,3]	39	−0.718	−1.821*	0.41	−1.121	Asia
2000–2021	[0,10]	39	−0.67	−1.297	0.35	−1.761*	Asia
2000–2021	[0,3]	4	−1.887	−2.502**	0	−2**	Europe
2000–2021	[0,5]	4	−2.932	−3.457**	0	−2**	Europe
2000–2021	[0,10]	4	−3.615	−2.276**	0.25	−1	Europe

*Note: The table shows the cumulative abnormal returns (CAR) of the BUX index and the corresponding t-statistics and z-statistics for different event windows by region, only in cases where statistically significant results can be observed. The significance levels are marked: * p < 0.10; ** p < 0.05.*

The US Dollar's Changing Global Role and Its Volatility – an Illustrative Analysis Using an Analogy from the Stock Market*

Anna Naszódi ⓘ

Over the past 25 years, the share of USD-denominated assets in the foreign exchange reserves of the world's central banks has gradually declined. On the one hand, this tendency can be partly attributed to exogenous factors, such as the US dollar's declining role in foreign trade and certain international financial transactions. On the other hand, it may also reflect changing perceptions of USD hegemony. This essay first maps the risks to the primacy of the dollar, relying on the research findings of Rogoff. Then, an empirical analysis is performed to address the following question: how is the volatility of the USD exchange rate expected to change if the risks were to materialise. The approach used exploits the analogy between a stock swap deal of two Hungarian listed companies and the changing composition of foreign reserves. Based on the results, it cannot be ruled out that further rearrangements in reserve composition may cause substantial fluctuations in the exchange rate, especially in the case where central bank decisions are driven by shifts in perceptions.

1. Introduction

In general, the *exchange rate regime* is a comprehensive indicator of how important the US dollar and other reserve currencies are for individual countries: when a decision is made on the exchange rate regime, central banks are advised to take into account the weight of the major currencies in their external trade and

international capital flows. For example, if two countries fix their exchange rates against a basket of currencies, then the US dollar is presumably more important to the country where it has a larger weight in the reference basket. Let us take another example, where the dollar is the only reference currency for two countries under comparison. It is reasonable to think that USD has greater importance in a country where the domestic currency is more closely tied to the dollar. Since the *de facto* exchange rate regimes can be different from the *de jure* regimes (see *Frankel – Wei 2008*; *Frankel – Xie 2010*), it is insightful to use the *composition of central banks' foreign exchange reserves*, rather than the officially declared regime, to quantify the relative importance of major currencies.[1]

In addition to foreign trade and capital flows, exchange rate volatility also plays a role in the choice of reserves (see *Gopinath – Stein 2021*). If a central bank considers that its economy is extremely sensitive to changes in the exchange rate of its domestic currency against a given major currency, such as the US dollar, it will pay attention to the stability of this exchange rate. To keep volatility low, it will form a larger reserve from the foreign currency in question. On the one hand, larger reserves enhance the central bank's ability to intervene on the forex market. On the other hand, it also makes intervention unnecessary if the market is informed about the central bank's objective and perceives the central bank as being committed to keeping its exchange rate stable.

It is a well-known fact that *the share of USD assets in the foreign exchange reserves of the world's central banks has been slowly but steadily declining over the past few decades*: according to the IMF's Currency Composition of Official Foreign Exchange Reserves (COFER),[2] at constant exchange rates, the US dollar's share of global foreign exchange reserves amounted to only around 58 per cent at the end of 2024,[3] compared to 69 per cent in 2007, just before the financial crisis, whereas it was 91 per cent in 1999, before the European Economic and Monetary Union was established.[4]

This trend can be studied using two different perspectives. First, the trend can be interpreted as the result of central banks' reaction in their reserve policy to exogenous changes in the world economy, which take into consideration the

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[1] An alternative approach for determining the relative importance of the major currencies for the domestic economy is to quantify the co-movement of the central banks' policy rates. However, policy rates are subject to country-specific shocks.

[2] https://data.imf.org/en/datasets/IMF.STA:COFER

[3] It is important to note that, despite the US dollar's declining share in reserves, neither the share of euro, nor that of renminbi have increased significantly over the last eight years, while the share of some other currencies has increased slightly. For example, the share of the Australian dollar increased from 1.7 per cent to 2.1 per cent, the Canadian dollar from 1.9 per cent to 2.8 per cent, and the Japanese yen from 4 per cent to 5.8 per cent between 2016 and 2024. Meanwhile, the People's Bank of China concluded currency swap agreements with 38 countries between 2009 and 2018 with a value of 2,664 billion renminbi (see *Bahaj – Reis 2020*).

[4] See *Ito – McCauley* (*2020*).

changing foreign exchange composition of both foreign trade settlements and international loans, as well as changing exchange rate volatilities. As an example of such exogenous changes, one can think of the declining role of the United States in international trade over the last two decades.

There is also an alternative interpretation: the foreign currency composition of reserves is not only a technical decision influenced by exogenous changes, but also has a signalling feature: It reflects the expectations and perceptions of central bankers, which then have a feedback effect on the global financial system, in particular, on the evolution of the competition between reserve currencies. Central bank decisions are therefore not only the consequences of economic and geopolitical changes, they also actively shape such changes. Along these lines, shifts in the composition of foreign exchange reserves can also be interpreted as a sign of trust in the stability of the economy behind the given currency and the stability of the currency's value.

McCauley (*2011*) makes the point that the relative position of reserve currencies is shaped not only by market forces, but also by political and institutional decisions. As an example, he mentions the rise of the renminbi,[5] which is taking place in a controlled manner similarly both to China's role in international capital transactions and the evolution of the strictly regulated Chinese financial system. In this framework, the declining share of USD in central bank reserves can be seen as a sign that confidence is eroding in the stability of the global economic order that emerged in the 1920s and consolidated after World War II. However, the same tendency can also be interpreted as the gradual emergence of a multipolar reserve currency system with increasing roles for the renminbi, the euro and some other currencies.

It is important to highlight that the literature is not conclusive about the future of the US dollar. While *Rogoff* (*2025*) predicts a gradual erosion of the dollar's global role, several other authors – such as *Bertaut et al.* (*2025*) – argue that the dollar's international role may remain stable in the long run. They make the point that the high liquidity of the USD-based financial markets and the strong global demand for safe assets may continue to preserve USD dominance. *Mühleisen – Zeneli* (*2025*) reach a similar conclusion, highlighting the geopolitical significance and technological advantage of the United States as stabilising factors. According to *Alekseeva et al.* (*2024*), the dollar's dominance is supported not only by economic but also by institutional factors: the IMF, the World Bank and other multilateral organisations continue to use USD-denominated instruments, which makes the dollar structurally embedded in the global financial system.

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[5] On the controlled international expansion of China, see *Hao et al.* (*2022*), and *Zhang et al.* (*2017*), who use econometric methods to analyse the trade and exchange rate effects of currency swap agreements provided by the Chinese central bank.

The arguments in favour of the stability of the US dollar's dominance are also strengthened by certain interpretations of some recent economic policy developments. Since the beginning of Donald Trump's second presidency, several measures have been explicitly aimed at maintaining the primacy of the dollar. These include several points in the US tariff negotiations, in which repositioning the US dollar globally appears as a strategic goal. A similar example is the regulation of crypto stablecoins under the "Guiding and Establishing National Innovation for US Stablecoins Act" (GENIUS Act). In addition, US-based global digital platforms – such as streaming services, Facebook, Meta and artificial intelligence systems – continue to support the technological dominance of the United States and indirectly strengthen the US economy.

To sum up, although several factors – institutional embeddedness, technological superiority, economic policy measures – support a continuation of the dominant global role of the US dollar, there are warning signs reflecting that financial market players are increasingly cautious about American assets. Central bankers' views are not independent of those of market participants, who have been willing to finance the growing sovereign debt of the US only at an elevated level of yields since mid-2023 (see *Jiang et al. 2025*). The rise in sovereign bond yields reflects that foreign investors are less willing to sacrifice yields for the liquidity and relative safety of the US dollar. Moreover, it may undermine the safety of USD assets in the long run through the decreasing seigniorage income of the United States.

In this essay, we first map the risks that may threaten the primacy of the US dollar. An empirical analysis is then conducted to address the question of how the volatility of the dollar's value is expected to change if the risks indeed materialise. In mapping the risks, it is primarily Kenneth Rogoff's 2025 book that is relied on. To perform the empirical analysis, we employ a novel approach.[6]

This approach relies on the similarity of two problems: one of the problems is studied in the international macro-finance literature, while the other one is studied in the corporate finance literature.[7] In particular, we use an analogy between the strategic alliance between two companies listed on the stock exchange and the cooperation of countries to maintain the status quo, even just out of necessity. In the analysis, using an example, we show that, in the case of two listed Hungarian companies, concluding such an alliance – as formalised by a stock swap agreement

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[6] While the implications of freezing Russian USD reserves and the evolving conflicts of interest between BRICS countries and the United States merit rigorous empirical investigation, this essay does not attempt to address these issues. Likewise, we refrain from evaluating the extent to which the depreciation of the US dollar against the euro observed in 2025 reflects a market-driven adjustment or constitutes a deliberate economic policy intervention by the United States.

[7] *Naszódi* (*2002*) used the similarity of another pair of problems studied in the same fields when she developed a model describing the exchange rate in a target zone with two financial options.

– resulted in a sudden, relatively lasting increase in the correlation between the returns of the stocks involved.

Analogously, we hypothesise that the continued changes in the composition of central banks' foreign exchange reserves may accompanied by a surge in USD volatility vis-à-vis other currencies.[8] One related surprising finding is that since the increase in the correlation after the stock swap agreement was triggered by a relatively small change in the cross-ownership of the companies concerned, namely OTP and Mol, a rise in USD volatility could also be triggered even by small additional change in the composition of reserves. At the same time, other exchange rates, such as the exchange rate between the Canadian dollar and the euro, could be stabilised if the Bank of Canada increases its euro reserves and the European Central Bank (ECB) increases its Canadian dollar reserves.

As we will see, the analogy between a stock swap and the changing composition of reserves is not perfect. One obvious difference, for example, is that while the fundamentals of the stocks directly involved in the swap were changed almost overnight by the deal, the composition of reserves changes only slowly and gradually, typically in response to changes in numerous other economic and political factors (see *Eichengreen – Mathieson 2000*). Fortunately, the rapid change in the former case allows us to quantify how the stock swap agreement itself and the strategic alliance sealed by the deal affect the correlation in returns for the stocks involved. Naturally, the correlation may have changed independently of the stock swap in the days around the analysed swap deal. We control for the effects of the confounding factors by computing the change in correlations between the stocks affected by the swap and a third stock, which was not involved in the swap.

