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# C O N T E N T S

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# Revisiting the Consumption-Wealth Nexus: A Nonparametric Exploration

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**ABSTRACT**
This study investigates the relationship between non-durable consumption and asset prices in 12 developed and 11 emerging economies, members of the European Union, emphasising the presence of nonlinearities through a nonparametric framework. Utilising the Categorical Regression Splines (CRS) approach, the analysis challenges traditional parametric models by allowing data to dictate the functional form of the relationship. The findings reveal distinct consumption-wealth dynamics: income remains the key driver in the emerging economies sample, with stock market fluctuations exhibiting potentially non-linear effects. Furthermore, consumption is primarily income-driven, with housing wealth playing a more pronounced role due to less-developed mortgage and financial markets in these emerging economies. Money wealth effects vary in significance, depending on the economic context and time period. These results underscore the advantages of nonparametric methods in accurately capturing complex economic relationships, providing insights for policymakers in designing effective strategies to support household consumption and economic stability.

**Keywords:** *non-durable consumption, asset prices, nonparametric analysis, Categorical Regression Splines*

**JEL Classification:** C22, C53, E21

## INTRODUCTION

The relationship between non-durable consumption and key macroeconomic variables, such as income, wealth, and interest rates, is central to understanding household behavior and macroeconomic dynamics. Although durable consumption may reveal more information about periods of economic expansion or downturn, analysing semi-durable and non-durable consumption is essential, as it can give a comprehensive understanding of the overall consumption patterns and their role in evaluating economic stability and resilience.

Non-durable consumption, which includes recurring expenditures like food and utilities, constitutes a stable component of aggregate consumption and serves as a reliable indicator of household well-being and financial resilience during periods of economic turmoil (Funke, 2004; Peltonen, 2012; de Bondt et al., 2019). During economic distress, households adjust their non-durable consumption patterns not only based on income but also changes in their asset values, reflecting their perceived wealth (Arellano et al., 2017; Coskun et al., 2022). These adjustments, however, may not always follow a linear trend, as suggested in much of the existing literature.

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Although numerous studies have examined the linear relationship between consumption and wealth, many fail to assess whether this specification appropriately captures potential nonlinearities (Casni, 2018; Nicolau, 2020; Singh, 2022, among others). Research employing non-linear frameworks has demonstrated their capacity to uncover turning points and structural breaks in these relationships, offering valuable supplementary insights (Racine and Nie, 2011; Ma and Racine, 2013; Bernard et al., 2015; Baker & Yannelis, 2017). By allowing for a flexible analysis, these methods challenge conventional assumptions and reveal particularly relevant nuances during periods of economic distress.

This paper aims to contribute to the literature by analysing the functional shape of the relationship between non-durable consumption, household wealth components (such as housing and stock prices), and interest rates in developed European and emerging economies. A key focus is uncovering nonlinearities and regime shifts in the consumption-wealth nexus. Using a flexible, nonparametric approach, precisely the Categorical Regression Splines (CRS) method proposed by Racine and Nie (2011) and Ma and Racine (2013), this study explores whether the relationship diverges from linearity and identifies potential turning points.

Beyond methodological innovation, this study provides novel empirical evidence by disaggregating household wealth and examining its influence on non-durable consumption. The analysis spans two subsamples, covering the first quarter of 2000 to the fourth quarter of 2019, and focuses on periods of economic distress while excluding the exceptional disruptions caused by the COVID-19 pandemic. This temporal segmentation enables a more precise assessment of the dynamics during economic turmoil.

Moreover, this paper identifies differences between developed and emerging economies when defining the relationship between non-durable spending and its main determinants, shedding light on the adjustments of household non-durable spending to changes in financial conditions. Understanding these variations is essential for policymakers to design tailored macroeconomic stabilisation and stimulus measures, particularly in economies experiencing pronounced asset price fluctuations.

The remainder of the paper is structured as follows. The next section reviews the relevant literature on the relationship between consumption and wealth in developed and advanced economies. The following two sections detail the data and subsamples used in the analysis and the identification strategy, and place the research question within existing theoretical frameworks. The results and their implications are discussed in a separate section, followed by conclusions, policy recommendations, and avenues for future research.

## LITERATURE REVIEW

The wealth effect is a key indicator in economic theory, with an increasing interest in understanding how changes in wealth influence household consumption. While some economists argue that increased wealth significantly boosts spending and consumer confidence, others suggest that such effects are limited unless households transform their assets into liquidity, either by selling them or borrowing against them (Aruoba et al., 2019; Kaplan et al., 2020; Cocco et al., 2020; Aruoba et al., 2022). In other words, perceived increases in wealth may not directly stimulate consumption unless they translate into available resources. Despite varying views, growing empirical evidence supports a positive relationship between rising asset values and household consumption, with ongoing discussions about its magnitude and mechanisms.

In theoretical terms, the relationship between consumption and wealth is grounded in the life-cycle hypothesis (Ando and Modigliani, 1963) and the permanent income hypothesis (Friedman, 1957), both of which suggest that individuals smooth consumption based on their expected lifetime resources. However, these models typically assume a simplified and homogeneous consumption-wealth nexus. Over the recent decades, the empirical adaptation of these models has

revealed heterogeneities across types of assets considered as measures for wealth, as well as across samples and periods analysed.

While financial wealth, such as equity, may dominate household asset portfolios in developed economies, housing wealth typically constitutes a larger share of household assets in emerging economies (Singh, 2022). This composition matters because different asset classes influence consumption through distinct channels—e.g., housing wealth may affect consumption indirectly via collateral or expectations about future income, while financial wealth can be more easily transformed into liquidity (Sousa, 2009; Cocco et al., 2020).

These asset-based differences are further amplified by institutional factors. Developed economies typically feature robust financial systems, which enable greater asset liquidity and diversified investment opportunities, thereby enhancing the transmission of wealth effects into consumption (Rodil-Marzabal and Menezes-Ferreira-Junior, 2016; Kaplan et al., 2020). By contrast, emerging economies often have less-developed financial markets, limited access to credit and mortgages, and stronger precautionary saving motives—all of which may weaken or distort the expected impact of wealth on consumption (Ciarlone, 2011; Peltonen et al., 2012).

Therefore, comparing these two groups of countries is not only empirically insightful but also necessary from a theoretical standpoint, as it reveals how institutional factors and asset categories mediate the transmission of wealth effects into household consumption behaviour.

This theoretical divergence across asset types and institutional settings has motivated a growing body of empirical research focused on the distinctive wealth effects across economies. Empirical studies have extensively analysed the wealth-consumption relationship using various methodologies, including cointegration analysis and nonlinear models. Cointegration studies, such as those by Lettau and Ludvigson (2004), Ciarlone (2011), and Singh (2022), among others, typically assume linear relationships and find stable long-term interactions between consumption, income, and asset wealth. However, linear model limitations emerge during economic downturns, where nonlinear responses are more appropriate.

Focusing on specific regions, Vizek (2013) found lasting consumption responses to housing market shocks in Central and Eastern European (CEE) countries. Recent studies by Casni (2018) and Nicolau (2020) also confirmed the predominance of housing wealth effects in European emerging economies, notably before the 2008 crisis. All the above-mentioned studies employed a series of cointegration-based methodologies, from the pooled mean group (PMG) estimators to General Method of Moments (GMM) methods.

More recent literature has begun to explore alternative econometric methods that account for these heterogeneities (such as Bampinas et al., 2017), yet such studies remain limited, especially in emerging markets. Coskun et al. (2022) emphasise nonlinearities in wealth effects, identifying asymmetric and time-varying responses to housing wealth, financial wealth, income, and interest rates across 25 countries. This study finds more significant and persistent effects of housing wealth compared to financial wealth, especially during economic expansions, but does not differentiate between durable and non-durable consumption. However, it is essential to note that non-durable consumption is the more stable component of aggregate consumption, being a strong indicator of a household's financial stability and well-being. Durable consumption, on the other hand, is the more volatile component, having a procyclical evolution over time.

As for the economies that were typically the centre of attention in the empirical literature, most studies focus on developed economies, specifically the U.S., due to robust datasets. These studies generally show a positive relationship between financial wealth and consumption, influenced by asset types and macroeconomic conditions. For example, stock wealth fluctuations notably impact consumption in the U.S. (Catte, 2004; Lettau and Ludvigson, 2004). In contrast, European economies have shown that financial wealth affects consumption more than housing wealth, with Rodil-Marzabal and Menezes-Ferreira-Junior (2016) noting that this dynamic shifted during the global financial crisis.

Emerging economies, though less studied, offer valuable insights. Funke (2004) was among the first to report significant wealth effects in these markets, albeit smaller than developed ones. Subsequent research by Ciarlone (2011) showed that both housing and financial wealth positively influence consumption in these contexts, with housing wealth exerting a stronger effect. Peltonen et al. (2012) reinforced this, highlighting heightened wealth effects in countries with substantial capitalisation. Nevertheless, in the case of emerging economies from the European Union, the empirical literature is very limited (Casni, 2018; Nicolau, 2020), and so is the usage of non-linear approaches.

Comparative studies reveal key differences in wealth effects between developed and emerging economies. In developed economies, financial wealth tends to dominate, while housing wealth has a more substantial impact in emerging ones, where residential property is a significant share of household assets (Rodil-Marzabal and Menezes-Ferreira-Junior, 2016; Ciarlone, 2011). Singh (2022) further noted the transient nature of stock wealth effects in emerging markets, often due to concentrated ownership and market volatility.

This study builds on this literature by analysing the shape of the wealth-consumption relationship through a flexible nonparametric framework. By focusing on disaggregated wealth components and accounting for non-linearities, the study aims to provide novel insights into the differential impacts of asset price fluctuations on non-durable consumption in 12 developed and 11 emerging economies from the European Union and to bridge a gap in the related literature.

## DATA AND STYLISED FACTS

### Data

This paper examines the relationship between non-durable consumption, income, wealth, and interest rates across 23 European Union (EU) members, including the EU11 economies. The emerging economies considered are the members that acceded to the European Union between 2004 and 2013. We use quarterly data from 2000Q1 to 2019Q4, which provides up to 80 observations per country.

Our dependent variable is proxied by household expenditure on semi-durable and non-durable goods and services, and we will treat non-durable consumption as endogenous (Mehra, 2001; Lettau and Ludvigson, 2004). We also explore how income changes influence consumption behaviour, using compensation of employees rather than disposable income since the latter includes income from other sources (de Bondt et al., 2019; Vizek, 2013). The use of disaggregated income data in the literature is limited, often due to data availability issues.

The inconsistency in measuring the value of housing and financial wealth in the case of the emerging economies sample calls for alternative proxies, which are more readily available, such as asset prices. As a consequence, we measure housing health by house prices and stock wealth by stock prices. As delimited in the literature (Sousa, 2009), financial wealth includes a broader range of assets like deposits and pension funds, which are not considered in this study. Another component of wealth that is considered distinctively is money wealth, as motivated by Sousa (2009). This wealth component is proxied by Broad money (M2) and represents the most liquid form of wealth in this study. Distinguishing between these measures is crucial, as they can lead to different household responses. Using asset prices, we can identify the pure "wealth effect," which reflects changes in wealth due to price fluctuations rather than portfolio decisions. For more details, refer to Paiella and Pistaferri (2017).

We recognise the limitations of using price indices as proxies, as they may not accurately reflect wealth changes, leading to inconsistent results (Rodil-Marzabal and Menezes-Ferreira-Junior, 2016). However, the availability of housing price indices influenced our choice. While asset prices do not fully capture asset value evolution, they are vital for assessment. We opted for house price indices to minimise measurement errors and to ensure comparability with prior research

(Ciarlone, 2011; Casni, 2016, 2018; Singh, 2022, among others). Additionally, we considered Broad Money (M2) as a liquid wealth measure that reflects monetary policy's effects. Although the literature on the money wealth effect is limited (Funke, 2004; Mallick and Mohsin, 2010; Peltonen et al., 2012), Sousa (2009) emphasises the importance of analysing different wealth components, finding significant wealth effects from currency, deposits, shares, and mutual funds, alongside the influence of financial liabilities and mortgage loans on consumption.

While price indices may not fully capture the value of household wealth, particularly in emerging economies, they offer the most consistent and widely available proxy data across countries. In the case of the house price series, which occasionally contained missing values, we employed a multiple imputation technique to address this limitation. This step was essential, as the CRS methodology requires a complete data series. Given the limited proportion of missing observations relative to the total, multiple imputation allowed us to preserve the integrity of the data and maintain the relationships between key variables without introducing structural distortions.

Slow macroeconomic fluctuations and liquidity constraints may influence consumption, making interest rates a key variable (Hall and Mishkin, 1980; Jawadi and Sousa, 2014). Several studies indicate a significant negative effect of interest rates on consumption since high interest rates reduce consumption by increasing credit costs and enhancing financial returns (Rodil-Marzabal and Menezes-Ferreira-Junior, 2016; Nicolau, 2020).

We believe household spending on semi-durable and non-durable goods is less influenced by interest rate changes, as these often involve shorter-term credit or no financing (Jappelli and Scognamiglio, 2018). However, short-term interest rates can have an indirect effect by impacting borrowing costs and disposable income (Cloyne et al., 2020). Thus, our analysis included the short-term interest rate, focusing on the money market or treasury bill rate, which affects liquid assets easily converted to cash for consumption (Nagel, 2016).

The data series are publicly available and were obtained from the following sources: the series for non-durable spending, compensation of employees and house prices were obtained from EUROSTAT, while the series for stock prices was obtained from investing.com, the series for broad money was obtained from Trading Economics, and the series for short-term interest rates were obtained from the national bank of each country in the sample.

## Stylised Facts on Non-durable Spending

As the first step of our analysis, we look at the descriptive statistics for each variable and each sample, described in Table 1, and each graphical representation of the non-durable spending, presented in Figures 1 and 2. The first part of the table is dedicated to developed countries, while the second part presents the descriptive statistics for the sample of emerging economies.

**Table 1.** Descriptive statistics on variables for each sample

| Variable | Obs. | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| *Developed economies* | | | | | |
| Non-durable consumption | 960 | 986.28 | 61.28 | 772.19 | 1171.57 |
| Compensation of employees | 960 | 998.69 | 79.90 | 761.48 | 1239.35 |
| House prices | 928 | 99.17 | 22.31 | 41.88 | 169.12 |
| Stock prices | 960 | 95.07 | 32.91 | 26.08 | 249.50 |
| Broad money | 960 | 904.31 | 157.66 | 569.22 | 1438.42 |
| Short-term interest rate | 960 | 1.69 | 1.77 | -0.77 | 5.84 |
| *Emerging economies* | | | | | |
| Non-durable consumption | 880 | 922.98 | 181.58 | 397.38 | 1340.64 |
| Compensation of employees | 880 | 917.94 | 234.33 | 352.72 | 1617.43 |
| House prices | 726 | 105.92 | 17.33 | 50.59 | 173.22 |

| Variable | Obs. | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| Stock prices | 880 | 116.63 | 65.26 | 24.20 | 566.33 |
| Broad money | 880 | 783.95 | 313.56 | 83.53 | 2006.10 |
| Short-term interest rate | 880 | 3.87 | 5.59 | -0.55 | 56.9 |

*Source: Author's calculations in STATA 17.*

*Note: The table presents the descriptive statistics for the initial values of the series.*

We want to emphasise the preliminary steps that were required before being able to run the Categorical Regression Splines (CRS) method, namely, the missing values that can be observed in the series of house price indices in Table 1 were obtained through a technique called the multiple imputations method that generates the missing values in such a manner that it preserves the identified relationship between the outcome and the factors of interest. This is an important step, as the CRS function requires data with no missing values; therefore, employing the multiple imputation method was the necessary and most suitable step to preserve the initial relationship without distorting the results.

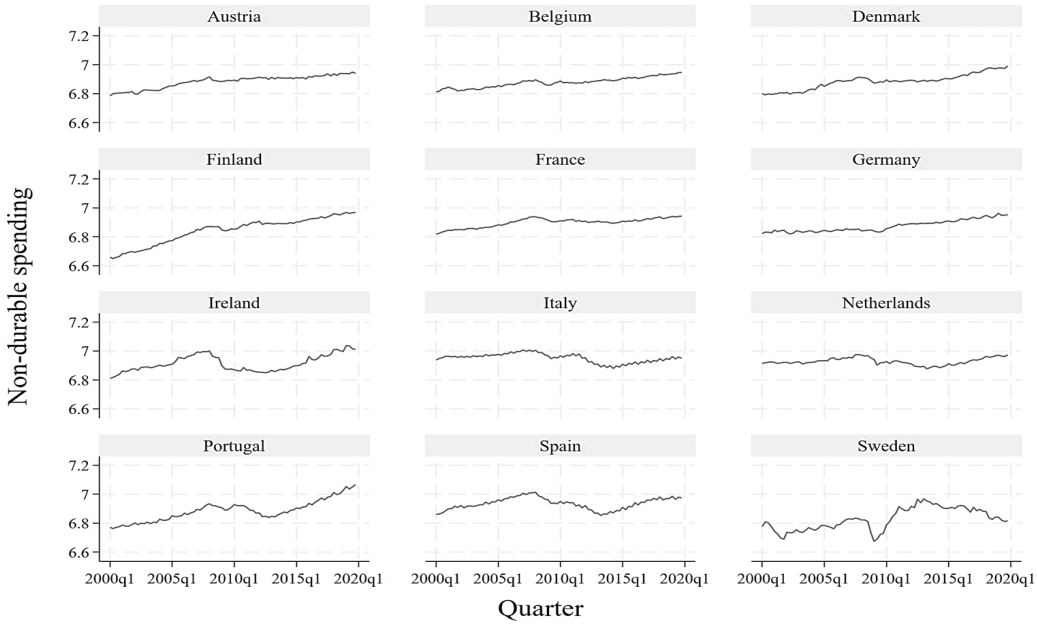


**Figure 1.** The evolution of non-durable spending over the analysed period – Developed economies sample

*Source: Author's calculations in STATA 17.*

Between 2000 and 2019, semi-durable and non-durable consumption in the case of advanced economies from the European Union experienced a series of ups and downs. The early 2000s saw moderate growth due to economic expansion, the introduction of the euro, and EU enlargement. However, the Global Financial Crisis in 2008-2009 led to a sharp decline in consumption, with bank failures and high unemployment causing reduced spending.

The subsequent European Sovereign Debt Crisis (2010-2012) worsened the situation, further decreasing consumption due to austerity measures and declining consumer confidence in countries like Greece, Portugal, and Ireland. A slow and uneven recovery followed, with semi-durable and non-durable consumption gradually increasing from 2013 to 2019 as the economy improved, consumer confidence returned, and unemployment rates fell. The recovery varied across countries, with some experiencing more substantial growth than others. Overall, the evolution of consumption during this period was shaped by global economic events, regional crises, and country-specific factors.