In the following, we summarise *Rogoff's* (*2025*) main points on the causes behind the US dollar's potential loss of dominance.[9] We then introduce the stock swap agreement between the Hungarian companies before discussing the potential and the limitations of the analogy between the swap deal and reserve management. Finally, we conclude the paper.

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[8] In addition, one can expect the continuing weakening of the US dollar if the dollar's loss of primacy will be similar to the dethronement of the British pound in the 1920s. While one pound cost more than 4 US dollars before 1920, it cost less than 3 after 1950. It is important to emphasise, however, that the historical analogy has its limits similarly to the analogy between a stock swap and foreign exchange reserve management. The economic environment after World War I – including the increased debt of the United Kingdom due to its war-related expenditures and the associated rearrangement of international debtor-creditor relations – entailed unique factors that cannot be directly compared to the current situation in the US. The United States still functions as a global creditor, and although its sovereign debt is significant, other fiat-currency countries, such as Japan or the members of the eurozone, have similar or even higher debt-to-GDP ratios.

[9] This study provides only a dry summary of *Rogoff's* (*2025*) book. However, we recommend reading the original work, which is a particularly enjoyable book. In addition to its stylistic and rhetorical richness, it is also entertaining. Rogoff achieves this by illustrating the economic ideas discussed with some personal elements, as well as with striking quotes capturing complex ideas in a concise form.

2. What could threaten the hegemony of the US dollar according to Rogoff?

A frequently repeated claim in *Rogoff's* (*2025*) book is that the primacy of the US dollar will certainly remain unchanged in the short term. However, there are risks in the long run.[10] Let us review the three main risk factors identified by Rogoff.

Rogoff identifies three main risks. According to him, one of these stems from the fact that even the mere mention of *financial sanctions* by the US will force China to loosen the close ties between the renminbi and the US dollar. For example, Chinese investors will reduce their purchases of US government bonds and money market instruments, and the People's Bank of China will continue to trim its USD reserves.

In recent years, the State Administration of Foreign Exchange (SAFE) has released some information on the composition of China's central bank reserves. In its 2018 annual report, for example, SAFE revealed that while the share of USD in the Chinese reserve portfolio was 79 per cent in 1995, this share had fallen to 58 per cent by 2014 (see *Ferranti 2023*). *Prasad* (*2019*) interprets the SAFE statement not only as suggesting that China is simply reducing the share of the US dollar in its reserves, but also as suggesting that the USD share in Chinese reserves in 2014 was already smaller than the dollar's share in the aggregate portfolios of all other central banks.

One expected *qualitative effect* of this trend, according to Rogoff, is that the renminbi's exchange rate against the US dollar will become more volatile, which will have an impact on other Asian countries. They may also reduce their USD reserves and at the same time increase the use of renminbi in their trade with China.

Rogoff does not attempt to *quantify the expected effects*. This is not an easy task, as several factors make it difficult to empirically study the relationship between the compositional choice of foreign exchange reserves and the strength of the US dollar's relative position. One factor is that most central banks do not publish the foreign exchange composition of their reserves: This limits the possibility of conducting multi-country empirical analyses.[11] We consider it to be a more

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[10] What exactly the short and long run mean is a bit unclear. Rogoff quotes *Rudiger Dornbusch*'s related insight: "In economics, things take longer to happen than you think they will, and then they happen faster than you thought they could." Relatedly, *Ilzetzki et al.* (*2022: p. 92*) state that "although the renminbi may well be the global currency in the year 2100, to date it has still made limited headways as an international currency". *Eichengreen – Flandreau* (*2009, 2010*) also give a hint about the time horizon of the changing roles of the reserve currencies: they find that it took nearly 15 years for the US dollar to overtake the prominent role of the British pound.

[11] While conducting a multi-country analysis is not impossible, it requires considerable preliminary work. For example, it involves estimating the composition of reserves of the central banks that do not publish the related data. *Ferranti* (*2023*) uses a hidden Markov model for this purpose. He estimates the composition of reserves for China and Singapore from the total value of reserves published each month by using the observed fluctuations in the exchange rates of the major reserve currencies. According to his point estimates, which are subject to high uncertainty, the Bank of Singapore has slightly increased the proportion of the renminbi in its portfolio since 2022, but it had not reached 5 per cent by 2024.

important limiting factor relative to the lack of publicly available data that the composition of reserves typically changes slowly. The slow pace makes it difficult to compute the impact of the shock which is the focus of our interest, net of some other effects. For example, it is challenging to estimate the extent to which the 11-percentage points global decline in the USD share in reserves between 2007 and 2024 contributed to the increase in economic uncertainty.

Finally, there is probably a critical threshold for USD reserves; after exceeding this threshold, the results of analyses for periods before the threshold was reached are of little relevance for future periods. Accordingly, even if we could estimate how the decline in the USD share of foreign exchange reserves between 2007 and 2024 affected exchange rate volatility in the past, there remains considerable uncertainty about the expected future volatility of the US dollar.

Another set of factors, according to Rogoff, that could potentially threaten USD hegemony is the rise of crypto-assets, central bank digital currency (CBDC) and the euro. His claim gains support from the following trend: while previously USD cash played a significant role in conducting illegal transactions (e.g. human, weapons and drug trafficking), it is now demand for cryptocurrencies that is typically strengthened by transactions in the black economy. Since the weight of the black economy is significant (nearly 30%), the effect of cryptocurrencies on weakening USD demand cannot be neglected, according to Rogoff.

He continues by noting that while there has been no drastic change in relation to the emergence of digital central bank money, CBDC could also cause disruption in the functioning of the USD-dominated financial system, both in the US and indirectly in the rest of the world. Rogoff's opinion on whether the euro can compete with the US dollar is clear, insofar as that as long as there is no common fiscal background for the European currency, the euro does not threaten the primacy of the dollar. However, he also notes that if the Russian invasion of Ukraine ultimately forces fiscal and political unity in the EU, then his view of the potential of the euro will have to be revised.

Finally, Rogoff makes the point that "although external challenges to dollar dominance and stability are serious enough, the greatest vulnerabilities come from within." He identifies the United States' large debt as a key threat with internal roots. US sovereign debt reached 120 per cent of GDP by mid-2024,[12] and is projected by the Congressional Budget Office to continue rising for the next three decades. Rogoff believes that if the rapidly rising debt is not curbed – and he sees no commitment from either Democratic or Republican politicians in this regard – the United States and the world will experience persistently elevated financial volatility,

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[12] See "Gross Federal Debt as Percent of Gross Domestic Product" (series: GFDGDPA188S), FRED (Federal Reserve Bank of St. Louis) (https://fred.stlouisfed.org/series/GFDGDPA188S).

accompanied by higher average real interest rates and inflation, and more frequent debt and financial crises.

Analysing the relationship between risks from within and outside the US, Rogoff builds on an idea well-known among chess players:[13] a game can be lost not only if the opponent plays well (meaning the fundamentals of the euro, renminbi, or crypto assets are strong), but also if we make mistakes.[14] The relevance of the example with chess is also seen from the historical experience that the fall of great empires – such as the Roman Empire and the Soviet Union – was often not the result of external attacks, but of internal conflicts or weaknesses.

From a European perspective, we would like to see mistaken policies in the US – especially a fiscal policy with sharply rising sovereign debt after the outbreak of the Covid pandemic – as being primarily an internal problem. If this were not the case, then the world outside the US would run a serious moral hazard vis-à-vis the country. Unfortunately, the arguments put forward by Rogoff call into question whether the United States' problems are primarily those of the Americans. For example, we might think that just as Japan's debt-to-GDP ratio of 230 per cent – which even exceeds that of the US – is primarily a Japanese problem, so the same could be true for the US.[15] There is, however, a crucial difference between the two countries: the US is more indebted to foreign investors than Japan. All of these facts shed light on why Rogoff chose "Our dollar, your problem" as the title for his book.

3. An example for a stock swap

Let us turn to the example of the Hungarian stock swap agreement mentioned in the introduction. Its relationship to reserve composition will be explained in *Chapter 4*. Here, we introduce the deal itself. The stock swap was carried out by two listed companies, OTP and Mol. OTP is one of the largest banks in Hungary, while Mol is the country's leading oil and gas company. The swap deal was announced on 16 April 2009. According to the deal, Mol acquired an 8.57 per cent stake in OTP Bank, while OTP acquired a 4.9 per cent stake in Mol.[16]

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[13] The analogy with chess occurs at several points in the book after Rogoff reveals that he himself is a chess Grandmaster and was among the top chess players until the age of 17–18.

[14] *Baldwin* (*2025*) provides a detailed analysis of the United States' failed economic and social policies. One of the central ideas of his analysis is that the decline in potential productivity in the US in the 21st century has been significantly contributed to by a series of policy measures put in force after 1980 that undermined the living standards of the middle class and weakened welfare institutions (see *Case – Deaton 2020*).

[15] While US government debt held by foreigners accounts for about 25 per cent of total government debt (see FRED statistics https://fred.stlouisfed.org/series/FDHBFIN), in Japan this ratio was below 12 per cent in June 2025 (see Bank of Japan, Flow of Funds Accounts – Preliminary Figures, June 27, 2025, https://www.boj.or.jp/en/statistics/sj/sj.htm).

[16] For more details see, the official communication of OTP entitled "Extraordinary Report" reference number BK-113/2009 (https://www.bet.hu/newkibdata/101897820/090416_csere_113.pdf), and *Vince* (*2013*).

Additional details of the swap are as follows. The stock swap agreement was due to expire in July 2012, until which date either party could initiate cash or physical settlement of the transaction. That is, according to the stock swap agreement, OTP received the right to repurchase the OTP stocks affected by the agreement, while Mol was granted the right to repurchase the Mol shares involved in the swap. Ex post, we know that neither of the options were exercised. In fact, the stock swap agreement has been extended multiple times. It is still in effect in 2025, at the time of writing this study.

Another feature of the deal is that "the transaction does not involve a change in the number of own stocks held by Mol, and OTP will also hold the same number of Mol stocks as before the transaction. The reason is that OTP already had 6,987,362 Mol shares under a previous agreement, of which 5,010,501 stocks were now lent, and the same number was now exchanged for OTP stocks."[17]

To understand who gained what with the deal, it is worth mentioning that OTP's capital adequacy ratio increased by 125 basis points due to the swap.[18] However, an even more important gain is due the strategic alliance of the two companies. It is worth noting that the cross-ownership of Mol and OTP does not fit into the typical stock swap transactions, as most such swaps are between companies operating in the same industry and can be seen as an initial step in the process of mergers and acquisitions. The purpose of the agreement between OTP and Mol was rather to mutually help each other avoid external acquisitions and unwanted stock price fluctuations.[19]

4. Comparing changes in reserves' composition and stock swaps

Let us turn to the common features of reserves' composition and stock swaps. First, central banks' foreign exchange reserves represent a guarantee for the repayment of sovereign debt denominated in foreign currency. While reserves are reported on the asset side of the state's consolidated balance sheet, sovereign debt is reported on the liability side. Thus, the reserves contribute to maintaining the stability of loans borrowed and bonds issued by the state. Similarly, the swapped Mol stocks – reported on the asset side of OTP's balance sheet – contribute to the value of the OTP stocks reported on the liability side of OTP's balance sheet. (The same applies for the swapped OTP stocks recorded on the asset side of Mol's balance sheet and the Mol stocks on the liability side.) Accordingly, from a *balance sheet perspective*, corporate cross-ownership and the central bank's foreign exchange reserves are similar.

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[17] See: Index – Economy – MOL becomes major shareholder in OTP. https://index.hu/gazdasag/ma-gyar/2009/04/17/nagytulajdonos_lett_a_mol_az_otp-ben/
[18] Hungarian regulation interprets the swap of common stocks as if the stocks were sold.
[19] The cooperation between the two companies was also strengthened by the fact that there were already overlaps in their management in 2009: for example, Sándor Csányi, the Chairman and CEO of OTP, was also the Vice Chairman of the Board of Directors of Mol.

Second, the management expected the cross-ownership between Mol and OTP to provide protection against adverse price movements on the stock market. The mechanism they might have in mind is this: stock price volatility can be mitigated by the fact that cross-ownership increases the opportunity for purchasing own shares, thus giving companies more room to prevent fluctuations in their stock prices. Similarly, the foreign exchange reserves of emerging countries provide protection against unwanted changes in exchange rates.

Third, the stock swap between Mol and OTP also represents a strategic alliance that is difficult to price. The difficulty can be explained by the fact that it was also part of the deal to prevent the buyout of Mol by OMV (OMV is a competitor of Mol, which also operates in the energy sector). Selecting the composition of foreign exchange reserves can be interpreted along similar lines, as this is not merely a technical decision and is often the result of financial and geopolitical cooperation. Take China, for example, the country with the largest USD reserves: over a long period, it opted for a gradual reduction of its USD reserves, signalling that the country would continue to accept the international economic role it had previously developed. Coming either as a forced decision or reflecting China's free will, this served to maintain the status quo, within the framework of which China had accumulated significant trade surpluses and participated financing the US sovereign debt, while continuing to maintain a high household saving ratio. The bilateral financial agreements concluded after 2009 point in a new direction: their purpose is to strengthen the global role of the renminbi. The partner countries in these agreements are aware of China's long-term strategic ambitions, and thus their decisions can be interpreted as conscious participation in the transformation of the international financial system.

Other parallels can be drawn between stock indices, such as the Hungarian BUX index, and a basket of currencies, such as the SDR; and also between requirements imposed on commercial banks' capital adequacy ratio and a rule of thumb's, such as the Greenspan–Guidotti rule.[20] Finally, a similarity can be found between OTP's call option on its own shares and some conditionalities in the agreements between central banks.

Interestingly, some of the conditional swap and credit line agreements between central banks have become as atypical over the past decade as the OTP–Mol agreement was in comparison to most corporate equity swaps. The reason for this is that currency swap and credit line agreements with China are increasingly becoming geopolitical elements of the international financial architecture. While the currency swap agreements of Western central banks – such as the US Federal

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[20] Under the Greenspan-Guidotti rule, reserves must cover 100 percent of short-term external sovereign debt to eliminate the repayment risk caused by a potential sudden stop on the debt market.

Reserve or the ECB – typically serve to increase supply when demand for foreign liquidity in their own currencies rises,[21] the Chinese central bank often provides renminbi-denominated liquidity to countries where there is no explicit market liquidity shortage in renminbi. [22]

Horn et al. (*2023*) built a comprehensive database of China's international financial arrangements concluded between 2000 and 2021. They show that the global currency swaps provided by the PBoC are increasingly functioning as a financial rescue mechanism. Within this framework, more than USD 170 billion worth of revolving liquidity has been given to countries in crisis, which typically have low levels of foreign currency reserves. These arrangements have allowed the affected countries to increase their gross reserves. However, they were priced with a relatively higher interest rate and in a less transparent manner. In addition, these swap agreements were offered almost exclusively to countries participating in the Belt and Road Initiative. The swaps implicitly serve the internationalisation of the renminbi, while they expand China's financial influence. As a by-product, they also challenge the IMF's traditional role as an international lender of last resort.[23]

Having reviewed some similarities, let us turn to the *differences between reserves and stock swaps*. First, while it is relatively easy to determine the cross-ownership ratio of companies using the balance sheet approach,[24] it is far more challenging to define and compute its counterpart in the other problem. It may be tempting to determine the "cross-ownership" ratios of countries based solely on the composition of foreign exchange reserves.[25] However, there are strong arguments in favour of considering broader categories of assets and liabilities in both the denominator and the numerator of the ratio. At the same time, it is not worthwhile investing too much effort into calculating the "cross-ownership" ratios if the balance sheet approach is limitedly suitable to explain the changes in share prices. As we see in the next chapter, the balance sheet approach provides indeed only a partial explanation for the observed jump in the correlation of stock prices following the MoI–OTP stock swap. Therefore, it seems likely that the balance sheet approach is also limitedly applicable to analyse the nexus of different currencies.

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[21] For example, the ECB made some swap and credit line agreements with certain European central banks in 2009 as a response to the liquidity shortage in the financial crisis (*Wiggins et al. 2023*).

[22] As highlighted by *Gerőcs* (*2017*), the PBoC started to provide significant amounts of liquidity to the world's central banks in 2009, when China announced the policy of internationalising the renminbi – in response to the global financial crisis originating in the US mortgage market.

[23] The case of Argentina is particularly insightful: in 2023, the Argentine central bank called on a renminbi-denominated loan from the PBoC, which was then partially converted into US dollars and used to repay Argentine's IMF debts (see *Arnold 2023*).

[24] For those familiar with derivative pricing and geometric series, it is not a difficult task to take into account the call options embedded in the swap, and the fact that the MoI stocks involved in the stock swap are partly backed by OTP stocks, which in turn are partly backed by MoI stocks, and so on. Similarly, the OTP stocks involved in the stock swap are partly backed by MoI stocks, which in turn are partly backed by OTP stocks, and so on (see *Footnote 29*).

[25] Before mechanically applying such an approach, it is important to note that renminbi enters the Fed's balance sheet almost exclusively through the SDR stock in its reserves.

There is also a significant difference between the stock swaps and the reserves' composition in their roles of *price protection and buyout prevention*. Specifically, the scope of public information is different: for example, while OMV's attempt to buy out MOL and its failure are publicly known, the details of currency attacks on the foreign exchange market and interventions rarely become public.[26]

Another difference is that while the Hungarian stock market has low liquidity and consists of assets with high-beta, the USD market has exceptionally high liquidity and consists of financial assets with the lowest beta.[27] Furthermore, another significant difference is that while listed companies are required to publish detailed reports and balance sheets, most central banks report only a selected set of information on their reserves. The Swiss, Croatian and Brazilian central banks are exceptions (see *Figures 1, 2 and 3*). The Swiss National Bank, for example, publishes the foreign exchange composition of its reserves on a monthly basis.

Figure 1
Share of USD and EUR in the foreign exchange reserves of the Swiss National Bank (SNB) between June 2016 and October 2025
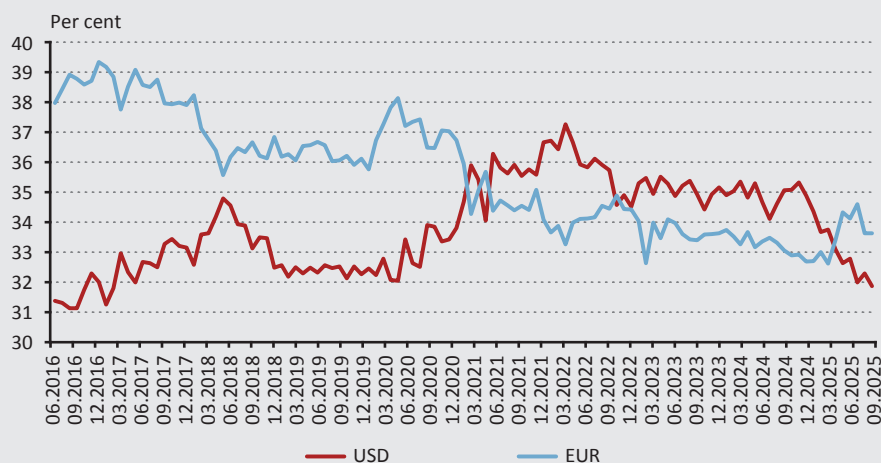
Source: SNB, https://www.snb.ch/en/the-snb/mandates-goals/investment-assets/reserves-bonds, downloaded on 19 June 2025

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[26] A well-known exceptional case was when a group of currency speculators successfully attacked the British pound on 16 September 1992.
[27] These differences were emphasised by an anonymous reviewer of the essay.