At the same time, semi-durable and non-durable consumption in emerging countries followed a pattern of steep growth, decline, and recovery. In the early 2000s, strong growth occurred as these countries transitioned to market economies and anticipated EU membership, with several CEE countries joining the EU in 2004 and 2007. However, the Global Financial Crisis in 2008-2009 caused a decline in consumption due to reduced credit, lower export demand, and rising unemployment. The European Sovereign Debt Crisis (2010-2012) further impacted consumption, even though the emerging countries had lower public debt than their Eurozone counterparts. Economic slowdowns, austerity measures, and decreased demand from trading partners further contributed to the decline in consumption.

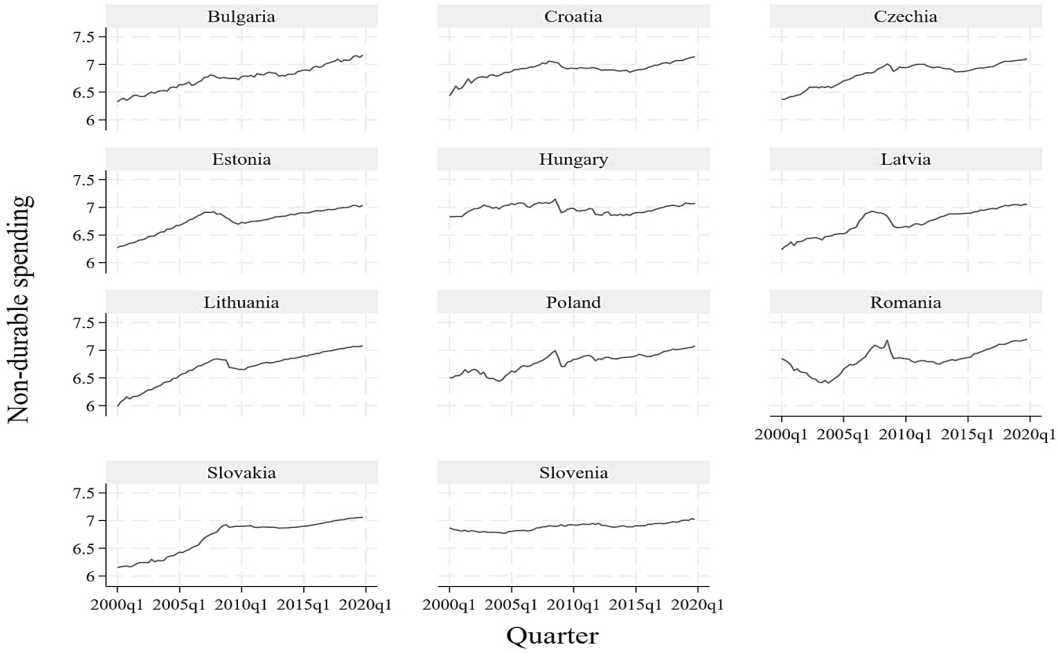


**Figure 2.** The evolution of non-durable spending over the analysed period – Emerging economies sample

*Source: Author's calculations in STATA 17.*

From 2013 to 2019, a faster recovery in consumption occurred compared to developed EU countries, driven by low interest rates, increased domestic demand, infrastructure investment, and an increasingly competitive export sector. Countries like Poland, for instance, experienced stable growth, while others, such as Romania and Hungary, faced fluctuations. Overall, the evolution of consumption in emerging countries was shaped by these global economic events and regional integration, while country-specific factors remained relevant.

## METHODOLOGY

Panel data regressions often face bias from trending, endogeneity, heterogeneity, or pooling issues. This may lead to fragile estimations of the key coefficients, specifically regarding housing, stock, and money wealth. Unreliable estimates can compromise other objectives, such as policy implications and conclusions about the elasticity of consumption in response to changes in these three components of wealth.

Most literature focuses on results obtained through panel cointegration-based methods, generally indicating a positive wealth effect, though this varies depending on the specific wealth component examined. Recent research has focused on the functional forms, control variables, assumptions, and trends in the datasets used. However, questions remain about the estimation

uncertainty associated with elasticity coefficients, as it might happen in our case, which involves working with asset price indices rather than actual values of wealth.

To study the empirical relationship between consumption and wealth, we adopt the nonparametric, nonlinear modelling approach that Racine and Nie (2011) and Ma and Racine (2013) proposed. This method, called the Categorical Regression Splines (CRS) method, offers a simpler alternative to the classical Markov regime-switching model, as it does not rely on assumptions about the presence of distinct regimes in the data-generating process. Importantly, this approach allows us to capture any potential regime changes that may occur.

The Categorical Regression Splines (CRS) method was selected for its ability to flexibly model complex nonlinear relationships between household consumption and its determinants without imposing strict functional form assumptions. Compared to other nonparametric approaches - such as kernel-weighted local polynomial regression, an alternative method considered for this empirical exercise but omitted for brevity - CRS offers several advantages. First, CRS handles mixed data types—continuous and categorical—efficiently, making it suitable even for our panel structure. Second, spline-based estimation is computationally more stable and facilitates the easier interpretation of partial effects through smooth approximating functions (Racine & Nie, 2011; Ma & Racine, 2013). This makes CRS particularly well-suited to capturing turning points, threshold effects, and asymmetric relationships often observed in macroeconomic data (Bernard et al., 2015).

Unlike kernel-based approaches, which can become unstable with high persistence or multicollinearity, this method assumes smoothness in the underlying functional relationship but does not require specification of a parametric form or the number of regimes a priori, unlike threshold or Markov-switching models.

Similar to the empirical exercise proposed by Bernard et al. (2015), these estimators account for the high degree of persistence in the data and the presence of endogeneity. Disaggregating our panel into sub-regions also places the estimation method within a "small sample" framework, particularly with small N, where N denotes the number of countries involved.

We employ non-parametric regression to identify the best-fitting model for our data while also considering the baseline linear model commonly used in previous studies. We assume the conditional mean follows a non-linear and unknown function, approximated using best-fit B-splines. This approach allows for heteroskedasticity of an unknown form, which we presume depends on income, the three components of wealth, interest rates, and other control variables (Bernard et al., 2015).

$$LNC_{it} = f(LINC_{it}, LHW_{it}, LSW_{it}, LMW_{it}, IRST_{it}) + \sigma(LINC_{it}, LHW_{it}, LSW_{it}, LMW_{it}, IRST_{it}) \cdot \omega_{it} \quad (1)$$

with $f(.)$ and $\sigma(.)$unknown, where $\omega_{it}$ are i.i.d. We define the variables as follows: LNC - non-durable consumption proxied by the household expenditure on semi-durable and non-durable goods and services; LINC – compensation of employees, used as a proxy for income; LHW – logarithm of household wealth which we proxy by house prices; LFW – logarithm of financial wealth, proxied by stock prices; LMW – logarithm of money wealth which we proxy by broad money; IRST denotes the short-term interest rate. Using the CRS estimation procedure, we conduct estimations that assume exogenous and possibly endogenous covariates.

Since $f(.)$ is unknown, as mentioned above, we estimate the function by employing the B-spline function introduced by Ma and Racine (2013), a combination of B-splines of degree $m$. The paper of Ma and Racine (2013) offers a complete representation of the linear combination of these B-splines. We will briefly outline the estimation steps for the unknown function $f(.)$, which is estimated using least squares as follows:

$$\widehat{\mathcal{B}}(LINC_{it}; LHW_{it}; LSW_{it}; LMW_{it}; IRST_{it}) \quad (2)$$
$$= argmin_{\mathcal{B}(.)} \sum_{i=1}^{n} \sum_{t=1}^{T} [LNC_{it} - \mathcal{B}(LINC_{it}; LHW_{it}; LSW_{it}; LMW_{it}; IRST_{it})]^2$$

When generating the partial $LNC|LINC$ curve, generated from the conditional mean, we denote the following specification:

$$\hat{f}_{LINC} = \hat{f}(LINC|LHW, LSW, LMW, IRST) \quad (3)$$

Similarly, we generate the partial $LnNC|Other\ variables$ curves, denoted as:

$$\hat{f}_{LHW} = \hat{f}(LHW|LINC, LSW, LMW, IRST) \quad (4)$$

$$\hat{f}_{LSW} = \hat{f}(LSW|LINC, LHW, LMW, IRST) \quad (5)$$

$$\hat{f}_{LMW} = \hat{f}(LMW|LINC, LHW, LSW, IRST \quad (6)$$

$$\hat{f}_{IRST} = \hat{f}(IRST|LINC, LHW, LSW, LMW) \quad (7)$$

More specifically, the estimation output will illustrate two main elements: (i) the fitted function that is adjusted for each covariate and (ii) accompanying point-wise confidence bands. This type of estimation overlooks the panel structure of the data and its time series properties, imposing the assumption of stationarity. While there is a shape constraint, the non-parametric assumptions are not always less stringent than some of our parametric assumptions. Consequently, the estimated curves are not used to test the fit of the parametric model; instead, we consider them as summary representations of our data. In the absence of a consensus in the literature regarding the fit of the linear model, relaxing the shape restriction can still provide valuable insights. (Bernard et al, 2015).

As our linear parametric equation assumes symmetry, we look for asymmetries in the estimated function and identify turning points. As a robustness check for our findings, we also investigate potential time instabilities, as outlined by Bernard et al. (2015), by dividing the period into three sub-periods for estimation: (i) developed economies: pre-crisis (2000q1 – 2007q3), crisis (2007q4 – 2013q4), post-crisis (2014q1 – 2019q4); (ii) emerging economies: pre-crisis (2000q1 – 2007q2), crisis (2007q3 – 2012q2), post-crisis (2012q3 – 2019q4). These sub-samples are defined to reflect global economic cycles and financial crises in accordance with the European Financial Crises Database prepared by Lo Duca et al. (2017), which considers both systemic crises and residual events. It is important to note that our analysis of these split periods is not intended as a formal examination of breaks or stability tests. Instead, we aim to identify any inconsistencies over time by checking for consistency of results across both developed and emerging economies samples, and visually inspecting the confidence intervals surrounding the fitted functions to assess the degree of uncertainty and local significance.

## RESULTS AND DISCUSSION

One of the central strengths of the CRS approach lies in its capacity to reveal nonlinear patterns that would remain obscured under linear specifications. By allowing the data to dictate the functional shape of relationships, this method enables the identification of turning points, thresholds, and varying marginal effects between consumption and its determinants. In the case of non-durable consumption, these nonlinearities are particularly important because they reflect

asymmetric household responses to changes in income and wealth under different macroeconomic conditions.

The estimations presented in the following sub-sections were obtained using the "crs" package in R, introduced by Racine and Nie (2011). The code is available upon reasonable request.

## Results of the CRS Estimations for the Sample of Developed Economies

The results of the non-parametric model estimation are presented in Figures 3, 4, and 5 for the developed economies and Figures 7, 8, 9, and 10 for the emerging economies. The graphs report partial regression surfaces for non-durable consumption for the entire period and the three sub-periods (pre-crisis, crisis, and post-crisis), as defined in the previous section. In some cases, the observed best-fit curves deviate from the linear model supported by consumption theory.

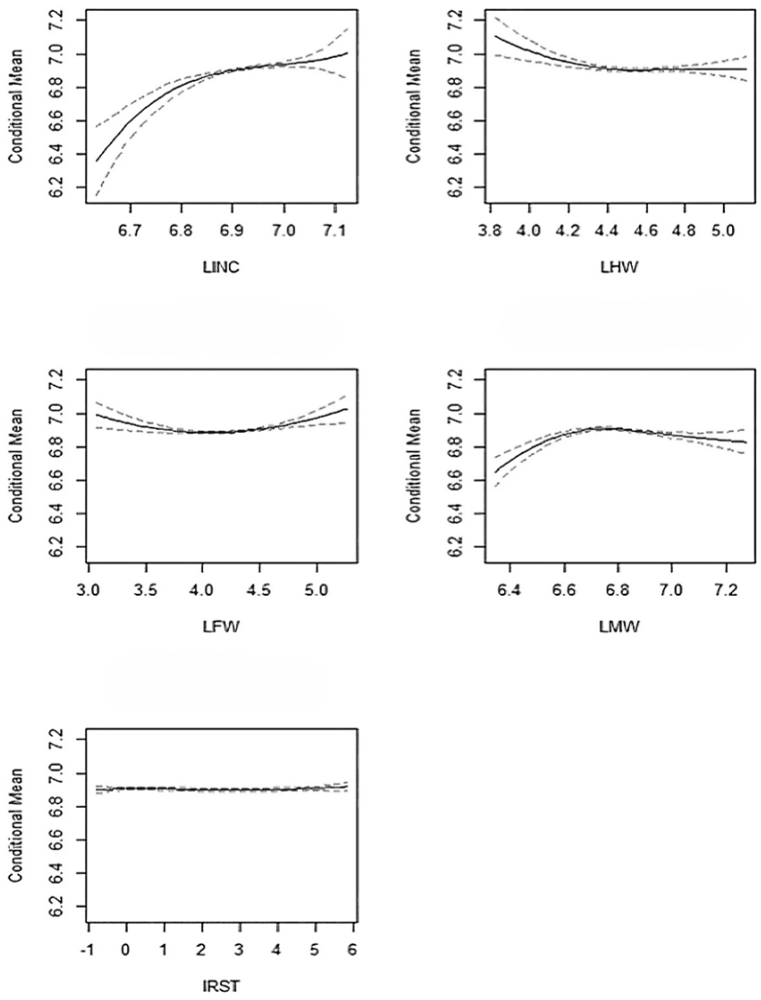


**Figure 3.** CRS estimates for the entire period (2000Q1 – 2019Q4) – Developed economies

*Source: Author's calculations in R. Note: The abbreviations refer to LINC - Ln of Compensation of employees; LHW - Ln of House Price Index; LSW - Ln of Stock Price Index; LMW - Ln of Broad money M1; IRST - Short-term Interest Rate.*

From the partial regression surfaces generated for the sample of developed countries over the entire period considered for the analysis, 2000Q1 – 2019Q4, we identify that compensation of employees (LINC) has a positive and increasing relationship with household spending, meaning higher compensation leads to increased expenditure. Conversely, the house price index (LHW)

shows a weaker link to non-durable spending, indicated by a flatter graph. In contrast, the stock price index (LFW) exhibits a mild U-shaped relationship, initially correlating negatively but later positively. This may reflect diverse wealth effects among households. Broad money (LMW) displays a slightly inverted U-shape, indicating that while increased money supply boosts consumption, the effect diminishes beyond a certain point. Lastly, the flat curve identified for the short-term interest rate (IRST) suggests a negligible direct effect on non-durable spending within the observed range.

The weaker response in house prices and short-term interest rates might suggest that these factors in current values are not direct drivers of consumption in the developed economies, possibly due to financial market stability or credit access smoothing consumption over time.

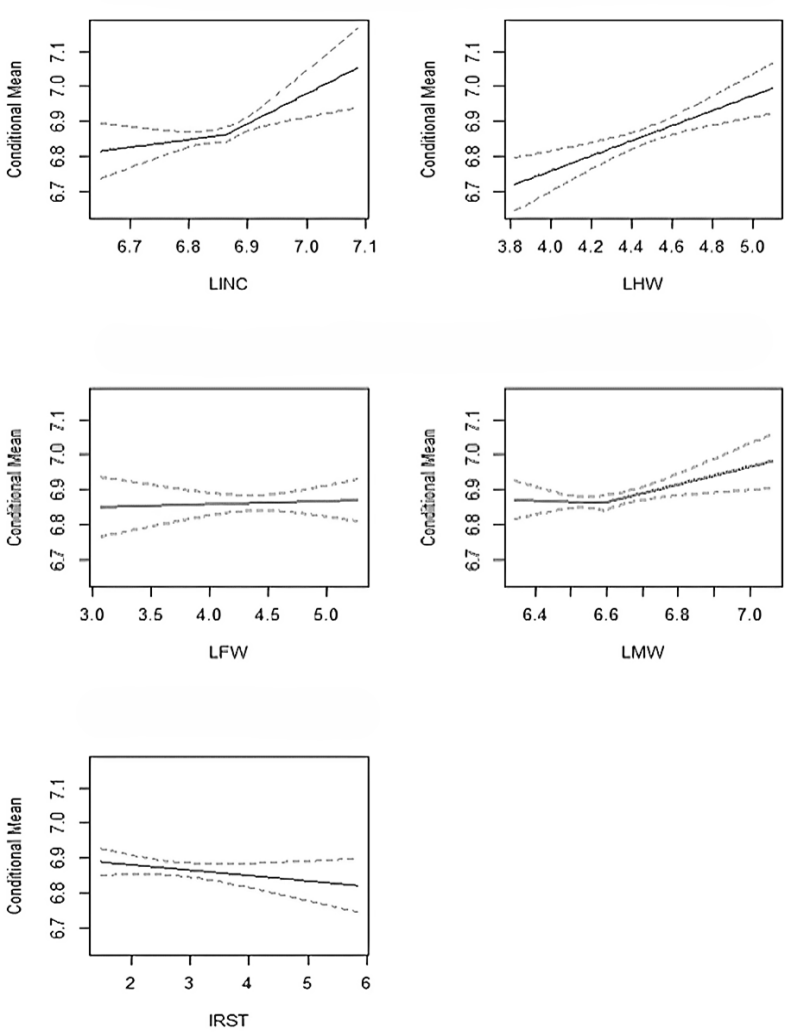


**Figure 4.** CRS estimates for the pre-crisis period (2000Q1-2007Q2) – Developed economies

*Source: Author's calculations in R. Note: The abbreviations refer to LINC - Ln of Compensation of employees; LHW - Ln of House Price Index; LSW - Ln of Stock Price Index; LMW - Ln of Broad money M1; IRST - Short-term Interest Rate.*

Although the estimations for the entire period offer some information about the shape of the relationship between non-durable spending and the proposed set of determinants, we proceed with estimating the same CRS regression over three main sub-periods (pre-crisis, crisis, and post-crisis) separately.

During the pre-crisis period, compensation of employees (LINC) exhibits a steeper curve at higher income levels, indicating a stronger marginal effect on non-durable spending. The house price index (LHW) shows a positive relationship, suggesting that rising house prices drove household spending due to a wealth effect. In contrast, the wide confidence intervals for the stock price index (LFW) indicate limited significance, as most middle-income households were not reliant on stock wealth. The broad money (LMW) suggests a mild U-shaped relationship, hinting at a possible liquidity effect. Lastly, the short-term interest rate (IRST) reveals a weak negative relationship, indicating stable credit access that diminished the impact of interest rate changes on spending decisions.