Figure 2
Share of USD and EUR in the foreign exchange reserves of the Croatian National Bank (Hrvatska narodna banka, HNB) between December 2001 and Croatia's accession to EMU in January 2023
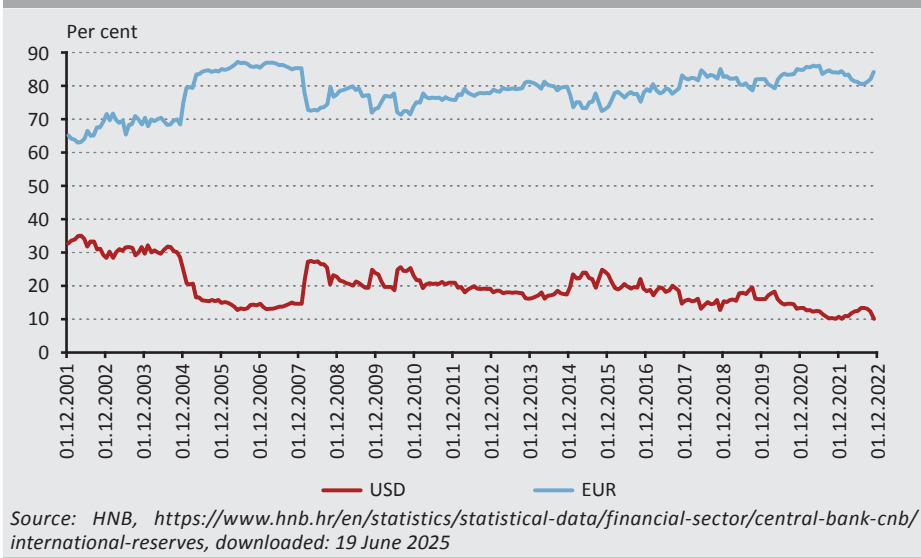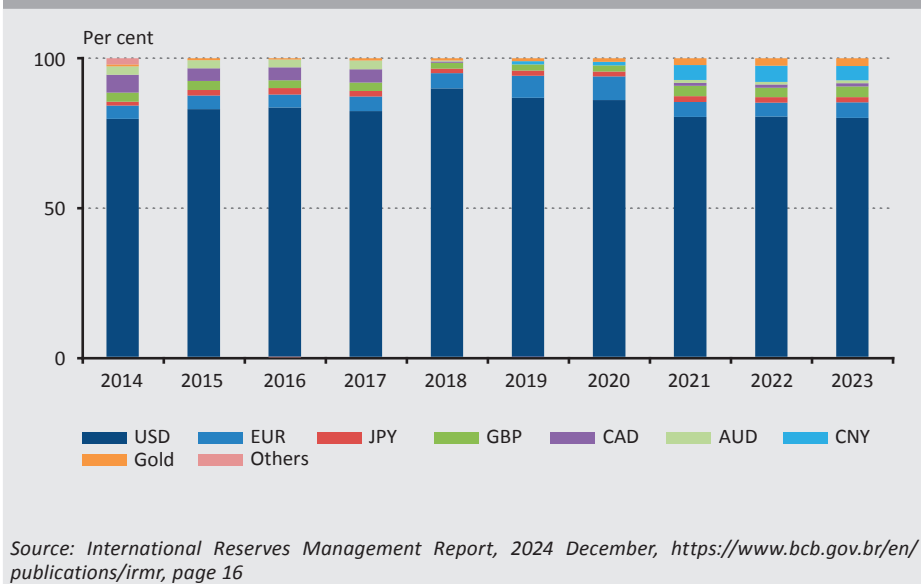

Source: HNB, https://www.hnb.hr/en/statistics/statistical-data/financial-sector/central-bank-cnb/ international-reserves, downloaded: 19 June 2025

Figure 3
Share of the dollar and other currencies in the foreign exchange reserves of the Brazilian Central Bank (Banco Central do Brasil) between 2014 and 2023

Source: International Reserves Management Report, 2024 December, https://www.bcb.gov.br/en/ publications/irmr, page 16

5. Empirical analysis

There is a well-known monotonic relationship between two variables: the higher the cross-ownership ratio, the higher the correlation between percentage changes in the stock prices of companies involved in a stock swap. This relationship has the direct consequence that as the degree of cross-ownership increases, the volatility of the price of one stock expressed in terms of the other stock becomes smaller. In the hypothetical extreme case, where the cross-ownership ratio is so high that the stocks of OTP and Mol generate the same cash flow, their stock prices (more precisely, the percentage changes in the prices) are perfectly correlated, while the ratio of the prices remain unchanged.

The cross-ownership of the two Hungarian companies was far from the extreme level discussed above. Thus, the correlation measured after the stock swap was not 1, but "just" 0.7 (see the dark blue line in *Figure 4* for the last quarter of 2009 and 2010). At the same time, the correlation of 0.7 is still surprisingly high (besides also being relatively stable), especially in light of the fact that the same correlation was close to 0.4 before the stock swap (see the dark blue line in *Figure 4* around the vertical blue line in a 2- to 3-month range).

We can decompose the increase of 0.3 in the measured correlation – denoted by ΔCorr – as follows:

$$\Delta Corr = IE + ME + SE, \tag{1}$$

where IE, ME and SE denote, respectively, the effects of factors independent of the stock swap, the mechanical effects of the stock swap agreement, and the effects of the strategic partnership sealed by the stock swap agreement.

How can we rationalise the decomposition given by *equation (1)*? First, a certain fraction of the 0.3 (= 0.7 – 0.4) increase in correlation can be attributed to factors independent of the stock swap. Since 2009 was an eventful year (see *Figure 5*), we cannot disregard the effects of some potential confounding factors simultaneously impacting the stocks involved in the swap, while also impacting some other listed Hungarian companies. We estimate IE to be roughly 0.1. Thus, the fraction of the increase in the correlation between OTP and Mol – that is not due to the stock swap agreement – is around one-third of the total increase in correlation.

Our estimates are based on how much the correlations increased between OTP and some other companies' stocks not involved in the swap and also how much the correlations increased between Mol and some other companies' stocks (also not involved in the swap). An example for such a company is Magyar Telekom.

We obtain an underestimate of the correlation between the returns of OTP and Magyar Telekom, and of Mol and Magyar Telekom, with a value of 0.4 for the period before the stock swap. It is an underestimation, because the correlations between the daily returns of OTP and Magyar Telekom, and of Mol and Magyar Telekom computed from the closing prices in 60 days before the stock swap agreement were typically somewhat higher than 0.4 (see the light blue and green lines in *Figure 4* before the vertical blue line). However, within 60 days after the stock swap – when the potential effect of the agreement could not yet be fully reflected in the three correlation indicators – the correlations reached values of around 0.4.

In the period between 28 August 2009 and 30 August 2010 – when the potential impact of the stock swap was reduced neither by the retrospective nature of the correlation indicator, nor by the potential legal challenge of the stock swap agreement by a third party – the average of the daily correlations took a value of around 0.5 for both between the OTP and Magyar Telekom, as well between Mol and Magyar Telekom. All in all, the increase in correlation of 0.1 (= 0.5 – 0.4) is an overestimate of the effects independent of the stock swap.

It is important to note that the light blue and green lines in *Figure 4* – which show the evolution of the correlation between OTP and Magyar Telekom and Mol and Magyar Telekom – do not show a cascading pattern following the stock swap agreement. By contrast, the dark blue line depicting the correlation between OTP and Mol is clearly cascading. We interpret this finding as a sign of a regime switch triggered by the stock swap. Our interpretation is confirmed by the fact that, according to *Figure 4*, all three time series of the correlations moved closely together in 2008. This shows that Magyar Telekom's returns also closely followed those of OTP and Mol when country-specific risk increased in the run-up to the autumn of 2008. However, the correlation increase after the share swap only occurred between OTP and Mol, while the correlations related to Magyar Telekom did not change similarly. This suggests that the jump in the correlation between OTP and Mol was not the result of a general, country-specific shock, but rather specifically the effect of the share swap.

Let us turn to the discussion of the so-called mechanical effect (ME). We can quantify this by calculating how much correlation would have increased between two portfolios if the initial portfolios had only contained OTP and only Mol shares, respectively, while the final portfolios had also included OTP and Mol shares according to their shares involved in the stock swap. Thus, the initial weights are (100%; 0%) and (0%; 100%). The final portfolios also include both OTP and Mol shares, in accordance with the cross-ownership ratios according to the swap transaction. Therefore, the final weights are close to the values (100% − 8.57%;

4.9%) and (8.57%; 100% − 4.9%).[28] Such a change in the composition of the two portfolios makes the correlation increase by no more than 0.13.

An increase of 0.13 is clearly an overestimation of the mechanically quantifiable effect of the stock swap, as it does not account for three specificities of the deal: 1) It ignores the fact that the Mol stocks involved in the swap had already been transferred to OTP before the swap; 2) and it also ignores the fact that the swap had a predetermined maturity date rather than being perpetual; 3) and that a pair of buyback options were also part of the agreement. Intuitively, each of the three ignored specificities would justify a correlation increase of less than 0.13.

Figure 4
Correlation between daily returns of OTP, Mol and Magyar Telecom
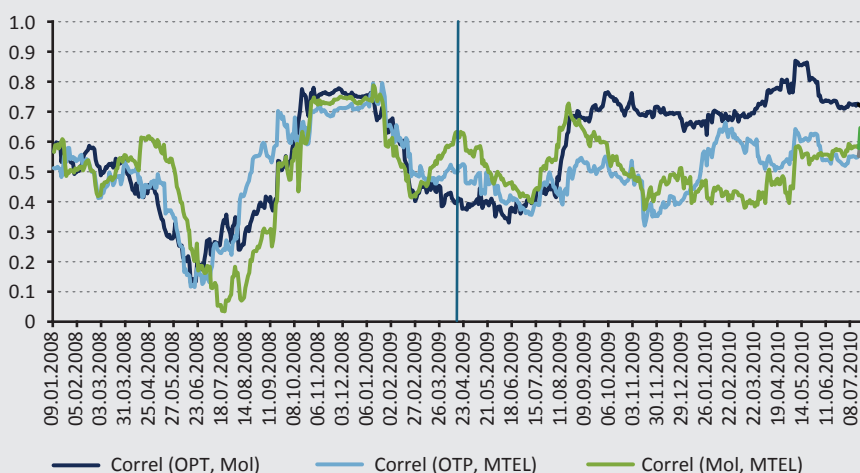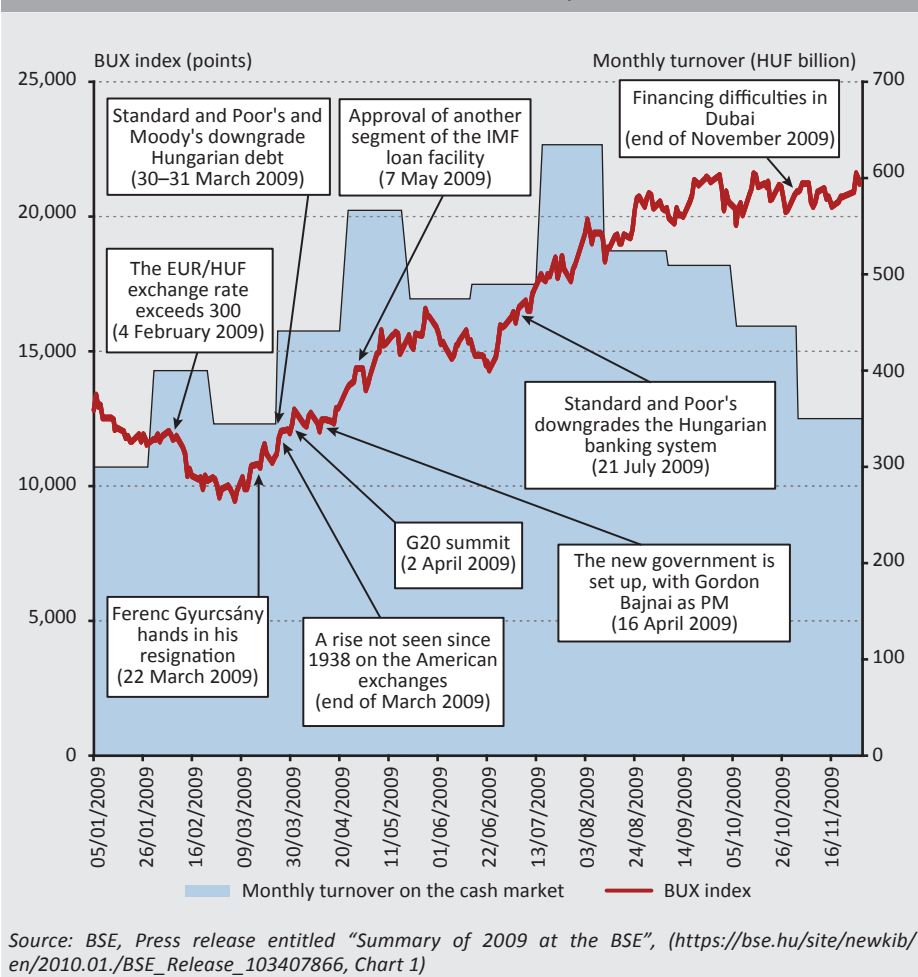

Note: The vertical line marks 16 April 2009 on which the Mol–OTP stock swap agreement was made. The correlations are calculated from the daily returns of the previous 60 days, which is why the correlation only jumped with a seemingly delayed effect compared to the announcement of the stock swap.

Source: Author's calculations based on closing prices published on the website of the Budapest Stock Exchange (BSE), (https://www.bse.hu/pages/data-download)

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[28] A somewhat more precise approximation of the corresponding weights in the first portfolio are (100% − 8.57% + 4.9%*8.57% − 4.9%*8.57%^{2} + 4.9%^{2}*8.57%^{2} − 4.9%^{2}*8.57%^{3} + …; 4.9% − 4.9%*8.57% + 4.9%^{2}*8.57% − 4.9%^{2}*8.57%^{2} + 4.9%^{3}*8.57%^{2} −…) ≈ (91.8%; 4.5%).

Figure 5
Evolution of the BUX index and cash market turnover, as a reflection of events in 2009

Source: BSE, Press release entitled "Summary of 2009 at the BSE", (https://bse.hu/site/newkib/en/2010.01./BSE_Release_103407866, Chart 1)

Finally, let us examine the third effect. We can express it by rearranging *equation (1)*:

$$SE = \Delta Corr - IE - ME, \qquad (2)$$

We can think of SE as that fraction in the increase in the correlation that is explained neither by the independent, nor by the mechanical effects.

The question arises as to what could have caused the unexplained part of the increase in correlation? Our answer is that it was the "strategic partnership" factor, the content of which is difficult to define. In relation to this, we could quantify its effect on the correlation only as a residual term. We found the residual term to account for at least 1/3 of the observed increase in the correlation (see *Table 1*).

Table 1

Correlations between daily returns calculated from the closing prices of OTP, Mol, and Magyar Telekom

	Mol–OTP	Mol–MTelekom	OTP–MTelekom
Correlations			
Minimum correlation before the 2008 financial crisis	0.13	0.12	0.04
Maximum correlation between end of 2008 and beginning of 2009, reflecting the impact of the financial crisis	0.78	0.79	0.79
Estimation with potential downward bias – before the full impact was realised of the OTP-Mol stock swap	0.4	0.4	0.4
Average after the OTP–Mol share swap*	0.71	0.51	0.49
Changes in correlation			
Estimation with potential downward bias of the correlation increment (ΔCorr) around the date of the stock swap	0.31		
Estimation with potential upward bias of the effect of factors independent of the stock swap (IE)	0.10		
Estimation with potential upward bias of the mechanical effect of cross-ownership (ME)	0.13		
Estimation with potential downward bias of the residual term, also called the strategic partnership effect (SE)	0.08		

*Note: * Average correlations between daily returns calculated from closing prices of 60 days between 28 August 2009 and 30 August 2010.*

What is the relevance of our findings to the composition of foreign exchange reserves and exchange rate volatility? First, we can conclude that the total effect of moving to a new regime of reserve policies can be twice as large, or even larger than what one can estimate by using either the balance sheet approach or data from the past two decades. Second, the example of the Mol–OTP stock swap also shows that even a relatively small shift in cross-ownership of, for example, 5–8 percentage points can induce significant changes in the correlation of returns. Analogously, a small additional decrease in the weight of the US dollar in global foreign exchange reserves could trigger a significant increase in the volatility of the US dollar's value.

6. Conclusion

In this essay, we first reviewed the risks described by *Rogoff* (*2025*) in his recently published book that could potentially threaten the primacy of the US dollar in the long term. We then explained what aspects of the problem make it difficult to

predict the future volatility of the dollar. Finally, we performed a qualitative analysis of the relationship between the volatility and the composition of foreign reserves using the analogy between the problem at hand and the empirical relationship between a stock swap agreement and the correlation of the stocks involved in the swap.

We concluded that the impact of a regime switch reflected in further changes in reserves on volatility may be substantially larger than the mechanically quantifiable effects. Furthermore, a surge in volatility could occur even with a small further decline in the USD share in reserves. One key aspect of our argument is that the composition of foreign exchange reserves indicates the intention and ability of central banks to stabilise the value of their domestic currencies, while the changing composition of reserves signals the shifting intentions and abilities.

This essay leaves some additional questions to future research. For example, the question of whether the faster changes in the financial architecture in the 21st century relative to that in the 20th century can accelerate the potential reordering of the significance of the major reserve currencies. It is also worth analysing how individual central banks adapt their foreign exchange reserve policies to changing geopolitical conditions.

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Trends, Tools, and Challenges: Artificial Intelligence in Marketing*

Gábor Kovács ⓘ

The authors of the book – Melinda Klausz, Viktória Sáringer, Kata Rózsa, and Zsófia Páczkán – are social media communications specialists who began their careers during the iWiW and MyVIP era, when they first developed marketing communications and advertising management for companies. In 2007, they founded their company, which now not only deals with advertising management and marketing communications but also chatbot development and application creation. Their work has been recognised with several awards from the Hungarian Marketing Association, and in 2022, the company won the title of 'Most Digital Domestic 'SME'. Their professional focus is on marketing and business growth. Their business book, 'AI Marketing: How to Use Artificial Intelligence for Business Growth', was published in Veszprém in 2025 by Klausz Social Group Kft. This work presents the relationship between artificial intelligence (hereinafter referred to as 'AI'), a rapidly evolving and increasingly popular field, and marketing communication, emphasising the related opportunities for business growth. Their target audience is primarily employees who are concerned about how the new technological era brought about by AI may transform or even threaten their jobs. By sharing their extensive experience, they aim to provide support for the practical application of AI, the selection of appropriate AI platforms, and the customisation of related marketing strategies.

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In a brief introduction, the authors outline the book's potential target audience and address them directly. The introduction is followed by a presentation of the practical applications of AI, starting with its general positive effects, such as performance enhancement and faster processing of large databases. Next, we are introduced to the basic concepts used in the field, followed by detailed instructions on prompt creation. Moving on to the connections with the marketing profession and a comparison of offline and online marketing tools, emphasis is placed on the important elements of the latter (online), such as data-driven decision-making, trend recognition, real-time data processing, and the automation of marketing campaigns. Several case studies are also presented on how large companies – such as Netflix, Coca-Cola, and Nike – have used AI for product development or to boost user engagement. Another chapter examines the personalisation of customer experience, from data collection to performance measurement. The authors then describe AI tools for campaign management, from testing and analysis to reporting. They focus separately on the successes and pitfalls of AI-based customer services, as well as the future of the profession and the possible tools associated with it. The following sections present trends, concepts, and tools.

One particular strength of the book is that it presents the most widely used AI tools, including ChatGPT, DeepSeek, and Copilot, along with their unique features and most important areas of application. *ChatGPT* is an AI-based chatbot developed by OpenAI that can answer complex questions, write creative text, and simulate conversations. Its applications in marketing include content creation, social media posts and campaigns, customer support, e-mail marketing, and personalised messages. It also plays a role in SEO (search engine optimisation[1]), a crucial step in which is keyword research, as well as market research, advertising campaigns, customer feedback analysis, customer service support, and competitor analysis. ChatGPT supports marketers' work, accelerates processes, and enables better results to be achieved. *DeepSeek* is a China-based artificial intelligence software company that strives for cost- and energy-efficient solutions. Its system can autonomously develop its problem-solving abilities. While it is more affordable for users, there are still unresolved issues in data management and storage. From a marketing perspective, it can be used primarily for data collection, SEO, content creation, automated analysis, interactions, and communication. Its main focus is on market research and data collection, while ChatGPT concentrates more on content generation and interactive dialogue. *Copilot* is an AI-based assistant developed by GitHub and Microsoft, aimed at increasing work efficiency. It is primarily used as a code completion and generation tool. However, it can also be beneficial for

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[1] Its objective is to elevate a website or its content as high as possible, ideally to the top of the search results list among organic, i.e. unpaid search results. This increases the visibility and traffic of the website, generating free traffic.

marketing experts, for example, in keyword research, competitor analysis, campaign idea generation, website and content optimisation, social media monitoring and analysis, influencer and partnership research, content strategy and campaign planning, and email marketing. Its primary purpose, however, is to support developers and expedite coding processes.