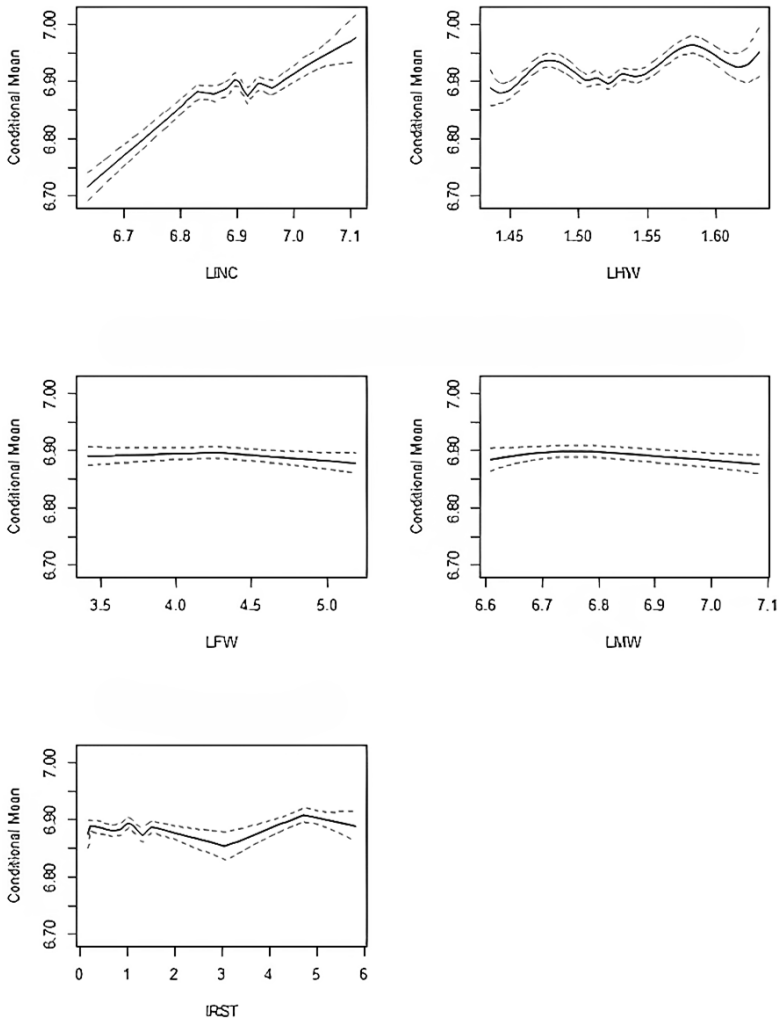


**Figure 5.** CRS estimates for the crisis period (2007Q3-2012Q2) – Developed economies

*Source: Author's calculations in R. Note: The abbreviations refer to LINC - Ln of Compensation of employees; LHW - Ln of House Price Index; LSW - Ln of Stock Price Index; LMW - Ln of Broad money M1; IRST - Short-term Interest Rate.*

During the crisis period (2007Q4–2013Q4), the link between income (LINC) and household expenditure remained positive but exhibited non-linearity, as rising compensation was tempered by labour market volatility and policy changes. House prices (LHW) had an unstable relationship with consumption, affected by declining values and mortgage instability, which increased uncertainty in non-durable spending. The influence of stock prices (LFW) on spending diminished due to financial risk aversion and a shift toward saving. Broad money (LMW) showed a flat

relationship with consumption, indicating limited effects from monetary expansion amid consumer confidence issues. Short-term interest rates (IRST) also had minimal impact, as households prioritised deleveraging over spending.

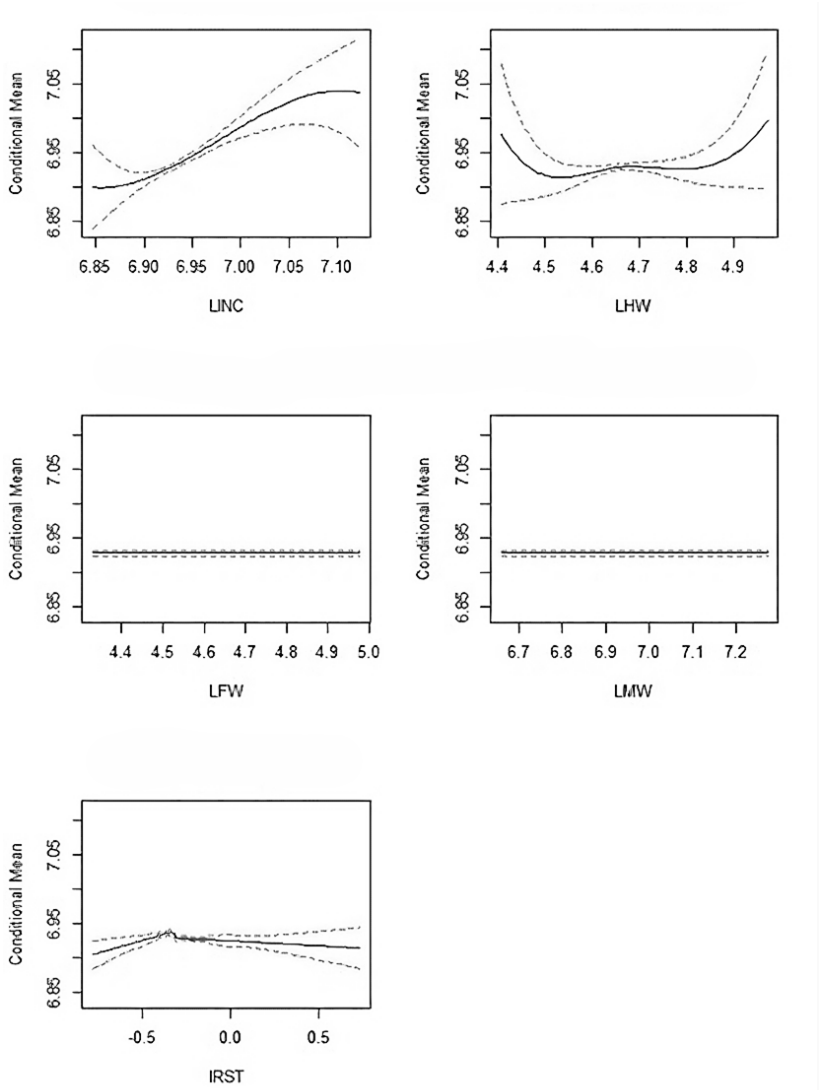


**Figure 6.** CRS estimates for the post-crisis period (2012Q3-2019Q4) – Developed economies

*Source: Author's calculations in R. Note: The abbreviations refer to LINC - Ln of Compensation of employees; LHW - Ln of House Price Index; LSW - Ln of Stock Price Index; LMW - Ln of Broad money M1; IRST - Short-term Interest Rate.*

During the post-crisis period (2014Q1–2019Q4), household expenditure on non-durables remained primarily driven by income (LINC), with a stronger marginal effect at higher income levels, reflecting improved economic stability. House prices (LHW) exhibited a U-shaped relationship with consumption, suggesting that while initial declines dampened spending, rising home values eventually supported it, likely due to improved credit conditions. In contrast, stock prices (LFW) and broad money (LMW) had no significant impact, indicating that equity wealth effects were weak and monetary expansion did not translate into higher household spending. Short-term interest rates (IRST) showed a positive but small effect, suggesting that while monetary policy provided stability, its direct influence on consumption remained limited. Overall, post-crisis consumption patterns became more income-driven, with housing regaining importance.

**Results of the CRS Estimations for the Sample of Emerging Economies**

Based on our CRS estimations, we do not have strong reasons to rule out any of the considered forms, either linear or non-linear, although imposing a quadratic or cubic curve, for instance, weakly identifies the tipping point if the curve is closer to a linear specification, namely of the bandwidth of the confidence intervals around the function are very wide.

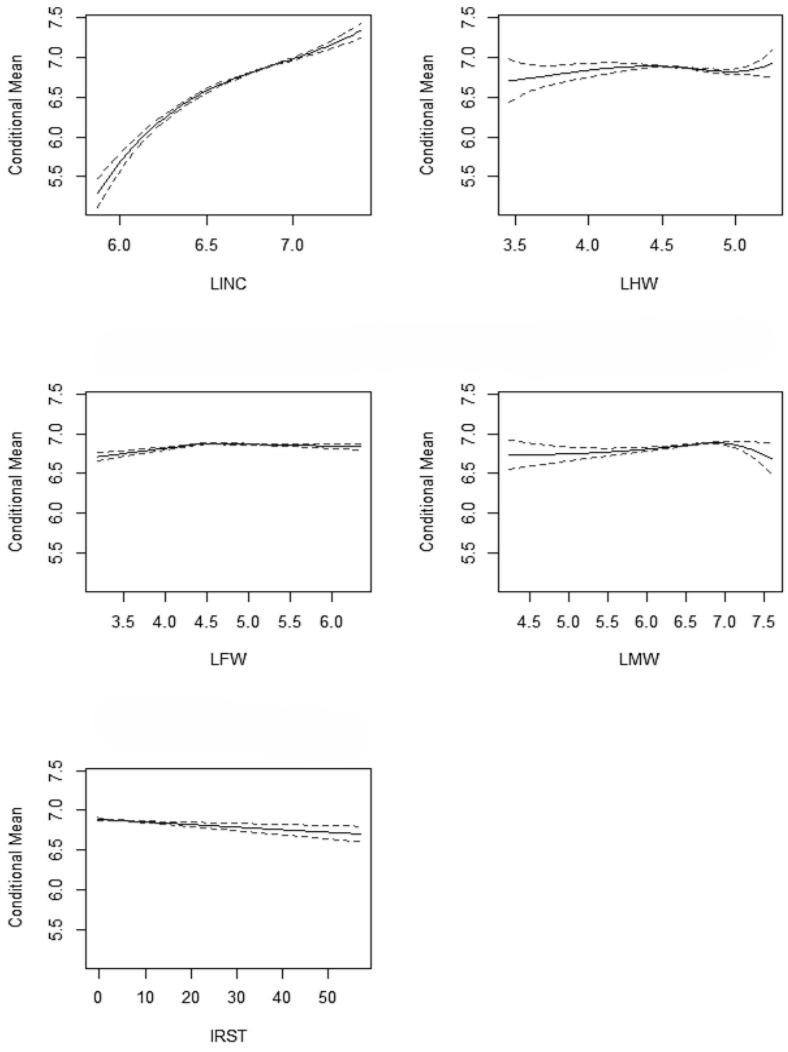


**Figure 7.** CRS estimates for the full period (2000Q1-2019Q4) – Emerging economies

*Source: Author's calculations in R. Note: The abbreviations refer to LINC - Ln of Compensation of employees; LHW - Ln of House Price Index; LSW - Ln of Stock Price Index; LMW - Ln of Broad money M1; IRST - Short-term Interest Rate.*

For the emerging economies over the full period (2000Q1–2019Q4), non-durable consumption is primarily driven by income (LINC), reflecting the strong role of income. House prices (LHW) show a weak but positive relationship with spending, suggesting limited housing wealth effects, likely due to lower homeownership or less-developed mortgage markets. Stock prices (LFW) and broad money (LMW) have minimal influence, indicating that financial market fluctuations and liquidity expansion play a minor role in shaping household demand. Short-term interest rates (IRST) exhibit a slightly negative relationship, implying that higher borrowing costs may constrain spending, though the effect is weak. Overall, consumption in emerging economies is

largely income-driven, with financial factors playing a much smaller role compared to the developed economies.

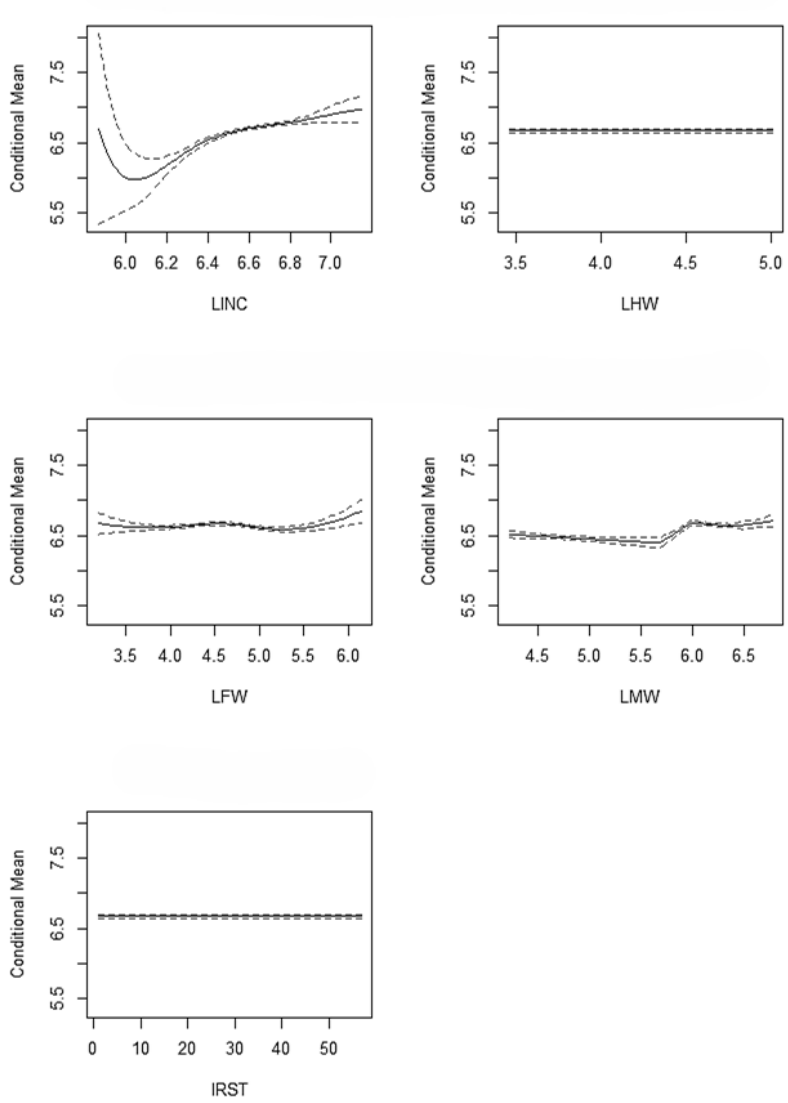


**Figure 8.** CRS estimates for the pre-crisis period (2000Q1-2007Q2) – Emerging economies

*Source: Author's calculations in R. Note: The abbreviations refer to LINC - Ln of Compensation of employees; LHW - Ln of House Price Index; LSW - Ln of Stock Price Index; LMW - Ln of Broad money M1; IRST - Short-term Interest Rate.*

During the pre-crisis period (2000Q1–2007Q2) in emerging economies, household consumption was strongly driven by income (LINC), displaying a positive relationship consistent with rising wages and employment that supported spending. House prices (LHW) had a minimal effect on consumption, suggesting that housing wealth effects were weak, likely due to less-developed mortgage markets. Although exhibiting non-linearities, stock prices (LSW) and broad money (LMW) also showed little influence, indicating that financial conditions played a secondary role in shaping consumption behaviour. Short-term interest rates (IRST) had a mildly negative impact, suggesting that higher borrowing costs slightly constrained spending but were not a major determinant. Overall, consumption in this period was predominantly income-driven, with limited responsiveness to financial and monetary variables.

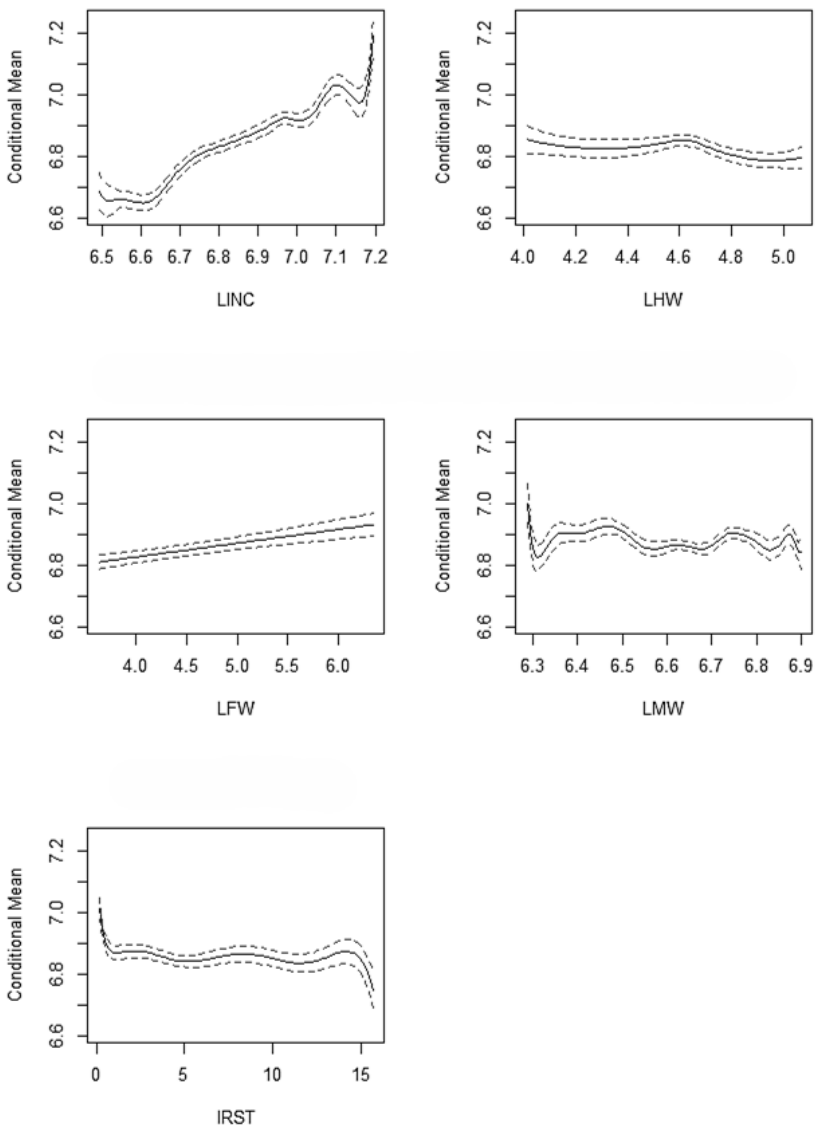


**Figure 9.** CRS estimates for the crisis period (2007Q3-2012Q2) – Emerging economies

*Source: Author's calculations in R. Note: The abbreviations refer to LINC - Ln of Compensation of employees; LHW - Ln of House Price Index; LSW - Ln of Stock Price Index; LMW - Ln of Broad money M1; IRST - Short-term Interest Rate.*

During the crisis period (2007Q3–2012Q2) in emerging economies, household consumption remained positively linked to income (LINC), though with increased non-linearity, suggesting heightened sensitivity to income changes amidst economic distress. House prices (LHW) had a weak and slightly negative effect, indicating that declining property values may have dampened spending, but the effect was not strong. Stock prices (LFW) showed a mild positive influence on consumption, possibly reflecting the growing importance of financial assets despite overall market volatility. Broad money (LMW) exhibited fluctuations, suggesting instability in liquidity effects, while short-term interest rates (IRST) displayed a non-monotonic relationship, indicating that monetary policy responses to the crisis may have had mixed effects on household spending. Overall, the crisis period saw greater uncertainty in consumption responses, with income remaining the dominant driver of consumption.