The book also highlights the possibilities for corporate use, detailing and presenting the integration of AI into corporate processes step-by-step, and finally, addressing unresolved issues such as copyright, data protection, and counterfeiting, as well as the future role of artificial intelligence in digital marketing.

As a reader, I particularly appreciated the emphasis in the introduction on the important point that AI tools are indeed *tools* that must be used appropriately to increase productivity. Another positive aspect was that the book provides detailed, yet easy-to-follow insight into background knowledge and various areas of application. The capabilities and practical application opportunities of each tool are presented in sufficient detail. However, given the dynamic developments in this field, the question arises as to how long the information provided will remain relevant, especially since the book was published in March 2025. The situation is well illustrated by the fact that the fifth version of ChatGPT, the most widely used AI tool, was released just five months later. This highlights that no matter how hard a printed publication strives to provide up-to-date information, technological upgrades will always be faster. Therefore, those working in this field must constantly monitor industry developments and cannot be satisfied solely with the knowledge provided by a newly published book.

The use of artificial intelligence, however, not only has advantages, but also presents challenges. While it is necessary to keep up with the constant changes in the world of AI, a significant proportion of copyright issues have yet to be resolved. Keeping pace requires proactive thinking to ensure that artificial intelligence does not take precedence over humans. It is important to emphasise the necessary separation of AI and human factors, as opinions, insights, and values can only be incorporated into work processes through human involvement.

In summary, the book presents the relationship between artificial intelligence and marketing, with a particular focus on the opportunities for business growth. It provides a detailed overview of the most well-known AI tools, such as ChatGPT, DeepSeek, and Copilot, as well as their areas of application. It focuses on content creation, social media campaigns, email marketing and market research. It places great emphasis on personalising the customer experience, from data collection to performance measurement. It introduces AI tools for campaign management and the processes of testing, analysis, and reporting. A separate chapter deals with the

advantages and pitfalls of AI-based customer services and their future role. The text explains the concepts understandably, making it useful reading for both laypersons and professionals. One of the central messages of the book is that AI tools are indeed tools that must be used consciously to increase productivity. One criticism that could be levelled at the book is that, despite its well-structured themes and numerous practical examples, the analyses are sometimes more descriptive than interpretative in terms of depth and detail.

Report on Some of the Sessions of the Hungarian Economic Association Congress 2025*

Ferenc Tóth ⓘ *– Benjámin Nagy* ⓘ *– Emese Kreiszné Hudák* ⓘ *– Ágnes Nagy* ⓘ

On 4–5 September 2025, Veszprém hosted the 63rd Annual Congress of the Hungarian Economic Association, which is one of the most significant traditions and largest annual conferences of the Hungarian economics community. Mihály Varga, Governor of the Magyar Nemzeti Bank, gave a presentation at the opening plenary session. In this report, we provide an account of the panel discussions on the banking system, stagflation, post-pandemic inflation, competitiveness and innovation.

Roundtable discussion of bank leaders

One of the most prominent, and most popular sessions, the *Roundtable Discussion of Bank Leaders* panel discussion[1], had the theme "A financially strong banking system: we have fuel, but do we have a roadmap?". *Pál Péter Kolozsi*, General Deputy CEO of the Government Debt Management Agency, gave a welcoming speech as President of the Finance Section of the Hungarian Economic Association (HEA).

This was followed by a roundtable discussion moderated by *Zoltán Kurali*, Deputy Governor of the Magyar Nemzeti Bank (Central Bank of Hungary, MNB), with participants including *Ádám Egerszegi*, General Deputy CEO for Digitalisation and Operations at MBH Bank Nyrt., *Éva Hegedüs*, Chair and CEO of GRÁNIT Bank Nyrt. and Secretary General of the HEA, *Radován Jelasity*, Chair and CEO of ERSTE Bank Hungary Zrt. and President of the Hungarian Banking Association, *Pál Simák*, Chair and CEO of CIB Bank Zrt., and *László Wolf*, Deputy CEO of OTP Bank Nyrt., Vice-President of the HEA.

The panel discussion commenced with questions set for the audience. *Zoltán Kurali* initiated the session by asking participants about the potential risks that could

[1] Available on the HEA's YouTube page (in Hungarian): https://www.youtube.com/watch?v=T3cLg6qSo6U

shape inflation and economic growth in Hungary in the near term, prospective developments in housing prices, expectations regarding the forint–euro exchange rate, and the level of deposit interest rates at which individuals would be willing to place their savings with banks. A significant share of responses indicated that housing prices were expected to rise by an average of 15 per cent over the next year, the forint was anticipated to depreciate slightly against the euro, while the most influential risk factor was perceived to be the persistence of slower decreasing inflation expectations.

Zoltán Kurali opened the panel discussion by addressing recent trends in bank lending, noting that the Hungarian credit market was characterised by a dual structure: while household lending – particularly in mortgage loans and personal loans – had exhibited double-digit growth, corporate lending had expanded only moderately. Demand was not confined exclusively to subsidised schemes, although these had played a decisive role over the past decade.

Ádám Egerszegi observed that, within corporate lending, investment loan volumes had not increased, despite the availability of funding sources. Instead, demand had mainly been directed toward working capital financing. Foreign currency lending occurred only when borrowers possess foreign currency revenues. An upturn in investment loan activity was expected in connection with agricultural support programmes.

Zoltán Kurali emphasised that, in order to stimulate corporate lending, the Magyar Nemzeti Bank had launched the Certified Corporate Loan (CCL) product. This initiative enabled a broad range of SMEs to access market-based investment loans with standardised, transparent, and efficient procedures at favourable pricing. Through the CCL certification, the MNB was able to promote sustainable, market-based lending without central bank financing or macroeconomic side effects. This meant that CCLs did not appear on the MNB's balance sheet; their objective was to provide investment funding through simplified documentation, competitive conditions, and expedited approval processes.

Several participants concurred that the *Home Start* housing loan programme was expected to stimulate demand in the mortgage market. The Home *Start* scheme could trigger substantial loan disbursement in a short period, accompanied by rising real estate prices. *László Wolf* noted that OTP Bank anticipated HUF 1,400 billion in total loan disbursements across the sector by the end of next year as a result of the programme. Recent housing price appreciation had primarily been driven by investment-oriented purchases and transactions in the secondary market, given the decline in new housing developments. The programme's impact mechanism was likely to be most effective if it succeeded in catalysing new construction.

In the context of the programme, the central bank had reviewed the adequacy of its macroprudential instruments concerning the domestic real estate and mortgage loan markets. Starting from January 1, 2026, a 1 per cent systemic risk buffer would also apply to exposures secured by both residential and commercial real estate. At the same time, to support the smooth functioning of lending processes, the central bank had abolished the age restriction associated with the own-equity requirement for first-time homebuyers.

The Home Start loan programme was expected to further boost the market activity, as evidenced by the robust demand: housing searches had increased by 90 per cent, and thousands of loan calculations were already being generated daily with the assistance of artificial intelligence. The share of housing loan portfolio overdue for more than 90 days remained below 1 per cent, indicating favourable credit quality. *Éva Hegedüs* highlighted that, compared to other EU member states, the ratio of household loans to GDP in Hungary was still low, suggesting room for further growth.

In recent months, the share of euro-denominated household savings had increased. A growing proportion of households' wealth had been invested directly or indirectly (via investment funds) in foreign currency assets. However, foreign currency investments had not yielded higher returns: in the case of equities, government securities and investment funds, forint-denominated assets had performed better.

The MNB would soon be launching a new publication entitled the *Savings Report*, providing a long-term analysis of savings yields. The report aimed to inform households and market participants about domestic saving trends, highlighting deeper macroeconomic relationships and providing information for making optimal savings decisions. Interestingly, while the euro and the European Central Bank were viewed positively among the Hungarian population, EU institutions more broadly tended to receive critical assessments. Regarding the optimal timing of euro adoption, *Zoltán Kurali* emphasised that such a step should be taken when the economic environment permits, rather than under conditions of compulsion.

In 2025, growth in the savings market was expected to moderate relative to the previous year. The volume and share of government securities had increased significantly, while bank deposits had expanded only slightly, accompanied by increased outflows to the Hungarian State Treasury. Investment funds had also gained in popularity.

The profitability of the Hungarian banking system had been extremely high over the past decade, supported by a favourable interest rate environment, prudent lending practices and minimal impairment ratios. The sector continued to exhibit strong

profitability, abundant liquidity and robust capitalisation, resulting in outstanding shock resilience.

Banks had adopted more conservative lending practices than in previous years, while digitalisation and the application of artificial intelligence had enhanced cost efficiency. Several participants noted that Revolut had emerged as a major competitor in recent years, setting new standards with its flexible business model, albeit operating under different regulatory conditions than domestic banks. In foreign exchange services, several Hungarian financial institutions had already developed competitive offerings.

For the banking sector, cost pressures represented the biggest challenge: digitalisation, ATM network maintenance and expansion, and cybersecurity investments required significant resources. The tax and regulatory environment also imposed a considerable burden. The sector had committed not to pass inflationary effects into the retail fee structure until mid-2026.

Radován Jelasity underlined that artificial intelligence posed a significant challenge, but also created new opportunities for banks. In the long term, the interplay of international competition, regulatory compliance and cost control would define the scope of action for the domestic banking system.

Fighting the wave of inflation after the pandemic

The Monetary Policy session focused on the varying trajectories of the inflationary wave following the coronavirus pandemic[2] and how central banks in the euro area member states and countries using their own currencies in the Central and Eastern European region had dealt with it. The session was opened by *Előd Takáts*, Chairman of the Monetary Policy Section of the HEA, Deputy Head of Secretariat of the Committee on the Global Financial System at the Bank for International Settlements (BIS) and Visiting Professor at the London School of Economics and Political Science (LSE). In his opening speech, he stressed the importance of the topic of the session, since, as he said, stable and low inflation was the cornerstone of sustainable growth, and the experience of regional countries with similar historical backgrounds, structural conditions and facing similar economic challenges, could be particularly useful for the Hungarian economics profession, especially in the context of the assessment of the euro area membership.

In his opening speech, *Martin Reiner*, Executive Director of Národná banka Slovenska, examined the effectiveness of the central banks of the Visegrád countries in fighting inflation in recent years in the light of the different monetary policy

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[2] Available here (in English): https://www.youtube.com/watch?v=zWNWREtq5hM

regimes applied. He highlighted that the higher-than-European-average price increases experienced by the region's economies in 2022 and 2023 had been driven by high exposure to the fragmentation of global value chains and the energy price boom, the greater weight of energy and food in the consumer basket and stronger domestic demand pressures, due to very tight labour markets and less intense competition. He also pointed out that central banks in the countries with independent monetary policies in the region – Hungary, the Czech Republic and Poland – had reacted more quickly to the surging inflation, starting their interest rate hike cycles almost a year earlier than the European Central Bank, but they had to raise their policy rates to substantially higher levels. However, despite the faster and more intense monetary policy response, Slovakia, a member of the euro area, had experienced lower price increases, which might be due to the weakening effect of fiscal policies on monetary transmission in the three non-euro area countries and, in this context, to looser financial conditions. He stressed that, while comparable international data were not available, the use of the euro may have contributed significantly to anchoring inflation expectations and thus curbing price increases, and that the stability of the euro exchange rate might have led to a significantly lower imported inflation effect. In terms of the economic policy mix, he highlighted that while fiscal and monetary policies had typically been both countercyclical before the coronavirus outbreak, fiscal policies had remained loose in many countries after the pandemic, making it difficult for central banks to achieve their price stability objective. He concluded that the euro was an effective macroeconomic stabilisation instrument, but not an instrument for real convergence, which was not determined by the monetary regime but rather by the productivity-enhancing effects of private and public investment, the quantity and quality of labour, and an efficient and secure institutional environment. He also pointed out that small, open countries had *de facto* limited monetary sovereignty in the global economic space.

Gergely Tardos, Director of the OTP Bank's Research Centre, and *György Szapáry*, Chief Advisor to the Governor and former Deputy Governor of the Magyar Nemzeti Bank, joined the roundtable discussion following the presentation. The discussion was moderated by *Ádám Banai*, Co-Chairman of the Monetary Policy Section of the HEA, Chief Economist and Executive Director at the Magyar Nemzeti Bank.

As a prelude to the discussion, *György Szapáry* examined the catching-up of the Central and Eastern European countries, which had previously operated within the framework of the socialist planned economy and had later joined the European Union, from 1990 to the present day in the light of the monetary policy regimes chosen by each country, the accession to the euro area and central bank independence. He said that, among the countries studied, central bank

independence had played a significant role in the long run in terms of nominal convergence, i.e. bringing down of inflation, among other factors, while it had been an even more dominant factor in terms of real convergence. He stressed that this not only meant that the credibility of central banks and the effective anchoring of inflation expectations was a key determinant of real convergence, but that it also reflected democratic functioning, the rule of law, trust in institutions and general confidence in the economy. He noted that, in addition to indirectly contributing to the improvement of the institutional environment and external perception, joining the euro area also gave a small, open economy greater resilience to crises. He identified the creation of a capital markets union as the next important step in European economic integration.

Gergely Tardos explained that, in his view, an autonomous monetary policy with a floating exchange rate – besides being the most effective shock absorption mechanism – played a decisive role in the development of inflation in the short run, as evidenced by the higher depreciation of the forint compared to the region in recent years and the higher domestic price increase rate. He added that the euro area as a monetary union had evolved in many respects, having learned the lessons of the 2008 global financial crisis and the sovereign debt crisis, and its functioning had been complemented by new institutional mechanisms, making it even more attractive for Hungary to join. Turning to inflation developments in the region, he said that in the short term, disinflation might continue in some countries, but in the longer term, tight labour markets, dynamic wage growth, increasing trade fragmentation and the growing likelihood of external supply shocks all pointed to a higher price dynamic environment.

Martin Reiner added that, beyond monetary policy integration, the euro area had also made much progress in the area of the regulation and supervision of the banking system since the European sovereign debt crisis. The Single Supervisory Mechanism (SSM), established in 2014, had centralised bank-specific, microprudential supervision to a high degree, with the supervision of large European banks being carried out centrally, according to uniform procedures, while national authorities had strong powers in terms of macroprudential policy, which, in his opinion, was particularly important as it allowed for different responses to asymmetric shocks within the monetary union. He stressed that the success of the SSM was also demonstrated by the fact that the euro area banking sector had proved to be stable and resilient in the face of the series of crises in recent years. He considered the concept of a capital markets union to be a forward-looking initiative, but saw the biggest challenge in the much more risk-averse investment attitude of European savers compared to their American counterparts. In addition to changing this attitude, regulators could help deepen European capital markets

and expand the range of available asset types by strengthening private pension funds and encouraging securitisation.

Following the discussion, *Ádám Banai* concluded that catching up required a well-functioning, prudent and transparent economic policy institutional framework that enjoyed the confidence of economic actors, whether through an independent monetary policy or within the euro area.

Competitiveness and innovation: the key to success in times of great transitions

The Competitiveness session of the Congress[3] identified innovation as the key to success for Hungarian small and medium-sized enterprises (SMEs) in response to the challenges of the current great transitions. *Barnabás Virág*, Deputy Governor of the Magyar Nemzeti Bank, opened the session with a thought-provoking presentation entitled *"Successful SMEs in an era of transitions?!"*. The presentation gave an overview of the main trends shaping the global economy as well as the challenges these pose for Hungarian SMEs and presented the hidden champions of the Hungarian economy, innovation-driven Hungarian enterprises, as positive examples.

In his presentation, *Barnabás Virág* pointed out that the current great transitions in the global economy were leading to structural transformations, the combined effect of which was causing changes of unprecedented scale and speed. The great transition was currently taking place in at least five areas: technology, geopolitics, debt, climate change and demography. *Demographic trends* were reducing the supply side of the labour market, not only in developed countries anymore. Nowadays, countries with declining populations produced more than one-half of the world's economic output, and this share could rise to close to 90 per cent by the end of the century. After decades of stability, *geopolitics* had entered a more uncertain era, where trade and production chains needed to be rethought. In terms of *technological developments*, a paradox could be observed. On the one hand, technological developments seemed to be rapid, but productivity growth in the economy had slowed down. Economies and companies that were able to adapt faster to the spread of new technologies could gain a competitive advantage. Finally, globally rising *public debt ratios* limited the scope for government budgets to intervene to manage the other great transitions and cushion their effects.

All of these changes directly affected Hungarian small and medium-sized enterprises, which, as a result of the above, were simultaneously facing challenges caused by demographic constraints, a tight labour market, lower investment activity and high energy intensity. Demographic trends were reducing the working-age population:

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[3] Available here (in Hungarian): https://www.youtube.com/watch?v=z0wC8hsXKVY

members of the Ratkó generation born in the first half of the 1950s had gradually reached retirement age, and their numbers were significantly larger than the number of young people entering the labour market. Moreover, since the mid-2010s, labour market tightness had increased structurally in Hungary. Regardless of sector, it was becoming increasingly difficult for companies to replace their workforce. Large corporates typically had greater labour market absorption capacity than SMEs, as they were better able to retain their workforce during downturns and were able to generate higher average earnings than SMEs.

The productivity of Hungarian SMEs had improved significantly in the second half of the 2010s, but this process had slowed down in the early 2020s. The fragmented corporate structure might also play a role in this, which also put productivity at a disadvantage when applying new technologies. Harnessing collaborative resources offered a significant competitive edge in boosting innovation. In terms of digitalisation, less than one-fifth of Hungarian SMEs currently used some kind of advanced digital solution, which was lower than the 26 per cent rate for EU countries. Effective use of artificial intelligence (AI) required a higher level of preparedness than today, also in terms of innovation, human capital and the regulatory framework. Hungary and the EU as a whole were not doing well in terms of venture capital and innovation finance, which was holding back innovation.

Barnabás Virág presented the main characteristics of successful Hungarian-owned, innovation-driven enterprises (HIDE)[4] and the key factors behind their success. Companies were considered to be HIDEs that had some kind of innovation effort or achievement (e.g. a patent), were in a fast-growing status, or had a strong export performance. In its research, the MNB had identified around 1,100 innovation-driven companies, which accounted for only 0.3 per cent of all operating Hungarian companies, but 13 per cent of total gross exports and 23 per cent of annual domestic GDP growth in Hungary. Regardless of sector, these hidden champions all had higher labour productivity, on average 40 per cent higher than other companies in the sector; thus, they had significant potential for productivity gains at national economy level. Among innovative companies, four factors increased the likelihood of rapid growth: (1) the hiring of highly skilled workers; (2) the technological level of the corporate infrastructure; (3) export intensity, as the competitive situation in international markets encouraged greater innovation activity; and (4) access to external financing.

Virág concluded that the key to development was adaptation to change. Hungarian businesses could be successful in the long term if they were the quickest to adapt to changing circumstances in an era of great transitions.

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[4] Hungarian Innovation Driven Enterprises, HIDE

The panel discussion following the opening presentation was moderated by *Gergely Baksay*, Executive Director of the Magyar Nemzeti Bank, Chairman of the Competitiveness Section of the HEA. The participants of the roundtable discussion were *Zoltán Birkner*, Chairman of the Board of Trustees at the Pannon University Foundation, Co-Chairman of the Hungarian Association for Innovation, *László Bódis*, Deputy State Secretary for Innovation of the Ministry of Culture and Innovation, CEO of the National Innovation Agency, *Roland Jakab*, CEO of the HUN-REN Hungarian Research Network, President of the Artificial Intelligence Coalition, and *Gábor Kerékgyártó*, Chief Economist of the Hungarian Chamber of Commerce and Industry (HCCI).

At the beginning of the discussion, the participants reviewed the main challenges facing Hungarian SMEs. *Gábor Kerékgyártó* said that Hungarian businesses were a very heterogeneous group, and in the current economic situation, SMEs producing for domestic consumption were in a more favourable position, while companies that were more integrated into the global value chain were in a more difficult situation. Since the democratic transition, one of the strengths of the SME sector had been its adaptability. However, one challenge for the ongoing generational change was that the management of SMEs was often not seen as an attractive career for young people.