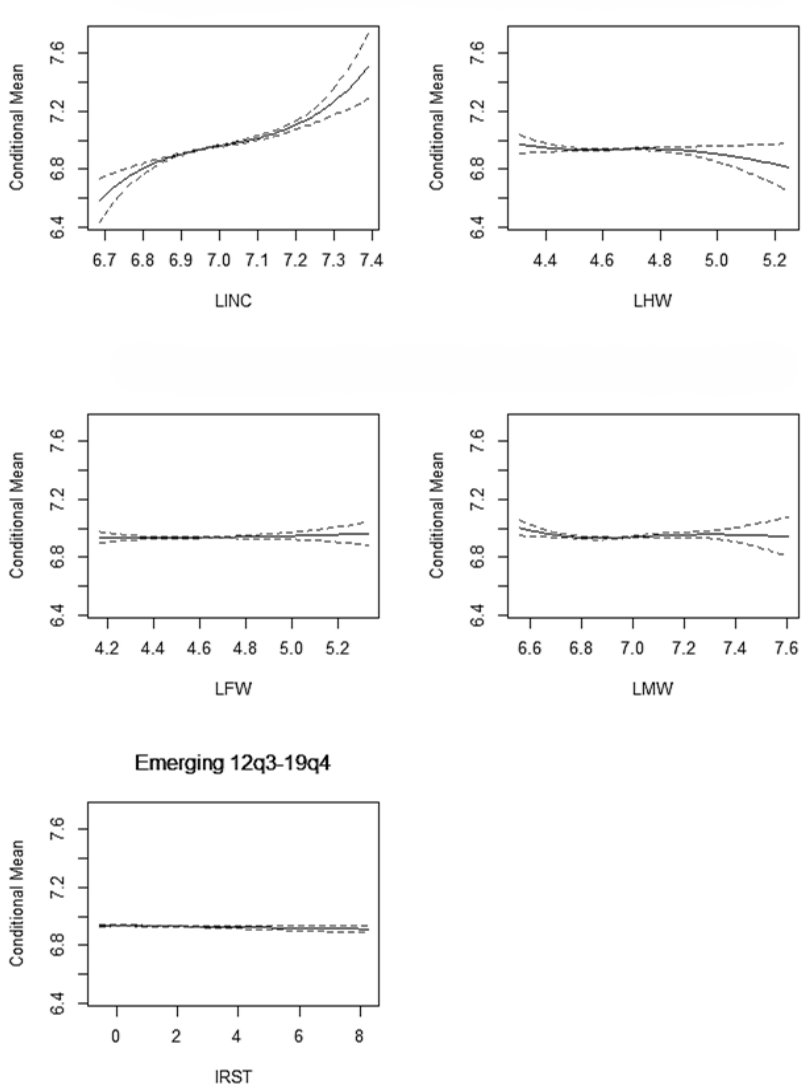


**Figure 10.** CRS estimates for the post-crisis period (2012Q3-2019Q4) – Emerging economies

*Source: Author's calculations in R. Note: The abbreviations refer to LINC - Ln of Compensation of employees; LHW - Ln of House Price Index; LSW - Ln of Stock Price Index; LMW - Ln of Broad money M1; IRST - Short-term Interest Rate.*

During the post-crisis period (2012Q3–2019Q4) in emerging economies, household consumption continued to be strongly driven by income (LINC), with a steeper relationship at higher income levels, suggesting that wage growth and employment expansion played an increasing role in sustaining spending. House prices (LHW) had a lower effect, indicating that housing wealth effects remained weak. Stock prices (LFW) and broad money (LMW) showed minimal influence, suggesting that financial and liquidity conditions had little direct impact on household expenditure. Short-term interest rates (IRST) exhibited no significant relationship with consumption, reflecting a period of monetary stability where borrowing costs did not materially affect spending decisions. Overall, the post-crisis period in emerging economies was marked by a return to income-driven consumption, with financial and monetary variables playing a limited role in shaping household demand.

We can identify a non-linear form of the partial regression surface between the non-durable consumption and its main determinants, with distinctions between developed and emerging economies, as follows:

**Table 2.** Potential non-linearities detected by the CRS method

| Period | Full period | Pre-crisis | Crisis | Post-crisis |
|---|---|---|---|---|
| *Developed economies* | | | | |
| LNC and LINC | * | * | * | / |
| LNC and LHW | / | / | * | * |
| LNC and LSW | * | / | / | / |
| LNC and LMW | * | * | / | / |
| LNC and IRST | / | / | * | * |
| *Emerging economies* | | | | |
| LNC and LINC | * | / | * | * |
| LNC and LHW | * | / | * | / |
| LNC and LSW | / | * | / | / |
| LNC and LMW | * | * | * | / |
| LNC and IRST | / | * | * | / |

*Source: Author's processing. Note: The non-linear specification is noted as "*", while a linear specification is noted as "/".*

Overall, our findings highlight the utility of nonparametric techniques in revealing subtle nonlinear dynamics in the consumption–wealth relationship that may be overlooked under standard parametric approaches. The result that income remains the dominant driver of non-durable consumption, particularly in emerging economies, aligns with previous literature (e.g., Ciarlone, 2011; Casni, 2018; Singh, 2022, among others), while also highlighting that wealth effects may be more context-dependent and nonlinear than commonly assumed. These insights help refine the understanding of household behaviour during financial cycles and offer a more nuanced view of how different wealth channels function across economies. As such, the findings may inform macroeconomic modelling and targeted policy design, especially in settings with underdeveloped financial systems.

## CONCLUSION

This study provides a comprehensive analysis of the relationship between non-durable consumption and key wealth components—housing, financial, and money wealth—as well as short-term interest rates across developed and emerging economies and members of the European Union. By employing a nonparametric approach based on the Categorical Regression Splines (CRS) method, the findings reveal nonlinearities in the consumption-wealth relationship, underscoring the complexity of these interactions beyond the linear specification.

The empirical contribution of this study lies in the employed nonparametric framework, which allows for greater flexibility in identifying the true shape of relationships without imposing restrictive parametric assumptions. This approach reveals functional forms that might otherwise be concealed; therefore, this empirical exercise underscores the necessity of considering such non-parametric techniques as a preliminary step in empirical analysis.

Empirical findings indicate distinct patterns between developed and emerging economies. In the developed economies, income remains the primary driver of non-durable consumption, while wealth effects, particularly from stock market fluctuations, exhibit non-linear characteristics. The role of housing wealth is less pronounced, reflecting greater financial market stability and diversified household portfolios. In contrast, emerging economies display a stronger reliance on income, with housing wealth playing a more significant role in shaping non-durable consumption, likely due to the relatively underdeveloped mortgage and financial markets. Money wealth and liquidity effects, while present, show variations in significance depending on the economic context and period analysed.

Furthermore, important differences have been identified across economic cycles. Pre-crisis periods show a more pronounced role of income and, in some cases, stock wealth, whereas crisis

periods exhibit weakened wealth effects and increased uncertainty in consumption behaviour. The post-crisis recovery is largely income-driven, with housing wealth regaining some influence in the developed economies but remaining weaker in emerging economies.

In developed economies, maintaining income stability and financial market resilience may help support spending, while in emerging economies, where housing plays a more central role, improving mortgage access and liquidity mechanisms may be more effective. These differentiated patterns highlight the need for tailored policy responses that reflect structural differences and observed nonlinearities. Further research could investigate the asymmetries and nonlinearities observed in this study. Understanding these complex interactions can help policymakers avoid the "one-size-fits-all" trap and design more effective strategies to support household consumption, considering both wealth constraints and monetary policy interventions.

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ORIGINAL SCIENTIFIC PAPER

# Is there a Connection between Finance and Innovation?

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**ABSTRACT**

Within the current macroeconomic environment, innovation activity, especially a radical one, is developed under extreme uncertainty conditions. A number of studies have proven the existence of severely asymmetrical information generated by innovation activities. Our research objective focuses on whether or not the development of financial systems influences the level of innovation, also analyzing the real impact of several features of the financial system on the overall innovative process of a country. In this respect, we propose a two-fold contribution. First, we address the impact on innovation which is exercised by the financial intermediation entities granting credits to the private sectors of the economy. Such a 'financial resources availability' view excludes the role played by financial markets or by the firms' internal resources. Second, we employ a Bayesian nonparametric empirical framework that can deal with various types of uncertainty about the 'true model' governing the relationship between finance and innovation. Our findings show that, at an empirical level, finance does matter in explaining the status of innovation processes and outcomes. However, this conclusion should be nuanced by adding that different features of the financial system have a non-uniform importance: while the global supply of financial resources through credit granted to the private sector is putting forth a positive and robust influence on innovation, the expansion of commercial banks network appears to play a more ambiguous and less robust role. Additionally, the existence of geographically spread specific mechanisms clearly influences the amplitude and shape of financial variables' impact on innovation. It is our view that the paper may contribute to proving that the development, as well as the functional capabilities of the financial systems, are highly relevant for the status of innovation processes in modern 'knowledge-based' economies.

**Keywords:** *finance, innovation, Bayesian nonparametric 'infinite-probits mixture linear' regression model*

**JEL Classification:** C11, C58, G20, O00

## INTRODUCTION

As with anything else in the economy, innovation is not a 'free lunch'. Instead, it might require a substantial amount of human, material, financial and informational resources in order to generate significant economic and social effects. Our main question of interest here is the following: Among such critical resources, how important are those with a financial nature? How can the status of financial systems development and efficiency impact the inputs and outputs of innovative processes?

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In his 1934 book, "*The theory of economic development*", Schumpeter came up with the idea that innovative activities may sometimes be very difficult to finance, especially within competitive economic environments, because of their specific characteristics. In such contexts, he states the idea that financial intermediaries have a very important role in technological innovation if they have the capacity to select the most promising and challenging projects in order to subsequently finance them. Schumpeter's idea was later developed by Dosi (1990), whose paper exhibits that different financial setups induce different levels of industrial innovation. Practically starting from Schumpeter's theory, King and Levine (1993) describe in an argumentative manner the actual implication of the financial system on overall economic growth. They present a four-direction approach on that subject and conclude that better financial systems lead to economic growth by accelerating productivity and innovation.

The problem of financing innovative activities should, in fact, be considered from a double perspective. In the first place, the real dependency of innovative activities on the financial system should be searched for from a macroeconomic point of view, and secondly, the microeconomic implications should be accounted for. Innovation is currently interfering with a multitude of fields, including social sciences and humanities. A current growing body of literature suggests that finance is relevant for differentiating countries with better innovation performances, both through micro and macro mechanisms.

From a microeconomic point of view, an essential part of the innovation literature has focused mainly on technological aspects of innovation. As Callegari (2018) states, recent attempts by some authors to reintegrate missing financial elements have been tempered by this theoretical lack. The new approach identifies innovation's economic role as dependent on financial constraints. Financial constraints reduce the appetite for innovation, especially for radical innovation, as firms prefer to use the classic, usually inexpensive, solutions for their businesses. Both microeconomic theory and empirical evidence have recognized the potential hurdles in the innovation financing process, as in Giordani (2015), which suggests that inventors may have financial constraints. The arguments proposed to explain the imperfections of the financial market in the innovation sector vary from transaction costs and tax advantages to agency costs due to the information asymmetries between the innovator and the funding body. As shown in Pyka and Andersen (2012), innovation in the public sector and entrepreneurship are fundamental elements that show the complex nature of creating the future orientation of economic systems. Le Corre and Mishchke (2005) consider that research and innovation are an inherently risky investment. This investment may or may not be profitable, depending on the results obtained and on the costs of financing. The higher the cost of financing or the more difficult access to financing, the riskier the innovation process becomes.

According to Laperche and Uzunidis (2008), companies, especially the large ones, use their financial strength to create convergence between science and technology centers, stimulating the development of the innovation processes. Under these conditions, finance has become a very powerful, results-based innovation regulation tool. Finance monitors the applications of science up to the details of the production process, and profit becomes the main criterion for selecting appropriate research programs to be implemented. Thus, taking into account only the financial criteria, the companies can weaken their potential for radical innovations. Amendola et al. (2003) suggest that the existence of financial constraints is a threat to competition, as innovative companies facing financial problems may be eliminated from the market. The stronger the financial constraint, the greater the threat to competition, except in companies where the innovation process is very intensive. As a result, there is a complex causal relationship between financial constraint and the frequency of innovation, which allows companies to stay on the market.

## THEORETICAL BACKGROUND

In order to analyze the restrictions existing in the financing of innovation, it is necessary to look at the process of finding and matching between the entrepreneurs who propose their innovative activities and the financial entities that select and finance the most profitable projects, as in Giordani (2015). In this sense, the amount of resources dedicated to innovation must be estimated to ensure a balanced growth of companies, with a reasonable financing cost. Financing constraints limit the innovation activities of companies, especially the hard type. On the contrary, financial constraints do not impede the implementation of easy innovation. Differential impacts are explained in Qi and Ongena (2019) by the fact that hard innovation requires greater capital, so greater credit is needed, while this is not the case with soft innovation.

Financial constraints are a serious obstacle to business innovation, especially in times of crisis, and offer new perspectives on the role of lending relationships, especially for small and medium-sized enterprises, as Brancati (2015) states. However, not only do small and medium-sized enterprises have a lower chance of innovation and a greater probability of coping with financial constraints, but innovative behavior is also more sensitive to financial conditions, even for large companies. Good relationships with the financing bodies and long-term trust can help overcome financial barriers to innovation.

From a macroeconomic perspective, Takalo and Tanayama (2010) highlight the idea that government programs that give grants to innovative applicants can provide valuable information to funding agencies. Public subsidies in the field of research and development can reduce the financing constraints of innovating entrepreneurs. Mainly, the subsidy helps the innovation projects by reducing the necessary capital on the market, and, on the other hand, if an entrepreneur has received a grant for an innovation project, it gives a positive signal to the funding bodies, which will be more willing to finance the future projects of that entrepreneur.

In a recent article, Fagiolo et al. (2019) studied the effects that finances have on the innovation activities of companies, as well as on the long-term performance of the economy. The results of their study show that banks, by granting advantageous loans for research activities, are able to encourage technological innovation and dissemination, thus improving long-term economic growth. Reasonable credit conditions allow for a better balance between technological exploration and business operations. They suggest that a more in-depth study of the relationship between innovation and financing will play a much more important role in economic development in the future. In the same direction, Glabiszewski and Zastempowski (2018) attempted to evaluate the absorptive potential of the financing companies in terms of their efficiency in the transfer of innovative technologies. The accomplishment of this potential confirms that the more developed the financial absorption capacities of companies, the stronger the effects of innovative activities based on external sources.

Also, in the intention to analyze the relationship between finance and innovation, Caiani et al. (2015) highlight the cyclical characteristic of the development process and emphasize the relevance of the relation between finance and innovation, analyzing the real and financial flows from the economy. The relationship between innovation and financing is studied, creating a multi-sectorial model of the economy based on consumption industries and capital goods, the banking sector and the household sector, which is divided into businessmen and employees. This model is framed from the perspective of structural change initiated by technological innovation. Another finding in the literature, as noted by Becchetti (1995), stipulates that in countries where financial markets are well developed and various financial intermediaries exist, but information is still imperfect and expensive, large and innovative firms benefit more from the advantages of the system and face fewer financial problems. Therefore, the assertion that larger companies with significant financial possibilities are more inclined to invest in research and innovation is reinforced. However, the role of financing in the development of innovation processes remains a matter of debate with theoretically ambiguous forecasts and empirically mixed results.

Based on this literature, we propose a two-fold contribution. First, we focus on the impact on innovation, which is exercised by the financial intermediation entities granting credits to the private sectors of the economy. Such a 'financial resources availability' view excludes the role of financial markets or firms' internal resources. Nonetheless, it has the intended advantage of more precisely identifying the sources of attracted financial resources and better emphasizing their relevance. Second, we employ a Bayesian nonparametric empirical framework capable of handling various types of uncertainty about the 'true model' governing the relationship between finance and innovation.

The next section describes this framework as well as the international data involved, while Section 3 reports and comments on the results.

## METHODOLOGY AND INTERNATIONAL DATA

### Bayesian Nonparametric 'Infinite-Probit Mixture Linear' Framework

Since most research questions in the field of social sciences can be described in terms of dependent variables responses to shocks occurring in explanatory covariates' levels or variances, regression models are perhaps the most common tool in applied modeling. Nonetheless, empirical applications often provide cases where the specific set of normal linear models' assumptions are, for one reason or another, not fully applicable. Thus, recent developments in modeling tools have focused on alternative approaches. Among these, one of the most flexible views is provided by the Bayesian frame. The starting point in building up such a frame is the idea that the model parameters' uncertainty can be depicted in terms of probability distributions. By providing a robust framework for estimation, Bayesian nonparametrics can be used to handle large parameter spaces as well as unknown density and regression functions. Hence, as Karabatsos (2017: 336) notes, Bayesian nonparametric (BNP) regression models "can provide a more robust, reliable, and rich approach to statistical inference, especially in common settings where the normal linear model assumptions are violated". Our argument for using this approach here is backed up by the idea that different violations of normality assumptions can easily occur whenever highly heterogeneous data about fast and significant time-varying processes of the international spread of innovation are involved. Among the various available BNP models, we choose the 'infinite-probit mixture linear' one. Infinite-mixture models exhibit a mixture distribution assigned a (BNP) prior on the entire space of probability measures and provide posterior-based clustering of subjects into distinct homogeneous groups (see Ghahramani, 2013; Karabatsos and Walker, 2012a, 2012b; Karabatsos, 2017; Müller et al., 2015).

More exactly, with a given covariate (x) dependent, discrete mixing distribution $G_x$, kernel (component) densities $\left(y|x;\psi,\theta(x)\right)$ ( with component indices j = 1, 2, . . ., respectively), fixed parameters $\psi$ and with component parameters $\theta_j(x)$having sample space $\Theta$ and given mixing weights $\omega_j(x)^{\infty}{}_{j=1}$ that sum to 1 at every $x \in$ ℵ (ℵbeing the covariate space), a Bayesian Non-Parametric (BNP) infinite-mixture regression model can be represented in the following the general form (see Karabatsos, 2017 for details):

$$f_{G_x}(y|x;\zeta) = \int f\left(y|x;\psi,\theta(x)\right)dG_x(\theta) = \sum_{j=1}^{\infty}\left(y|x;\psi,\theta_j(x)\right)\omega_j(x) \quad (1)$$

For such a model, the covariate-dependent mixing distribution is a random probability measure that has the general form:

$$G_x(B) = \sum_{j=1}^{\infty}\omega_j(x)\delta_{\theta_j(x)}(B), \forall B \in B(\Theta) \quad (2)$$

Thus, such a model can be viewed as a case of a species sampling model (Pitman, 1995).

Further, the mixture model from (1) is completed by the specification of a prior distribution $\Pi(\zeta)$on the space $\Omega_\zeta = \{\zeta\}$ of the infinite-dimensional model parameter, given by:

$$\zeta = \left(\psi, \theta_j(x), \omega_j(x)\right)^{\infty}_{j=1}, x \in \aleph \tag{3}$$

For the infinite-probits model, with prior $\Pi(\zeta)$, the mixture distribution (2) is defined by a dependent normalized random measure (Karabatsos and Walker, 2012a). More exactly, for a dataset $D_n = \{(y_i, x_i)\}^n_{i=1}$ a Bayesian infinite-probits mixture model can be defined by (see, for more details, Karabatsos, 2015, 2017):

$$y_i|x_i \sim f(y|x_i;\zeta), i = 1,2,\ldots,n \tag{4}$$

$$f(y|x;\zeta) = \sum_{j=-\infty}^{\infty} n\left(y|\mu_j + x^T\beta, \sigma^2\right)\omega_j(x) \tag{5}$$

$$\omega_j(x) = \Phi\left(\frac{j - x^T\beta_\omega}{\sigma_\omega}\right) - \Phi\left(\frac{j-1-x^T\beta_\omega}{\sigma_\omega}\right) \tag{6}$$

$$\mu_j|{\sigma^2}_\mu \sim N\left(0, {\sigma^2}_\mu\right) \tag{7}$$

$${\sigma^2}_\mu \sim U\left(0, {\sigma^2}_\mu\right) \tag{8}$$

$$\beta_0|\sigma^2 \sim N\left(0, \sigma^2 \upsilon_{\beta_0} \to \infty\right) \tag{9}$$

$$\beta_k|\sigma^2 \sim N(0, \sigma^2\upsilon), k = 1,2,\ldots,p \tag{10}$$

$$\sigma^2 \sim IG\left(\frac{a_0}{2}, \frac{a_0}{2}\right) \tag{11}$$

$$\beta_\omega|{\sigma^2}_\omega \sim N(0, \sigma^2\upsilon_\omega I) \tag{12}$$

$${\sigma^2}_\omega \sim IG\left(\frac{a_\omega}{2}, \frac{a_\omega}{2}\right) \tag{13}$$

Here $y_i$can be a proxy for country *i* level of innovation efforts and outcomes while $x_i$is a set of specific determinants of innovation status; $\Phi(.)$ denotes the normal $N(0,1)$ cumulative distribution function. For model parameters $\zeta = \left(\left(\mu_j\right)^{\infty}_{j=1}, {\sigma^2}_\mu, \beta, \sigma^2, \beta_\omega, \sigma_\omega\right)$ a prior $\Pi(\zeta)$ is assigned with cumulative distribution function being described by (with $J_p$denoting a *p X 1*vector of *1*s and $u\left(\sigma_\mu|0,b\right)$ referring to probability density function of the uniform distribution with minimum 0 and maximum $b$):

$$\pi(\zeta) = \prod_{j=-\infty}^{\infty} n\left(\mu_j|0,{\sigma^2}_\mu\right)u\left(\sigma_j|0,b_{\sigma_\mu}\right)n\left(\beta|0,\sigma^2 diag\left(\upsilon_{\beta_0}\to\infty, \upsilon J_p\right)\right) \tag{14}$$
$$\times ig(\sigma^2|a_0/2, a_0/2)n\left(\beta_\omega|0,{\sigma^2}_\omega\upsilon_\mu I_{p+1}\right)$$
$$ig({\sigma^2}_\omega|a_\omega/2, a_\omega/2)$$

## Geographical Spread Effects in Innovation

A key issue in the design of innovation models is the existence of a global spread process for their leading mechanisms and policies. Such spread can be driven by convergence tools implying cooperative harmonization of domestic practices or interdependent but uncoordinated diffusion of practices using cross-national imitation, emulation or learning (Busch and Jörgens, 2007). Indeed, the literature provides a large body of evidence suggesting that innovation diffusion is spatially variable (Baptista, 2001; Asheim and Gertler, 2016). Of course, geographical segmentation is not the only possible segmentation criteria: clusters of countries that share similar levels of development or even similar social, historical and cultural features might also be considered. Nonetheless, geographical proximity can be viewed as one of the most direct mechanisms for the existence of different layers in international data related to innovation spread. Thus, a robustness analysis of the results provided by any model of the innovation explanatory frame should include an assessment of potential diffusion effects at regional/international levels. With this aim, in addition to the BNP 'infinite-probits mixture linear' analysis, we also employ an 'ANOVA-linear DDP model' (see De Iorio et al., 2004, Karabatsos, 2017). These models can account for the existence of different data strata formed by countries with (relatively) homogenous levels of innovative processes and outcomes.

The first task for carrying out the analysis of the potential connection between financial resource accessibility and the status of innovative processes, mechanisms and institutions consists of a proper choice of the involved descriptors.

First, in order to capture the level of both input and output factors leading to the emergence of an innovation-based economy and society, we employ the 2019 data for the *Global Innovation Index* (GII) (Cornell University, INSEAD, and WIPO, 2019) for 114 countries, including developed, emerging and frontier economies, with a world-wide geographical spread. Data represents the overall GII score, which is the simple average of the Input and Output Sub-Index scores and is based on around eighty indicators.

Second, we employ a) Domestic credit to the private sector (% of GDP) and, b) Commercial bank branches (per 100,000 adults) as proxies for financial resource availability in the economy. The first variable includes all gross credit to various sectors, except for credit to the central government, which is net. The second variable accounts for retail locations of resident commercial banks and other resident banks that function as commercial banks. These locations provide financial services to customers, are physically separated from the main office, but are not organized as legally separated subsidiaries. The data are collected from the World Bank's *World Development Indicators* database (World Bank, 2019) and are computed as averages of all available data between 2005 and 2018. By expressing the data as long-run values, we aim to avoid potential endogeneity issues in our analysis.

In addition, several control variables are considered. The core model includes proxies for financial accessibility alongside GDP per capita (measured in Purchasing Power Parity, constant 2011 international dollars) as a proxy of economic development. An extended model will incorporate additional variables identified in the literature as innovation enhancement factors including: foreign direct investment net inflows (% of GDP) (Walz, 1997; Erdal and Göçer, 2015; Cheung and Qian, 2009); international migrant stock (% of population) (Bahar et al., 2019; Miguélez, 2018); the quality of logistic services, proxied by the *Logistics Performance Index* (Competence and quality of logistics services component) (Yang, 2009) and the age dependency ratio for the elderly (% of working-age population) (Henseke and Tivig, 2009). To capture the long-run effects potentially exercised by these control variables, the corresponding data are collected as averages of all available values between 2005 and 2018.

Finally, to eliminate scale effects, all the involved variables are transformed to their *Z*-scores by removing their mean and dividing the result by their standard deviation. The main statistics for the transformed data for the key-dependent and explanatory variables are shown in Table 1.

**Table 1:** Main statistics for the Global Innovation Index (GII) and availability of financial resources (Z-scores)

| | Global Innovation Index | Domestic credit provided by financial sector (% of GDP) | Commercial bank branches (per 100,000 adults) |
|---|---|---|---|
| Mean | 0.000 | 0.000 | 0.000 |
| Median | -0.223 | -0.331 | -0.235 |
| Standard deviation | 1.000 | 1.000 | 1.000 |
| Skewness | 0.626 | 1.108 | 1.634 |
| Kurtosis | 2.385 | 3.442 | 6.093 |
| Interquartile range | 1.532 | 1.283 | 1.105 |

*Source: own computations*

According to the empirical values of distribution parameters, it appears that, even after their transformation, these variables exhibit signs of deviation from normality. Thus, any involved estimation methodology used to analyze possible linkages between these variables should be able to deal with potential violations of the normality assumption.

## RESULTS AND DISCUSSION

A key choice for performing a Bayesian inference is the selection of the involved priors. Such choice lies around the decision of using a noninformative prior versus a *weak* informative or a complete informative one. As Gelman and Hill (2007:347) explain: "Noninformative prior distributions are intended to allow Bayesian inference for parameters about which not much is known beyond the data included in the analysis at hand… we consider noninformative prior distributions to be "reference models" to be used as a standard of comparison or starting point in place of the proper, informative prior distributions". Since our data does not appear to follow a standard distribution and are affected by a rather high degree of uncertainty related to implied reciprocal relationships, we choose to use a noninformative prior as a starting point.

The marginal posterior parameter estimates of the core model are reported in Table 2. The largest (and positive) posterior point estimate corresponds to the development levels followed by the provision of domestic credit, while the weakest impact on innovation status seems to stem from the territorial expansion of commercial banks. Meanwhile, the largest standard deviation of the estimates relative to their mean are occurring for commercial bank branches variable, while the lowest relative standard deviation is the one which corresponds to domestic credit provided by financial sector.

**Table 2:** Marginal posterior parameter estimates of the infinite probits mixture core model

| Parameter | Mean | Standard deviation | 25% | 75% | 2.50% | 97.50% |
|---|---|---|---|---|---|---|
| $\beta$ parameters for: | | | | | | |
| $\beta_0$ | -0.101 | 0.283 | -0.231 | 0.073 | -0.818 | 0.392 |
| Domestic credit provided by financial sector (% of GDP) | 0.254 | 0.067 | 0.209 | 0.296 | 0.125 | 0.396 |
| GDP per capita, PPP (constant 2011 international $) | 0.566 | 0.167 | 0.454 | 0.672 | 0.262 | 0.911 |
| Commercial bank branches (per 100,000 adults) | 0.06 | 0.064 | 0.013 | 0.107 | -0.056 | 0.185 |
| $\sigma^2$ | 0.06 | 0.031 | 0.034 | 0.085 | 0.017 | 0.124 |
| $\sigma^2{}_\mu$ | 0.509 | 0.68 | 0.24 | 0.53 | 0.122 | 1.962 |
| $\beta_\omega$ parameters for: | | | | | | |

| Parameter | Mean | Standard deviation | 25% | 75% | 2.50% | 97.50% |
|---|---|---|---|---|---|---|
| $\beta_{0_\omega}$ | -2.512 | 1.43 | -3.62 | -0.838 | -4.924 | -0.538 |
| Domestic credit provided by financial sector (% of GDP) | -0.199 | 0.192 | -0.312 | -0.079 | -0.628 | 0.156 |
| GDP per capita, PPP (constant 2011 international $) | 2.461 | 0.998 | 1.347 | 3.318 | 1.003 | 3.96 |
| Commercial bank branches (per 100,000 adults) | -0.287 | 0.283 | -0.449 | -0.095 | -0.935 | 0.153 |
| $\sigma^2_\omega$ | 0.335 | 0.27 | 0.075 | 0.494 | 0.029 | 0.971 |

*Notes:* The dependent variable is the corresponding Z-score of the Global Innovation Index (GII), while the covariates are expressed through their Z-scores having mean 0 and variance 1. A rather non-informative prior distribution is specified for the model parameters with: $b_{\sigma\mu} = 5, \upsilon = 100, a_0 = 0.01, \upsilon_\omega = 10, a_\omega = 0.01$ .

In order to estimate the model's posterior distribution, 20,000 MCMC sampling iterations were run, using an initial burn-in of 2,000 and a thinning interval of 5. The model obtained a *D(m)* statistic of 14.899, with an R-squared of 0.972, and had no outliers according to standardized residuals that ranged within −2 and 2.

*Source: own computations*

**Table 3:** Ninety-five percent MCCI half-widths of the marginal posterior point estimates of the intercept and slope parameters of the infinite-probits mixture from Table 2 (core model)

| Parameter | Mean | Standard deviation | 25% | 75% | 2.50% | 97.50% |
|---|---|---|---|---|---|---|
| $\beta$ parameters for: | | | | | | |
| $\beta_0$ | 0.1 | 0.042 | 0.121 | 0.093 | 0.157 | 0.087 |
| Domestic credit provided by financial sector (% of GDP) | 0.012 | 0.004 | 0.011 | 0.014 | 0.011 | 0.017 |
| GDP per capita, PPP (constant 2011 international $) | 0.053 | 0.013 | 0.051 | 0.057 | 0.049 | 0.073 |
| Commercial bank branches (per 100,000 adults) | 0.01 | 0.003 | 0.011 | 0.012 | 0.01 | 0.01 |
| $\sigma^2$ | 0.013 | 0.002 | 0.012 | 0.014 | 0.01 | 0.015 |
| $\sigma^2_\mu$ | 0.131 | 0.229 | 0.033 | 0.146 | 0.014 | 0.646 |
| $\beta_\omega$ parameters for: | | | | | | |
| $\beta_{0_\omega}$ | 0.683 | 0.074 | 0.708 | 0.667 | 0.736 | 0.62 |
| Domestic credit provided by financial sector (% of GDP) | 0.031 | 0.033 | 0.047 | 0.028 | 0.089 | 0.054 |
| GDP per capita, PPP (constant 2011 international $) | 0.468 | 0.052 | 0.452 | 0.493 | 0.399 | 0.516 |
| Commercial bank branches (per 100,000 adults) | 0.069 | 0.048 | 0.106 | 0.049 | 0.136 | 0.05 |
| $\sigma^2_\omega$ | 0.103 | 0.034 | 0.08 | 0.122 | 0.054 | 0.183 |

*Source: own computations*

Additionally, Table 3 reports the 95 % Monte-Carlo confidence interval (MCCI) half-widths of the (marginal) posterior coefficient point estimates for the core model from Table 2. Almost all half-widths are nearly 0.10, and thus, these posterior point estimates are quite accurate in terms of Monte Carlo standard error.

The core model seems to support the idea that there is empirical evidence in favor of a positive role played by the supply of financial resources for innovation processes. However, in order to

check the robustness of such evidence, we turn to an extended model that includes a supplementary set of control covariates. Table 4 shows the marginal posterior parameters for such an extended model. Interestingly, with the additional control variables, the level of development no longer appears to be the main driver of innovation. Instead, the largest positive effects relate to logistic performance, the age dependency ratio, the importance of high technology in international trade flows and domestic credit, while international migrant stock and the number of commercial bank branches show a lower impact. Perhaps the most ambiguous result is associated with low posterior point estimates and a relatively significant standard deviation of these estimates for the net inflows of foreign investment. Their expected positive spillovers do not seem to be manifested in a non-ambiguous manner in this analytical frame.

**Table 4:** Marginal posterior parameter estimates of the infinite probits mixture extended model

| **Parameter** | **Mean** | **Standard deviation** | **25%** | **75%** | **2.50%** | **97.50%** |
|---|---|---|---|---|---|---|
| $\beta$ parameters for: | | | | | | |
| $\beta_0$ | -0.132 | 0.174 | -0.259 | -0.013 | -0.467 | 0.194 |
| Age dependency ratio, old (% of working-age population) | 0.181 | 0.085 | 0.122 | 0.238 | 0.021 | 0.357 |
| Domestic credit provided by financial sector (% of GDP) | 0.102 | 0.045 | 0.073 | 0.133 | 0.015 | 0.191 |
| Foreign direct investment, net inflows (% of GDP) | 0.038 | 0.036 | 0.014 | 0.062 | -0.032 | 0.11 |
| GDP per capita, PPP (constant 2011 international $) | 0.044 | 0.079 | -0.005 | 0.098 | -0.118 | 0.185 |
| High-technology exports (% of manufactured exports) | 0.178 | 0.045 | 0.147 | 0.207 | 0.094 | 0.272 |
| International migrant stock (% of population) | 0.063 | 0.041 | 0.034 | 0.09 | -0.013 | 0.15 |
| Logistics performance index: Competence and quality of logistics services | 0.444 | 0.059 | 0.404 | 0.484 | 0.332 | 0.561 |
| Commercial bank branches (per 100,000 adults) | 0.08 | 0.047 | 0.048 | 0.111 | -0.012 | 0.174 |
| $\sigma^2$ | 0.058 | 0.01 | 0.051 | 0.064 | 0.041 | 0.08 |
| $\sigma^2{}_\mu$ | 0.191 | 0.306 | 0.06 | 0.202 | 0.02 | 0.895 |
| $\beta_\omega$ parameters for: | | | | | | |
| $\beta_{0_\omega}$ | -0.037 | 0.088 | -0.088 | 0.019 | -0.22 | 0.128 |
| Age dependency ratio, old (% of working-age population) | 0.557 | 0.091 | 0.504 | 0.609 | 0.379 | 0.76 |
| Domestic credit provided by financial sector (% of GDP) | -0.09 | 0.105 | -0.157 | -0.024 | -0.293 | 0.126 |
| Foreign direct investment, net inflows (% of GDP) | 0.085 | 0.153 | 0.021 | 0.183 | -0.28 | 0.328 |
| GDP per capita, PPP (constant 2011 international $) | 0.131 | 0.185 | 0.002 | 0.267 | -0.266 | 0.444 |
| High-technology exports (% of manufactured exports) | -0.095 | 0.11 | -0.159 | -0.025 | -0.343 | 0.122 |
| International migrant stock (% of population) | -0.004 | 0.09 | -0.065 | 0.059 | -0.183 | 0.164 |
| Logistics performance index: Competence and quality of logistics services | -0.134 | 0.132 | -0.213 | -0.057 | -0.385 | 0.135 |
| Commercial bank branches (per 100,000 adults) | 0.254 | 0.099 | 0.183 | 0.317 | 0.088 | 0.473 |
| $\sigma^2{}_\omega$ | 0.009 | 0.006 | 0.005 | 0.01 | 0.003 | 0.024 |

*Notes:* Same specifications as in Table 2. The model obtained a *D(m)* statistic of 13.907, with an R-squared of 0.952.

*Source: own computations*

Table 5 supplementary reports the 95 % Monte Carlo confidence interval (MCCI) half-widths of the (marginal) posterior coefficient point estimates for the extended model from Table 4. All half-widths are nearly 0.05, indicating that these posterior point estimates are reasonably accurate regarding Monte Carlo standard error.