Participants in the panel discussion also explored the meaning of the concept of innovation. According to *Gábor Kerékgyártó*, innovation meant satisfying consumer needs at a higher level, whereby either the quality improved or the price became more favourable. *László Bódis* said that one direction of innovation could be companies bringing new products to the market, while the other direction was business process innovation, as the application of new technologies was as important as the introduction of new products and was a much more relevant opportunity for Hungarian SMEs. In this context, he presented the results of their joint research with the Hungarian Central Statistical Office. According to the results, one-third of the Hungarian corporate sector innovated, and these companies were 58 per cent more efficient and profitable, and paid on average 31 per cent higher wages due to efficiency gains, exported 90 per cent more, and employed 2.5 times more people. These characteristics applied not only to large companies, but also to small and medium-sized innovative enterprises. *Roland Jakab* added that innovation always started from basic research, but there was a long way to go between basic research and innovation. To do this, researchers needed to be supported to ensure that those who want to innovate have the necessary resources, the best infrastructure and technological tools, as well as training. The innovation value chain had to be systematised to achieve the best impact. In defining innovation, *Zoltán Birkner* quoted Schumpeter, who called innovation the ability to do things differently.

In Hungary, universities could be a catalyst for innovation. *Zoltán Birkner* said that the innovation space was typically born in two places: in the research centres of large companies and in universities. In Hungary, there were very few large Hungarian-owned companies that employed large numbers of researchers; accordingly, Hungarian universities with specialised knowledge were more likely to be a source of innovation. The best place for the state to achieve results with its own resources was at the university level.

The panellists also reviewed the relationship between R&D expenditure and the number of patents and their characteristics in Hungary. *László Bódis* said that in 2024, Hungary had spent HUF 1,066 billion on research and development: one-third of this had been provided by the state and two-thirds by companies, including mainly multinational companies with international ownership. Typically, these companies did not file their patents in Hungary but in the country of origin, where the result of their research was published as a new patent. However, it was encouraging that the number of new patents filed had risen to nearly 600 last year, compared to the typical range of 400–450 over the past six to ten years. The surge had been linked to new patents in the university and research institute sector. The real challenge was how much of this could be converted into economic benefits in the long term. *Zoltán Birkner* said that it was a very long process to realise revenue from filed patents.

The panellists discussed the impact that AI may have on corporate competitiveness and innovation. According to *Roland Jakab*, the megatrend was not the development of technology, but rather its accelerated speed. However, technology did not create value by itself; an appropriate framework and set of conditions had to be established for this purpose. An overhaul of Hungary's Artificial Intelligence programme had been announced in early September. The three focus areas in the strategy offered a comprehensive approach to maximise the social, technological and business impact of AI. According to *Gábor Kerékgyártó*, HCCI was active in bringing artificial intelligence to SMEs. As one of their key instruments, they had launched their "Digital Wake-up Call" programme, which aimed to enable entrepreneurs to try out AI tools in a safe environment with the help of a trainer, tailored to their own business tasks. *László Bódis* drew attention to the need to prepare the future workforce for the use of AI; therefore, students in public education, vocational training and higher education should also acquire the knowledge related to the use of AI.

At the end of the roundtable, the participants agreed that the development of the venture capital market was a key to accessing finance for innovative companies, which was a challenge not only for Hungary but for Europe as a whole.

Can stagflation be avoided?

The participants of the Macroeconomic Analysts' Forum of the 63rd Congress discussed the topic of stagflation in greater detail. The panel discussion entitled *"Can stagflation be avoided?"*[5] was moderated by *Péter Halmai*, academic, Professor at the National University of Public Service and the Budapest University of Technology and Economics, and President of the Economic Policy and Economic Theory Section of the HEA. The participants of the panel discussion were *András Balatoni*, Director of Economic Forecasting and Analysis at the Magyar Nemzeti Bank, member of the Board of the Economic Policy and Economic Theory Section of the HEA, *István Madár*, Senior Analyst at Portfolio.hu, member of the Board of the HEA, *Orsolya Nyeste*, Senior Macroeconomic Analyst at ERSTE Bank Hungary Zrt., and *Gergely Suppan*, Deputy State Secretary for Macroeconomic Analysis at the Ministry for National Economy.

In his thought-provoking presentation, *Péter Halmai* briefly introduced the origins of the concept of stagflation and the macroeconomic trends in the United States in the 1970s and drew a parallel with today. In the US in the 1970s, supply shocks, especially oil market shocks, stagnating inflation expectations, unions and labour market rigidities had led to the phenomenon of stagflation: inflation and unemployment rates had risen while GDP growth had stagnated. The central bank had responded to stagflation with aggressive interest rate hikes and had recognised the importance of inflation expectations and credibility, establishing the system of inflation targeting that had resulted in a monetary turnaround in economic paradigms. The system of inflation targeting had proved effective since the 1980s and had led to a period of great moderation, with improved stability and high growth. The situation had really started to change in the 2020s as a result of the permacrisis, including the Covid crisis, supply shocks like those of the 1970s, as well as current trade policy shocks and general uncertainty. The current high inflation rates and slowdown in growth could thus be compared to the 1970s, and it was worth examining the risk of stagflation, what factors were at play in today's developments and what could help to avoid stagflation.

The panellists agreed that there were indeed parallels between today and the 1970s, but one significant difference was that in the 1970s, there had been no central banks with a price stability mandate independent of the government as there were today. *András Balatoni* pointed out that the stagflationary crisis of the 1970s had mainly been in the Anglo-Saxon countries, especially in the US, to which, in addition to institutional factors, the high nominal wage growth rate and inadequate economic policy responses had contributed significantly. Indeed, Nixon's New Economic Policy

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[5] Available here (in Hungarian): https://www.youtube.com/watch?v=8HWTyejCNbo

programme announced in 1971 had included a number of price restrictions, which had been circumvented by companies; thus, inflation and the inflation expectations of economic agents had remained at persistently high levels and fears of stagflation had been prolonged. According to *Orsolya Nyeste*, the Fed had then prioritised inflation over growth by raising interest rates, which had come at a great cost to growth, such as rising unemployment. On the contrary, as *Nyeste* and *Balatoni* mentioned, the growth sacrifice and social costs of disinflation in the 2020s had been much lower than during the disinflation of the 1980s, thanks to the credibility of central banks. *István Madár* and *Gergely Suppan* noted that the US was currently facing a stagflationary situation, which could become permanent if it was built into expectations in the long run. In his view, however, the European Union was not threatened by stagflation, but rather faced competitiveness problems. He also drew attention to the fact that there were a number of trends occurring today (e.g. war, price rises due to climate change) that were different from those of the 1970s.

When asked about the current processes affecting stagflation, the experts mentioned several cyclical and structural factors. They agreed that major global trends, such as demographic trends, technological change, the green transition, rising public debt and deglobalisation, had a significant impact on today's economic developments, including stagflation. The unfavourable demographic trends in Western countries were causing labour markets to tighten, due to the declining working-age population. *András Balatoni* also pointed out that there were lower and higher inflation regimes and shocks in economies. In a low-inflation climate, sector-specific shocks faded away and did not cause general inflationary pressures. It was therefore the task of the central bank to create this climate, which it could achieve primarily by anchoring inflation expectations and communicating transparently. Among global trends, the director of the MNB pointed out that in previous decades, globalisation and expanding world trade had moderated inflation, while today's deglobalisation processes, rising tariffs and deteriorating demographics were expected to have the opposite effect. *Orsolya Nyeste* also underlined the role of fiscal policy, as consistency between monetary and fiscal policy was essential for keeping inflation under control. *István Madár* also stressed the importance of fiscal policy, especially in the context of increased public debt, and drew attention to the phenomenon of financial repression, which was evident in several countries, but its effectiveness was questionable. He also drew attention to the fact that the efficiency-enhancing impact of technological upgrades and artificial intelligence was still questionable, in contrast to the efficiency gains seen in the 1970s, when economic agents had responded to cost shocks by significantly improving energy efficiency.

In addition to an overview of global developments, the panel discussed factors in Hungary that may amplify stagflationary risks. *András Balatoni* highlighted some structural weaknesses that had become increasingly apparent in recent times

as inflation had risen. He cited, for example, the low energy efficiency and low productivity of companies and drew attention to the importance of restoring balances and lowering inflation expectations. Among the specific features of Hungary, *Orsolya Nyeste* cited the high expectations related to food prices and, in this context, the low productivity of the Hungarian food industry, which was one of the lowest in the EU. According to *Gergely Suppan*, the Hungarian economy was not currently experiencing classic stagflation, as real wages and consumption were both rising, while the economy was being restrained by a lack of investment and external demand and currently by drought. In the latter context, he emphasised the vulnerability of Hungarian agriculture, highlighting the increasing importance of irrigation. The Deputy State Secretary also drew attention to the EU's over-regulation and the weaknesses of the European automotive industry as negative factors.

The discussion also covered factors and measures to avoid stagflation. The experts all agreed that increasing efficiency and productivity was essential not only to avoid stagflation, but also to effectively address global challenges. *Gergely Suppan* drew attention to the productivity gap in the national economy, in particular the need to address the corporate duality, as domestic SMEs continued to lag behind not only domestic large corporates but also foreign SMEs. In their case, it was important to promote generational change and digitalisation, which required appropriate funding, including venture capital and subsidies. He also stressed the need to improve entrepreneurship, increase agricultural irrigation, improve the energy intensity of the economy, especially in the food industry, and modernise household energy efficiency. *István Madár* highlighted the restoration of macroeconomic stability as the first priority to avoid stagflation, through monetary policy aiming at price stability and economic policy aiming at improving competitiveness. He also drew attention to the need to strengthen competition and an efficiency- and growth-oriented approach. *András Balatoni* saw innovation as the main way to boost productivity, but he also highlighted the importance of targeting the top of production chains, of strengthening innovation ecosystems around universities and of venture capital financing. *Orsolya Nyeste* also stressed the importance of stability and added that more emphasis should be placed on improving the productivity of SMEs when using EU funds. She also called for the development of human capital, especially in the light of demographic trends, which could be helped by increased spending on education and health.

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Manuscripts should be submitted in accordance with the following rules:

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- The unnumbered footnote of the author's name contains his/her position, the institution the author works at, his/her email address and any other relevant information and acknowledgment regarding the article.
- Papers always begin with an abstract which should not exceed 800–1,000 characters. In the abstract a brief summary is to be given in which the main hypotheses and points are highlighted.
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- Manuscripts should be written in clear, concise and grammatically correct Hungarian and/or English. Chapters and subchapters should be bold.
- Manuscripts should contain the list of references with the first and surname of the authors (in case of non-Hungarians the initials of the first name is required), the year of publication, the exact title of the book, the publisher, the place of publication. In case of papers, the exact title of the journal, the year, the volume, and the pages should be indicated. References in the text should contain the surname and the year. When citing the exact page should be indicated.
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