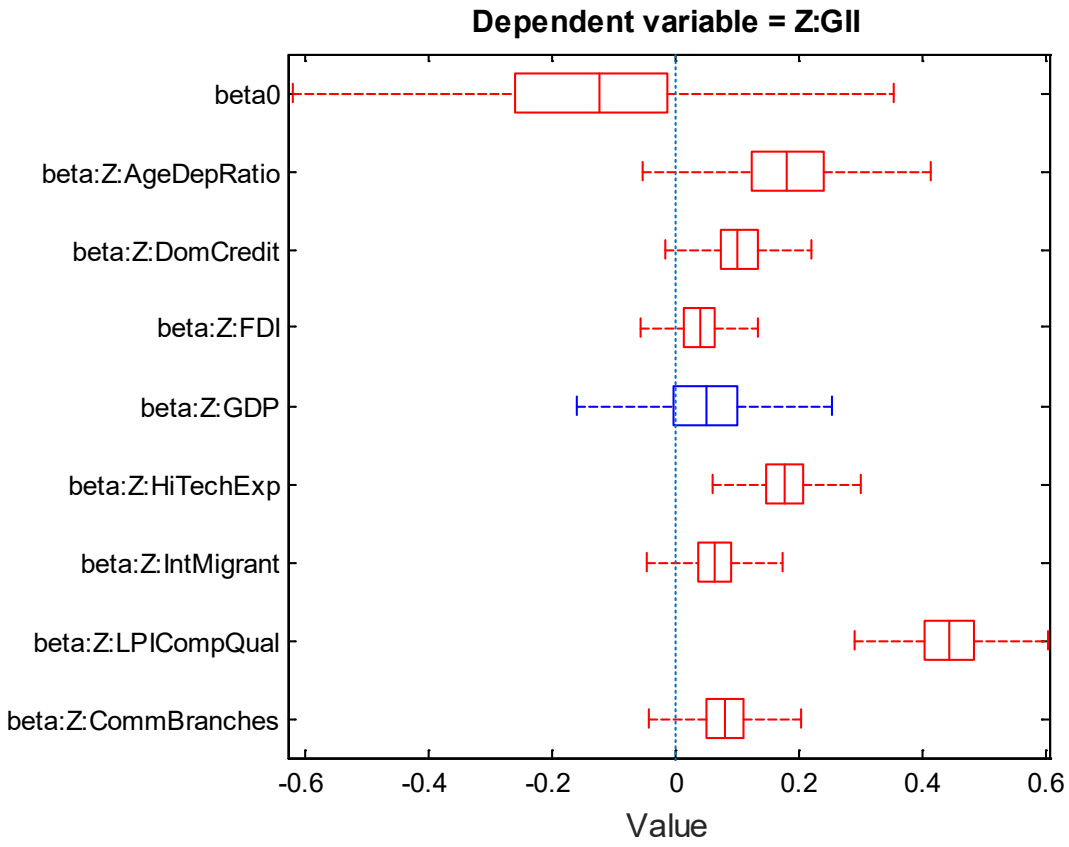
**Table 5:** Ninety-five percent MCCI half-widths of the marginal posterior point estimates of the intercept and slope parameters of the infinite-probits mixture (extended model from Table 4)

| **Parameter** | **Mean** | **Standard deviation** | **25%** | **75%** | **2.50%** | **97.50%** |
|---|---|---|---|---|---|---|
| $\beta$ parameters for: | | | | | | |
| $\beta_0$ | 0.048 | 0.018 | 0.05 | 0.052 | 0.053 | 0.05 |
| Age dependency ratio, old (% of working-age population) | 0.015 | 0.004 | 0.015 | 0.016 | 0.015 | 0.021 |
| Domestic credit provided by financial sector (% of GDP) | 0.004 | 0.001 | 0.004 | 0.004 | 0.005 | 0.007 |
| Foreign direct investment, net inflows (% of GDP) | 0.004 | 0.001 | 0.004 | 0.004 | 0.004 | 0.006 |
| GDP per capita, PPP (constant 2011 international $) | 0.019 | 0.005 | 0.021 | 0.019 | 0.029 | 0.019 |
| High-technology exports (% of manufactured exports) | 0.009 | 0.003 | 0.008 | 0.009 | 0.008 | 0.012 |
| International migrant stock (% of population) | 0.006 | 0.002 | 0.006 | 0.006 | 0.006 | 0.008 |
| Logistics performance index: Competence and quality of logistics services | 0.01 | 0.002 | 0.01 | 0.012 | 0.011 | 0.012 |
| Commercial bank branches (per 100,000 adults) | 0.006 | 0.002 | 0.007 | 0.006 | 0.009 | 0.007 |
| $\sigma^2$ | 0.002 | 0 | 0.001 | 0.002 | 0.002 | 0.002 |
| $\sigma^2{}_\mu$ | 0.022 | 0.04 | 0.008 | 0.026 | 0.003 | 0.154 |
| $\beta_\omega$ parameters for: | | | | | | |
| $\beta_{0_\omega}$ | 0.02 | 0.008 | 0.025 | 0.016 | 0.032 | 0.02 |
| Age dependency ratio, old (% of working-age population) | 0.018 | 0.009 | 0.016 | 0.02 | 0.023 | 0.036 |
| Domestic credit provided by financial sector (% of GDP) | 0.021 | 0.012 | 0.022 | 0.022 | 0.043 | 0.028 |
| Foreign direct investment, net inflows (% of GDP) | 0.055 | 0.019 | 0.062 | 0.051 | 0.078 | 0.05 |
| GDP per capita, PPP (constant 2011 international $) | 0.059 | 0.018 | 0.069 | 0.055 | 0.074 | 0.054 |
| High-technology exports (% of manufactured exports) | 0.026 | 0.016 | 0.03 | 0.027 | 0.041 | 0.036 |
| International migrant stock (% of population) | 0.017 | 0.01 | 0.02 | 0.02 | 0.027 | 0.025 |
| Logistics performance index: Competence and quality of logistics services | 0.034 | 0.016 | 0.033 | 0.038 | 0.061 | 0.047 |
| Commercial bank branches (per 100,000 adults) | 0.025 | 0.01 | 0.023 | 0.029 | 0.021 | 0.043 |
| $\sigma^2{}_\omega$ | 0.001 | 0.001 | 0 | 0.001 | 0 | 0.004 |

*Source: own computations*

Figure 1 is a box plot of the (marginal) posterior quantile point estimates of the intercept and slope coefficient parameters for the covariates (including the constant term). Clearly, with the

exception of GDP per capita, all the coefficient parameters of the extended model look significantly different than zero.




*Notes:* Center vertical line: posterior median. Thick box: inter-quartile range (50 % interval). Horizontal lines (whiskers): 95 % credible interval (.025 and .975 marginal posterior quantiles). A red box (blue box, resp.) flags a coefficient parameter that is (not, resp.) significantly different than zero, according to whether or not the 50 % (marginal) posterior interval (box) includes zero.

**Figure 1.** *Box plots* of the marginal posterior distributions of the intercept and slope coefficients of the infinite probits mixture model (extended model)

*Source: own representation*

The Markov Chain Monte Carlo (MCMC) convergence is evaluated in Figure 2. The trace plots appear to support good (although not a "perfect" one, especially in the case of foreign direct investment and high-technology exports) mixing for these parameters, since each trace plot appears to be reasonably stable.

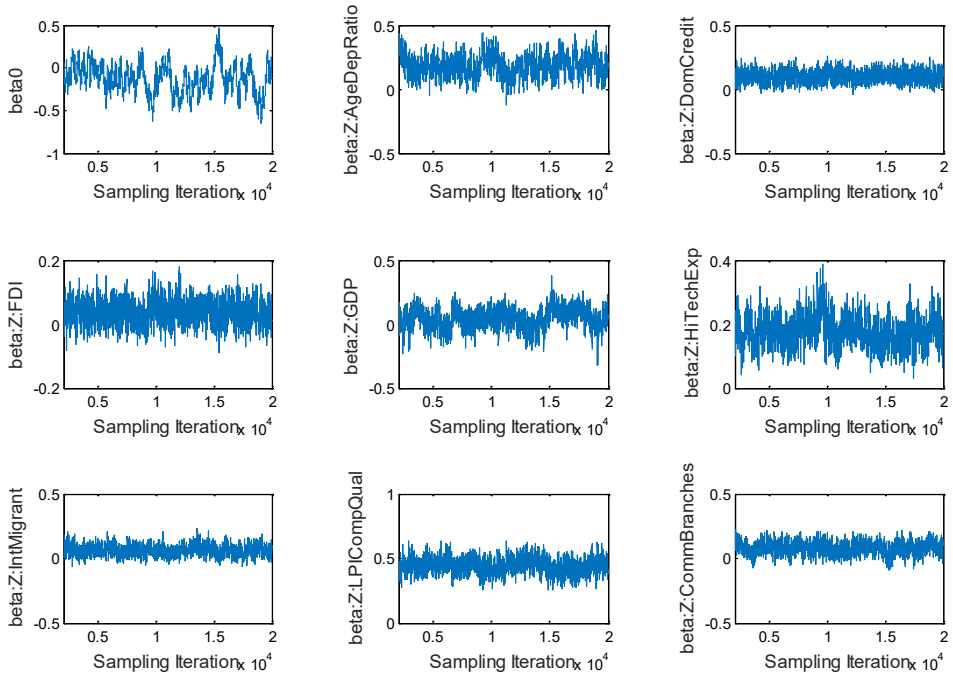



**Figure 2.** Trace plots of MCMC samples of the intercept and slope coefficients for the infinite probits mixture model (extended model)

*Source: own representation*

Figure 3 provides a quantile and mean regression analysis, by showing the estimates of the mean, and the .1, .25, .5 (median), .75, and .9 quantiles of the model's posterior predictive distribution of the Global Innovation Index, conditionally on selected values of the domestic credit covariate, and on zero for all the other covariates (using the zero-centering method). This figure suggests that there might be some small non-linear effects of domestic credit on innovation for high values of financial resources supply while for its 'middle' values the impact is relatively a 'flat' one.

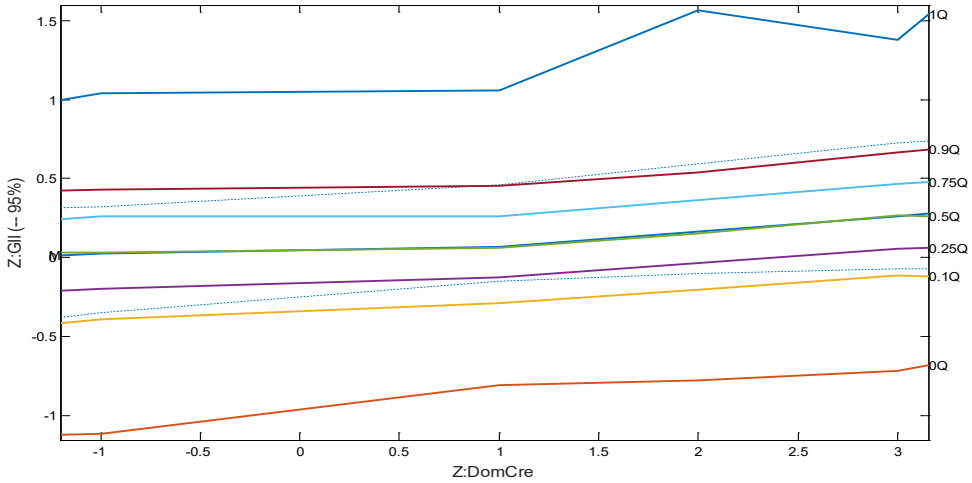



**Figure 3.** The posterior predictive mean and quantiles of the Global Innovation Index, over chosen values of the covariate domestic credit provided by financial sector (% of GDP) (extended model)

*Source: own representation*

In correlation with this, Figure 4 shows a three-dimensional plot of (Rao-Blackwellized) estimates of the model's posterior predictive probability density function (p.d.f.) of the Global Innovation Index (conditionally on the same values of the covariates). These results show that the location and shape of this index distribution change as a function of domestic credit.

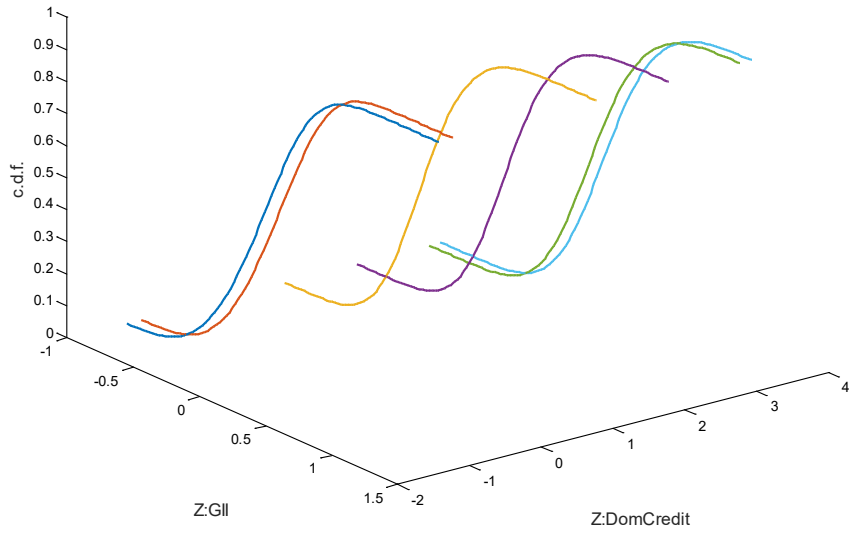



**Figure 4:** The Rao-Blackwellized estimate of the posterior predictive probability density function (p.d.f.) of the Global Innovation Index as a function of domestic credit provided by the financial sector (% of GDP) (extended model)

*Source: own representation*

A final analytical step is to check for the potential effects of geographical distribution in the levels of innovation. Indeed, as the results of the BNP 'ANOVA-linear DDP model' with a regional dummy as a grouping variable from Table 6 show, the geographical factor induces significant heterogeneity in the effects exercised by domestic credit supply and banking development. While in most regions, a higher level of credit granted to various sectors seems to clearly support better innovative performances, this influence is displaying a 'wrong' negative sign in the case of Europe, Northern Africa and Western Asia. Regarding the number of commercial banks, this is important in explaining the status of innovation in all regions. However, there are quite significant differences with lower estimated impacts in Central and Southern Asia, Latin America and the Caribbean and Sub-Saharan Africa compared to a much higher impact in the other regions.

**Table 6:** Marginal posterior parameter estimates of the intercept and slope parameters of a Dirichlet process mixture of homoscedastic linear regressions (ANOVA-linear DDP) model

| **Parameter** | **Mean** | **Standard deviation** | **25%** | **75%** | **2.50%** | **97.50%** |
|---|---|---|---|---|---|---|
| $\beta$ parameters for domestic credit provided by financial sector (% of GDP): | | | | | | |
| Region =1 | 0.276 | 0.342 | 0.314 | 0.396 | -0.491 | 0.903 |
| Region=2 | -0.219 | 0.133 | -0.286 | -0.128 | -0.286 | 0.182 |
| Region=3 | 0.311 | 0.192 | 0.314 | 0.396 | -0.402 | 0.399 |
| Region=4 | 0.311 | 0.187 | 0.314 | 0.396 | -0.402 | 0.399 |
| Region=5 | 0.276 | 0.178 | 0.314 | 0.396 | -0.193 | 0.396 |
| Region=6 | -0.174 | 0.224 | -0.286 | -0.128 | -0.286 | 0.509 |

| Parameter | Mean | Standard deviation | 25% | 75% | 2.50% | 97.50% |
|---|---|---|---|---|---|---|
| Region=7 | 0.31 | 0.184 | 0.314 | 0.396 | -0.402 | 0.399 |
| $\beta$ parameters for commercial bank branches (per 100,000 adults): | | | | | | |
| Region =1 | 0.146 | 0.458 | -0.109 | 0.426 | -0.706 | 1.018 |
| Region=2 | 0.265 | 0.082 | 0.293 | 0.293 | -0.03 | 0.298 |
| Region=3 | 0.041 | 0.358 | -0.109 | 0.426 | -0.564 | 0.426 |
| Region=4 | 0.026 | 0.34 | -0.109 | 0.426 | -0.564 | 0.426 |
| Region=5 | 0.185 | 0.268 | -0.109 | 0.426 | -0.109 | 0.528 |
| Region=6 | 0.214 | 0.232 | 0.293 | 0.293 | -0.638 | 0.298 |
| Region=7 | 0.032 | 0.343 | -0.109 | 0.426 | -0.564 | 0.426 |

*Notes:* The grouping variable is a regional dummy taking values of 1 for Northern America, 2 for Europe, 3 for Central and Southern Asia, 4 for Latin America and the Caribbean, 5 for South East Asia, East Asia, and Oceania, 6 for Northern Africa and Western Asia and, respectively, 7 for Sub-Saharan Africa. To estimate the model's posterior distribution, 100,000 MCMC sampling iterations were run. 5,000 initial burn-in and a thinning interval of 5 were considered. A non-informative prior distribution is specified for the model parameters. The full model is based on all the explanatory variables of the extended model. Only the corresponding values for domestic credit and commercial bank branches are reported here.

*Source: own computations*

As Table 7 reports, for these results, the MCMC convergence is confirmed by the results of small 95 % MCCI half-widths for (marginal) posterior point estimates (nearly all less than .1 or around this level).

**Table 7:** Ninety-five percent MCCI half-widths of the marginal posterior point estimates of the intercept and slope parameters of a Dirichlet process mixture of homoscedastic linear regressions (ANOVA-linear DDP) model from Table 6

| Parameter | Mean | Standard deviation | 25% | 75% | 2.50% | 97.50% |
|---|---|---|---|---|---|---|
| $\beta$ parameters for domestic credit provided by financial sector (% of GDP): | | | | | | |
| Region =1 | 0.046 | 0.043 | 0.078 | 0.054 | 0.1 | 0.151 |
| Region=2 | 0.047 | 0.011 | 0.045 | 0.051 | 0.042 | 0.054 |
| Region=3 | 0.058 | 0.033 | 0.077 | 0.058 | 0.098 | 0.034 |
| Region=4 | 0.058 | 0.034 | 0.077 | 0.059 | 0.093 | 0.02 |
| Region=5 | 0.055 | 0.03 | 0.067 | 0.053 | 0.087 | 0.053 |
| Region=6 | 0.056 | 0.039 | 0.055 | 0.068 | 0.048 | 0.112 |
| Region=7 | 0.058 | 0.033 | 0.077 | 0.06 | 0.081 | 0.02 |
| $\beta$ parameters for commercial bank branches (per 100,000 adults): | | | | | | |
| Region =1 | 0.085 | 0.057 | 0.111 | 0.096 | 0.221 | 0.166 |
| Region=2 | 0.028 | 0.01 | 0.033 | 0.026 | 0.035 | 0.023 |
| Region=3 | 0.121 | 0.04 | 0.131 | 0.122 | 0.138 | 0.15 |
| Region=4 | 0.121 | 0.033 | 0.131 | 0.122 | 0.138 | 0.109 |
| Region=5 | 0.095 | 0.034 | 0.099 | 0.101 | 0.097 | 0.106 |
| Region=6 | 0.062 | 0.034 | 0.077 | 0.061 | 0.099 | 0.053 |
| Region=7 | 0.122 | 0.034 | 0.13 | 0.122 | 0.144 | 0.122 |

*Source: own computations*

## CONCLUSIONS

Our findings provide empirical support for the idea that finance *matters* in explaining the status of innovation processes and outcomes. However, this overall conclusion should be nuanced by adding that different features of the financial system have a non-uniform importance: while the global supply of financial resources through credit granted to the private sector is putting forth a positive and robust influence on innovation, the expansion of commercial banks network appears to play a more ambiguous and less robust role. Additionally, the existence of geographically spread specific mechanisms clearly influences the amplitude and shape of financial variables' impact on innovation.

Several clarifications can be provided for a better understanding of these results. First, one can argue that the idea according to which 'finance matters for innovation' is somehow too general and, in fact, covers a full spectrum of empirical cases. The essential facts in this respect are actually the degree of financial system development, its sophistication, efficiency and stability, as well as the structural characteristics of financial intermediation processes. For instance, there might be some substantial differences between the cases in which firms are financing their innovations through internal cash flow and external equity markets and the cases in which they depend almost entirely on the loans granted by commercial banks or on the financial resources from venture debt or other non-bank lenders. Broadly, as Acharya and Xu (2017) found, public firms in external finance-dependent industries tend to spend more on research and development than their private counterparts. It should also be added that the effects of financial resource availability may further vary depending on the architecture and status of their providers, including factors such as market concentration, regulations and prudential supervision, specific efficiency and risk management mechanisms. For an extended discussion of these issues, see Kerr and Nanda, 2015).

Second, it is not enough to establish that 'finance supports innovation'; it should also be explained *what types* of innovation are promoted by changes in financial resource availability. For instance, Nanda and Nicholas (2014) provide historical evidence that bank distress periods were associated with a shift away from high-risk R&D projects toward more incremental innovation activities. Thus, not only the *level* but also the *structure* of innovation might be affected by changes in the financial conditions of the economy.

Third, the influence of geographical factors on the relationship between finance and innovation might highlight the role of the international flows of capital goods - especially those that incorporate technological advances. However, considering that our findings do not provide strong support for the positive impact of foreign direct investment (and, by extension, its associated technology, knowledge, skills and abilities) on the innovation status of host countries, further analysis is required at this point.

Fourth, it should be noted that, in a dynamic framework, the availability of financial resources in the economy may also influence the innovation *conditions*, such as the R&D frame, infrastructure, or innovation risk management systems. Thus, one can draw a distinction between the possible *direct* effects of finance on innovation (which are explicitly considered in this analysis) and the *indirect* effects that are not accounted for here.

Fifth, the explanation should be completed by integrating other explanatory variables explicitly considered in this analysis from the much-extended set of possible direct enhancers of innovation. For example, the positive and significant impact of demographic factors identified in this analysis aligns with the literature supporting the hypothesis that the scope of start-up activities is positively associated with two types of instrumental family support: financial and social capital (Edelman et al., 2016). Thus, the extent of finance's impact on innovation might be conditioned by the presence of other key determinants that could either amplify or compensate for the lack of such impact.

Nevertheless, even with such clarifications, there is still a list of open questions regarding these results. What are the specific mechanisms that differentiate the roles of different financial system

components in providing support for innovation? If the distinction between heavily dependent and less dependent sectors is neither fixed nor permanent, what factors drive the variation in the impact of financial resource availability over time? Do banks modulate the structure of innovation exclusively during their periods of financial distress, or is this intervention in the typology of innovation projects a constant characteristic of their financial support? How can our finding - that geographical proximity is relevant for discerning the impact of finance on innovation - be correlated with the effects of trans-regional globalization processes? What specific factors can compensate for (or, conversely, exacerbate) the existence of some 'hard restrictions' on the supply of financial resources? This list of questions could easily be extended.

Despite its limitations, this study points toward the fact that the development and functional capabilities of the financial systems are highly relevant for the status of innovation processes in modern 'knowledge-based' economies.

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ORIGINAL SCIENTIFIC PAPER

# Navigating Sector Momentum: Evaluating Performance in the US and Global ETFs for Retail Investors

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**ABSTRACT**

Modern-day investing comes with numerous options and complexities for non-professional investors. An easy way for them to earn acceptable returns is by investing in market index exchange-traded funds (ETFs). Nonetheless, evidence points to the potential for achieving superior results through a simple sector momentum strategy. This study aims to test whether those results hold when applied to a different dataset and to assess the performance attribution of such a strategy. The analysis is based on two sets of sector ETFs, one focused on the US market and the other on the global market, to explore the applicability of the results in both contexts. For each dataset, performance measures were calculated, and factor analysis was conducted. The findings indicate that sector momentum strategies outperform the benchmark, although no single strategy is universally optimal for every investor or investment opportunity set. Factor analysis confirms that the strategy generates alpha and that its performance cannot be fully explained by traditional factors. Thus, the study reinforces the potential of sector momentum investing, particularly for retail investors, while acknowledging its limitations, such as the exclusion of transaction costs.

**Keywords:** *ETFs, sector investing, momentum strategy, geometrically decreasing weighted portfolio, investment performance evaluation, factor-based models*

**JEL Classification:** G110

## INTRODUCTION

Investors nowadays are faced with a potentially intimidating number of investment opportunities. In order to optimize their investment process, finance theory suggests that they should consider all the possible investments in terms of their risks, returns, and correlations. However, most retail investors do not have enough expertise, or other resources (such as time and money) to perform those complex analyses.

To overcome this issue, retail investors may choose to invest in market index ETFs, as they are a time- and cost-efficient way of getting exposure to the market risk, while maintaining a certain level of diversification. In fact, data shows that ETFs are becoming an increasingly popular investment vehicle, with assets under management surpassing 11 trillion USD at the end of 2023 (PwC, 2024). While that approach may be satisfying for some investors, previous research showed that using simple sector momentum strategies could bring them better results (Korenak and Pavlović, 2023). Sector momentum strategies were based on choosing a certain number of winning sectors and investing in them as opposed to holding a benchmark market index ETF,

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which was represented by SPDR S&P 500 ETF Trust. This study covered the period starting at the beginning of 2010 and ending in June 2023.

The aim of this paper is to investigate whether similar results could be achieved by using different investment opportunity sets. One will be based on Fidelity Sector ETFs (similar to the previously mentioned study by Korenak and Pavlović that used 11 Fidelity sector mutual funds), and the other on iShares Global Sector ETFs, so that the analysis can be performed for the global market as well. The research will cover the results of the hypothetical portfolios in absolute and risk-adjusted terms. In addition to that, factor analyses will be performed to assess the performance attribution.

The conclusions will help us better understand the potential advantages of using sector momentum strategies. If the research further supports the previous findings, it could provide investors with more reliable information for decision-making. Additionally, it can further investigate the source of returns with factor analysis.

The rest of the paper is organized as follows: first, there will be a literature review to summarize the theoretical background of the paper; second, the used data and methodology will be described; third, the results of the portfolios will be presented together with the factor analysis; and lastly, the key findings will be outlined in the conclusion.

## LITERATURE REVIEW

ETFs are relatively new instruments introduced during the 1990s. Their structure makes them an effective tool for passive index investing (Pavlović, Korenak and Stakić, 2024), therefore recommending them to investors who do not have enough time or expertise to invest in a different manner. Their increasing popularity led to significant research concerning this topic.

Some of the research focuses on the advantages of ETFs that are related to the way they were designed. For instance, introducing ETFs to the NYSE has led to significant improvement in their liquidity (Boehmer and Boehmer, 2003). Guedj and Huang (2008) examined whether ETFs are replacing index mutual funds and concluded that the role of ETFs becomes more prominent when the underlying index is narrower and less liquid. Aber, Li and Can (2009) demonstrated that ETFs are more likely to trade at a premium compared to mutual funds based on the same index. Sherrill, Shirley and Stark (2020) proved that the use of ETFs could be beneficial for the actively managed mutual funds.

Other research focuses on the relationship between ETFs and their underlying assets. Richie and Madura (2008) found that including stocks in an ETF improves their liquidity. Ben-David, Franzoni and Moussawi (2018) concluded that stocks with higher ETF ownership exhibit higher volatility, as well as a higher negative autocorrelation. The research also confirms that there is a migration from stocks to ETFs when it comes to retail investing (Meier and Maier, 2023). Additionally, ETFs are proven to be used to indirectly short stocks that are otherwise not available for short selling (Li and Zhu, 2022).

To better understand the source of the ETFs' performance, research papers often use factor-based models. The Capital Asset Pricing Model (CAPM) uses market risk as a factor that drives returns (Jensen, Black and Scholes, 1972). It was further expanded by Fama and French (2004) in their three-factor model that also included value and size factors. They later introduced two additional factors to form a five-factor model: operational profitability and approach to investing (Fama and French, 2016).

When it comes to momentum, Jegadeesh and Titman (1993) documented its presence in single stocks. Carhart (1997) included it in its model as an additional factor. Breloer, Scholz and Wilkens (2014) discovered that introducing country and sector momentum factors to the Fama-French three-factor model reduces the alpha of international and global equity funds, indicating that country and sector momentums are among the sources of returns. Moreover, they proved that adding a traditional stock momentum factor does not significantly change their results, i.e. that

the momentum contained in individual stocks' performance was already captured by the country and sector momentum. Wang and others (2017) claimed that momentum sector investing appears profitable even after taking into account potential transaction costs and systematic risk adjustments. Strategies based on sector momentum were analyzed with the conclusion that there is a potential for simple use of this phenomenon by retail investors in order to achieve better risk-adjusted performance than by holding a benchmark index ETF (Korenak and Pavlović, 2023). This conclusion was further supported by a study that was based on a different investment opportunity set and covered the period that started at the beginning of 2013 and ended in September 2024 (Korenak, Balaban and Pavlović, 2024).

There are many other examples of research that analyzed the performance of ETFs. For instance, Arampatiz and others (2020) examined 50 ETFs using the CAPM model. Rompotis (2020) compared the performance of actively and passively managed ETFs and confirmed the superiority of the latter. Lobato, Rodriguez and Romero (2021) used a volatility match to investigate the risk-adjusted returns of different ETFs. Furthermore, there is evidence that the returns of non-index tracking ETFs are highly correlated to the returns of index ETFs, making the former unjustifiably expensive (Brown, Cederburg and Towner, 2024).

Similarly to the approach taken in this paper, Korenak and Stakić (2022) used the Fama-French five-factor model to analyze the performance of the US small-size value mutual funds. That study was followed by the application of the same model for the performance attribution of US ETFs (Korenak, Stakić and Vesić, 2023). This paper will focus on using the same principles, though the examined portfolios will be based on the sector momentum strategies.

## DATA AND METHODOLOGY

The research is based on two investment opportunity sets that consist of 11 sector ETFs and a benchmark market index ETF each. The first set is presented in Table 1 and encompasses Fidelity Sector ETFs (ETFs 1 to 11 in the table) and is paired with SPDR S&P 500 ETF Trust (ETF number 12) which serves as a benchmark. The other set is shown in Table 2 and is made of iShares Global Sector ETFs (ETFs 1 to 11 in the table) and uses Vanguard Total World Stock ETF as a benchmark (ETF number 12).

**Table 1.** Investment opportunity set based on Fidelity Sector ETFs

| | **Ticker** | **Name of the ETF** |
|---|---|---|
| **1.** | FBMPX | Fidelity Select Communication Services Portfolio |
| **2.** | FSCPX | Fidelity Select Consumer Discretionary Portfolio |
| **3.** | FDFAX | Fidelity Select Consumer Staples Portfolio |
| **4.** | FSENX | Fidelity Select Energy Portfolio |
| **5.** | FIDSX | Fidelity Select Financials Portfolio |
| **6.** | FSPHX | Fidelity Select Health Care Portfolio |
| **7.** | FCYIX | Fidelity Select Industrials Portfolio |
| **8.** | FSPTX | Fidelity Select Technology Portfolio |
| **9.** | FSDPX | Fidelity Select Materials Portfolio |
| **10.** | FRESX | Fidelity Real Estate Investment Portfolio |
| **11.** | FSUTX | Fidelity Select Utilities Portfolio |
| **12.** | SPY | SPDR S&P 500 ETF Trust |

*Source: Authors*

**Table 2.** Investment opportunity set based on iShares Global Sector ETFs

| | Ticker | Name of the ETF |
|---|---|---|
| **1.** | IXP | iShares Global Communication Services ETF |
| **2.** | RXI | iShares Global Consumer Discretionary ETF |
| **3.** | KXI | iShares Global Consumer Staples ETF |
| **4.** | IXC | iShares Global Energy ETF |
| **5.** | IXG | iShares Global Financials ETF |
| **6.** | IXJ | iShares Global Healthcare ETF |
| **7.** | EXI | iShares Global Industrials ETF |
| **8.** | MXI | iShares Global Materials ETF |
| **9.** | IXN | iShares Global Tech ETF |
| **10.** | JXI | iShares Global Utilities ETF |
| **11.** | IFGL | iShares International Developed Real Estate ETF[1] |
| **12.** | VT | Vanguard Total World Stock ETF |

*Source: Authors*

We constructed 13 hypothetical portfolios for every set. Eleven of them were portfolios that followed the sector momentum strategy. This strategy picks the winning sectors by finding those that achieved the highest return over the previous three months. Once those sectors are identified, the assets are invested in an adequate number of sector ETFs (from 1 to 11), with geometrically decreasing weights in accordance with the sector's performance ranking. These portfolios are rebalanced monthly. Additionally, there is an equally weighted portfolio that consists of all 11 sector ETFs. It is rebalanced monthly as well as the momentum portfolios. Lastly, the benchmark portfolio was constructed by investing all the available assets in the benchmark market index ETF and holding that position over the entire observed period.

The study covers the period starting from the beginning of 2009 and ending in September 2024. This period follows the Global Financial Crisis which led to significant changes in the world of finance. Additionally, the ETFs became more popular in this millennium, which assured the data availability for the mentioned period.

For all the portfolios the performance measures were calculated. They included the absolute return, risk, and risk-adjusted return metrics. The risk-free return is represented by the return on 3-month Treasury Bills. The risk-adjusted measures that were used are the following:

$$Sharpe\ ratio = \frac{Annualized\ arithmetic\ mean\ return - Annualized\ risk\ free\ return}{Annualized\ standard\ deviation\ of\ returns} \quad (1)$$

$$Sortino\ ratio = \frac{Annualized\ arithmetic\ mean\ return - Annualized\ risk\ free\ return}{Annualized\ downside\ deviation\ of\ returns} \quad (2)$$

$$Treynor\ ratio = \frac{Annualized\ arithmetic\ mean\ return - Annualized\ risk\ free\ return}{Beta} \quad (3)$$

$$Calmar\ ratio^{2} = \frac{Annualized\ arithmetic\ mean\ return}{Maximum\ drawdown} \quad (4)$$

$$Information\ ratio = \frac{Active\ return}{Tracking\ error} \quad (5)$$

[1] Because of the data availability, we chose the ETF that covers only developed markets for real estate sector.
[2] Calmar ratio is calculated over the last 36 months.

The performance attribution was performed through the use of the Fama-French five-factor model (Fama and French, 2016). Finally, we examined the validity of choosing the five-factor model over the original three-factor model of Fama and French (Fama and French, 2004) for these data sets. All the used factors are from the database provided on Professor French's webpage (Fama and French, 2024).

The three-factor model (equation 6) expands the CAPM (Jensen, Black and Scholes, 1972), which only uses a market premium as the explanatory variable, by introducing two additional factors that are based on a company's size and its categorization as a company with value or growth stocks. The company size is measured by its market capitalization, and the ratio of book to market value is used to determine whether a stock is considered a value or a growth stock. Equation 7 shows the five-factor model, which also includes factors that are based on the operational profitability and on the approach to investing. All the factors introduced by Fama and French are designed as long-short portfolios. E.g. the size factor "buys the small companies", and "shorts the big companies" (SMB – Small Minus Big). Small companies are distinguished as those that comprise 10% of the market, while the rest are considered big. The value (HML – High Minus Low), operational profitability (RMW – Robus Minus Weak) and approach to investing (CMA - Conservative Minus Aggressive) factors follow the same logic, though they are based on the 30$^{th}$ and 70$^{th}$ percentiles of the adequate measures.

$$R_{it} - R_{ft} = a_i + b_i\left(R_{Mt} - R_{ft}\right) + s_i SMB_t + h_i HML_t + e_{it} \quad (6)$$

$$R_{it} - R_{ft} = a_i + b_i\left(R_{Mt} - R_{ft}\right) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it} \quad (7)$$

## RESULTS AND DISCUSSION

### Portfolio Performances

*Performances of Portfolios Based on Fidelity Sector ETFs*

The performance of all 13 portfolios based on the first investment opportunity set (Fidelity Sector ETFs and SPDR S&P 500 ETF Trust) is illustrated in Figure 1. This figure shows the values of every portfolio at different points in time which would have been achieved if the appropriate strategies were implemented with the starting invested capital of $10,000. It is clear that the sector momentum strategy with one winning sector would have achieved the highest ending value of the portfolio. Other sector momentum strategies would have earned lower returns over the observed period, but they would have been quite similar, though generally slightly decreasing with the increase in the number of winning sectors. The lowest ending value would have been related to the equally weighted portfolio, followed by the benchmark portfolio (investment in SPDR S&P 500 ETF Trust).

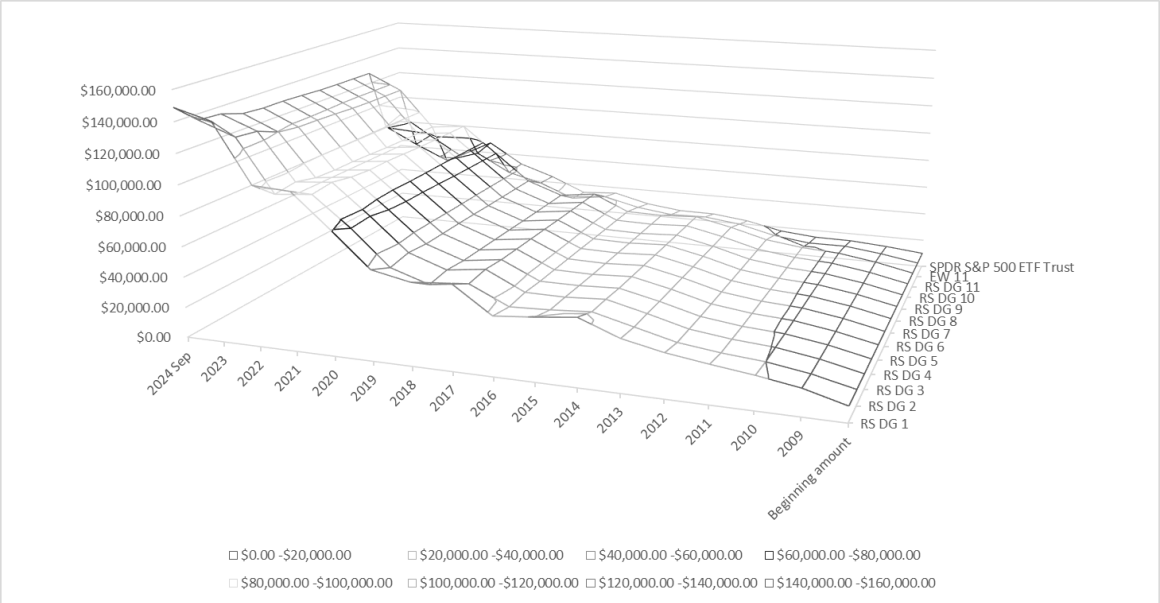


**Figure 1.** Value of portfolios based on Fidelity Sector ETFs

*Source: Authors*

However, these results only illustrate absolute returns, and do not account for the undertaken risk. Therefore, we present more comprehensive measures in Table 3, though every other sector momentum strategy has been omitted for greater legibility, as these strategies achieved similar results.

In addition to the returns (presented as arithmetic and geometric means), this table also presents several risk measures. When it comes to risk, there is no clear answer to the question of which portfolio is the riskiest, as different metrics rank the portfolios differently. Still, the sector momentum strategy with one winning sector has the highest standard deviation, downside deviation, and value at risk, as well as the lowest percentage of positive periods. Its excess kurtosis and maximum drawdown were also among the highest (in absolute terms). However, this portfolio had the highest positive skewness (only the portfolio with 2 winning sectors had the positive skewness as well, which is not shown in the table), and the highest gain-to-loss ratio, and therefore was able to overcome the losses. The other sector momentum strategies were generally less risky, but did not have the same ability to overcome the losses. The equally weighted portfolio had a lower standard deviation, yet it had the highest maximum drawdown and excess kurtosis. The benchmark portfolio achieved lower standard deviation and downside deviation, but it had a high maximum drawdown, the highest negative skewness, and the lowest gain-to-loss ratio. Still, it had the highest percentage of the positive periods.

The question of whether the higher risk was adequately compensated with the higher return remains. As in the previous part of the analysis, the answer is not clear, and it depends on the risk aspect that is the most important to the investor. For instance, the Treynor ratio is the highest for the one-winner strategy, which might be relevant for investors who already have a well-diversified portfolio that they want to expand. The value of all the ratios (Sharpe, Sortino, Treynor, Calmar and information ratio) are similar among the other sector momentum strategies, and they indicate that it might be optimal to choose a strategy with a low number of winners (e.g. three), as the trade-off between risk and return, as well as the simplicity of implementation might be the highest in that case. All of these indicators were lower for the equally weighted portfolio and for the benchmark portfolio, as their risks were followed by lower returns.

**Table 3.** Performance measures of portfolios based on Fidelity Sector ETFs

| | RS DG 1 | RS DG 3 | RS DG 5 | RS DG 7 | RS DG 9 | RS DG 11 | EW 11 | SPDR S&P 500 ETF Trust |
|---|---|---|---|---|---|---|---|---|
| Arithmetic Mean (monthly) | 1.59% | 1.50% | 1.48% | 1.47% | 1.47% | 1.47% | 1.22% | 1.24% |
| Arithmetic Mean (annualized) | 20.84% | 19.61% | 19.22% | 19.17% | 19.11% | 19.11% | 15.65% | 15.90% |
| Geometric Mean (monthly) | 1.44% | 1.39% | 1.36% | 1.36% | 1.36% | 1.36% | 1.11% | 1.14% |
| Geometric Mean (annualized) | 18.70% | 17.97% | 17.65% | 17.62% | 17.56% | 17.56% | 14.19% | 14.60% |
| Standard Deviation (monthly) | 5.56% | 4.86% | 4.76% | 4.74% | 4.73% | 4.73% | 4.64% | 4.37% |
| Standard Deviation (annualized) | 19.25% | 16.83% | 16.49% | 16.41% | 16.39% | 16.38% | 16.09% | 15.13% |
| Downside Deviation (monthly) | 3.00% | 2.75% | 2.70% | 2.69% | 2.69% | 2.69% | 2.83% | 2.70% |
| Maximum Drawdown | -19.93% | -16.32% | -16.49% | -16.58% | -16.67% | -16.68% | -24.15% | -23.93% |
| Beta | 0.83 | 0.9 | 0.91 | 0.91 | 0.91 | 0.91 | 1.03 | 1 |
| Sharpe Ratio | 0.93 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 0.84 | 0.91 |
| Sortino Ratio | 1.71 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.36 | 1.45 |
| Treynor Ratio | 21.69 | 18.89 | 18.28 | 18.18 | 18.11 | 18.1 | 13.14 | 13.77 |
| Calmar Ratio | 0.78 | 0.96 | 1.01 | 1 | 1 | 1 | 0.55 | 0.49 |
| Active Return | 4.11% | 3.38% | 3.05% | 3.02% | 2.97% | 2.96% | -0.41% | N/A |
| Tracking Error | 14.81% | 10.04% | 9.17% | 8.96% | 8.90% | 8.88% | 3.92% | N/A |
| Information Ratio | 0.28 | 0.34 | 0.33 | 0.34 | 0.33 | 0.33 | -0.1 | N/A |
| Skewness | 0.18 | -0.09 | -0.11 | -0.12 | -0.12 | -0.12 | -0.28 | -0.43 |
| Excess Kurtosis | 1.01 | 0.71 | 0.64 | 0.61 | 0.61 | 0.61 | 1.19 | 0.46 |
| Historical Value-at-Risk (5%) | 7.67% | 6.65% | 6.67% | 6.65% | 6.66% | 6.66% | 6.91% | 6.93% |
| Positive Periods | 60.32% | 66.67% | 65.08% | 65.08% | 65.08% | 65.08% | 66.67% | 69.31% |
| Gain/Loss Ratio | 1.39 | 1.11 | 1.18 | 1.18 | 1.18 | 1.18 | 0.99 | 0.9 |

*Source: Authors*

*Performances of Portfolios Based on iShares Global Sector ETFs*

In the same manner as for the previous investment opportunity set, the results for iShares Global Sector ETFs and Vanguard Total World Stock ETF are presented in Figure 2 and Table 4. As in the previous set, the one-winner strategy earned the highest return, and was followed by other sector momentum strategies that achieved similar, though generally lower results as the number of winners increased. Once again, the lowest return was achieved by the equally weighted portfolio, and then by the benchmark portfolio.

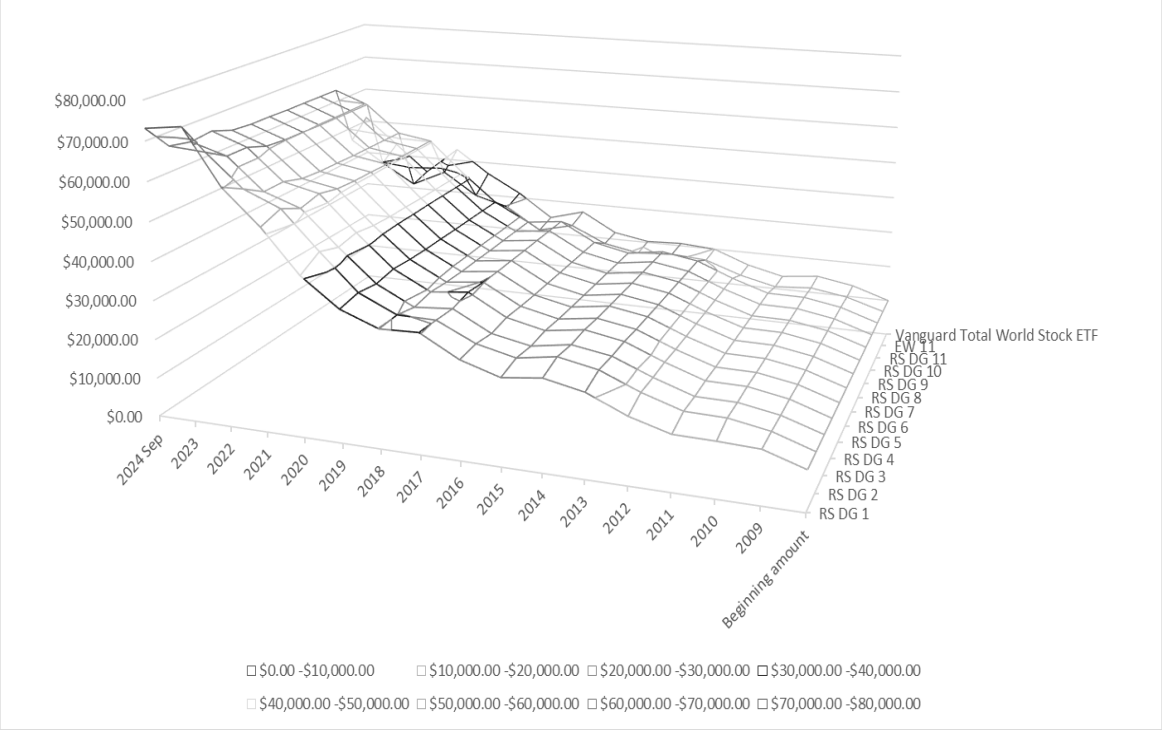


**Figure 2.** Value of portfolios based on iShares Global Sector ETFs
*Source: Authors*

When it comes to the risk measures, the results are somewhat different in comparison to the previous set. Among the sector momentum strategies, the one-winner strategy again seemed to be the riskiest. It had the highest standard deviation, downside deviation, maximum drawdown, excess kurtosis and value at risk, as well as the lowest percentage of positive periods. Still, it once more had the highest positive skewness and the highest gain-to-loss ratio and was therefore able to recover from the losses. The equally weighted portfolio behaved differently. Again, it had a lower standard deviation than the momentum portfolios, but it also had the lowest number of positive periods and was the most negatively skewed. Still, its gain-to-loss ratio was the highest, which helped offset some of the losses. The benchmark portfolio had a relatively high standard deviation, the highest maximum drawdown and value at risk, as well as the lowest gain-to-loss ratio. It was also quite negatively skewed and had a relatively low number of positive periods.

Overall, risk and return results are more uniform among the sector momentum strategies in this set, making it more difficult to distinguish "the best" approach. The values of all the ratios (Sharpe, Sortino, Treynor, Calmar and information ratios) are quite similar for all the sector momentum strategies, with the exception of Treynor and Calmar ratios for the one-winner strategy. In this case, those values are a little bit higher, which suggests that this strategy could be the best for investors who already have well-diversified portfolios that they would like to expand, or for those who would like to earn the highest reward for the maximum drawdown that they have to bear. As this portfolio might be too risky for some investors, others might be more appropriate, but there is not a clear winner, as different ratios rank them differently, though with very small differences. Based on the results, investors could choose any strategy from two to four winners to achieve similar performance and retain simplicity. The conclusion remains even when the equally weighted portfolio and the benchmark portfolio are considered, as they underperformed the sector momentum strategies on a risk-adjusted basis.

**Table 4.** Performance measures of portfolios based on iShares Global Sector ETFs

| | RS DG 1 | RS DG 3 | RS DG 5 | RS DG 7 | RS DG 9 | RS DG 11 | EW 11 | Vanguard Total World Stock ETF |
|---|---|---|---|---|---|---|---|---|
| Arithmetic Mean (monthly) | 1.19% | 1.10% | 1.09% | 1.08% | 1.08% | 1.08% | 0.91% | 0.97% |
| Arithmetic Mean (annualized) | 15.29% | 14.07% | 13.88% | 13.82% | 13.80% | 13.79% | 11.47% | 12.33% |
| Geometric Mean (monthly) | 1.06% | 1.00% | 0.99% | 0.98% | 0.98% | 0.98% | 0.81% | 0.87% |
| Geometric Mean (annualized) | 13.46% | 12.66% | 12.52% | 12.47% | 12.45% | 12.44% | 10.19% | 10.91% |
| Standard Deviation (monthly) | 5.23% | 4.60% | 4.53% | 4.51% | 4.50% | 4.50% | 4.41% | 4.63% |
| Standard Deviation (annualized) | 18.13% | 15.94% | 15.68% | 15.61% | 15.59% | 15.59% | 15.27% | 16.04% |
| Downside Deviation (monthly) | 3.09% | 2.74% | 2.72% | 2.71% | 2.71% | 2.71% | 2.80% | 2.94% |
| Maximum Drawdown | -17.96% | -17.52% | -17.52% | -17.45% | -17.45% | -17.46% | -23.07% | -25.52% |
| Beta | 0.87 | 0.87 | 0.88 | 0.88 | 0.88 | 0.88 | 0.94 | 1 |
| Sharpe Ratio | 0.73 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 | 0.64 | 0.66 |
| Sortino Ratio | 1.22 | 1.26 | 1.25 | 1.25 | 1.25 | 1.25 | 1 | 1.03 |
| Treynor Ratio | 15.24 | 13.92 | 13.68 | 13.6 | 13.58 | 13.56 | 10.46 | 10.61 |
| Calmar Ratio | 0.83 | 0.66 | 0.61 | 0.61 | 0.61 | 0.61 | 0.4 | 0.31 |
| Active Return | 2.55% | 1.75% | 1.61% | 1.56% | 1.54% | 1.53% | -0.72% | N/A |
| Tracking Error | 11.79% | 7.86% | 7.18% | 7.02% | 6.96% | 6.95% | 2.53% | N/A |
| Information Ratio | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | -0.28 | N/A |
| Skewness | 0.09 | -0.05 | -0.11 | -0.12 | -0.12 | -0.12 | -0.34 | -0.33 |
| Excess Kurtosis | 1.23 | 0.49 | 0.48 | 0.46 | 0.46 | 0.46 | 0.83 | 0.67 |
| Historical Value-at-Risk (5%) | 7.12% | 7.08% | 7.04% | 7.03% | 7.03% | 7.03% | 6.69% | 7.59% |
| Positive Periods | 61.90% | 64.55% | 62.96% | 63.49% | 63.49% | 63.49% | 59.79% | 62.96% |
| Gain/Loss Ratio | 1.12 | 1.02 | 1.09 | 1.06 | 1.06 | 1.06 | 1.14 | 0.98 |

*Source: Authors*

## Performance Attribution

*Performance Attribution of Portfolios Based on Fidelity Sector ETFs*

In order to better understand the source of the returns for the sector momentum strategies, we performed factor analyses. We chose the strategy with three winning sectors, as it achieved interesting results in both investment sets. The analysis was carried out through the use of the Fama-French five-factor model and presented in Table 5 (for the Fidelity Sector ETFs).

The factor that had the highest influence over the achieved returns was the market premium ($R_m$-$R_f$), as expected. Our portfolio is a long-only portfolio composed of stock ETFs, and therefore it is logical that it would follow the market. This factor had a positive performance over the observed period and our portfolio had a positive exposure to it, so the overall results were positive. On top of that, it was the only statistically significant factor at the level of 5%.

The SMB (Small Minus Big) factor is the size factor, to which our portfolio was positively exposed, as it favored smaller companies (based on market capitalization). However, over the

observed period the larger companies outperformed the smaller ones, and therefore the overall influence of this factor on our portfolio's return was negative.

The HML (High Minus Low) factor is the value factor based on the book-to-market value. Our portfolio favored the value companies over the growth companies, but they achieved lower returns, so the total effect of this factor on our portfolio was negative.

The RMW (Robust Minus Weak) factor is related to operational profitability. Our portfolio was tilted towards companies that had higher profitability and they did outperform the less profitable ones over the observed period. The overall influence on our strategy's performance was positive.

The CMA (Conservative Minus Aggressive) factor is based on the companies' approach to investing. Our portfolio had a slight bias towards companies that invest aggressively, but they underperformed over the observed period, which led to a total negative effect on the strategy's returns.

The model had an R2 of 66.52% and a positive annual alpha of 5.25%. It is not surprising that R2 was not higher, as our strategy is based on sector momentum and therefore should not be fully explained by the factors used in the Fama-French model. The same is true for alpha – it was expected that the higher returns of this strategy could not be fully explained by exposures to the used factors, which would lead to the alpha that remains in the model. Furthermore, it is statistically significant at the level of 5%.

**Table 5.** Factor analysis of portfolio based on Fidelity Sector ETFs with three winning sectors

| **Factors** | **Rm-Rf** | **SMB** | **HML** | **RMW** | **CMA** | **Annual Alpha** | **$R^2$** |
|---|---|---|---|---|---|---|---|
| Coefficient | 0.85 | 0.07 | 0.07 | 0.02 | -0.04 | 5.25% | 66.52% |
| t-stat | 16.596 | 0.726 | 0.845 | 0.207 | -0.330 | 1.982 | |
| p-value | 0.000 | 0.469 | 0.399 | 0.836 | 0.742 | 0.049 | |
| Factor Premiums (BPS) | 115.82 | -1.79 | -12.22 | 29.53 | 2.79 | | |
| Factor Return | 98.51 | -0.12 | -0.89 | 0.72 | -0.13 | | |

*Source: Authors*

*Performance Attribution of Portfolios Based on iShares Global Sector ETFs*

Just like in the case of Fidelity Sector ETFs, we did a factor analysis based on the Fama-French five-factor model and a sector momentum strategy for three winning sectors, now for the iShares Global Sector investment opportunity set. It is presented in Table 6.

Again, the market risk factor had the highest influence on the returns of our portfolio, as expected. Our strategy was positively related to the stock market, which consistently earned higher returns than the risk-free asset, and determined that our portfolio would achieve positive returns. This factor was statistically significant at the level of 5%.

When it comes to the other factors, the portfolio had a negative exposure to the SMB factor, however, it achieved negative returns, so the overall effect was positive. Exposures to all the remaining factors were positive, but only the RMW factor earned a positive return and led to an overall positive impact on our portfolio, while the effects of the HML and the CMA factors were negative. The HML factor was statistically significant at the level of 5%, the others were not.

$R^2$ of the model was 78.67%. As mentioned before, this result was expected, because the strategy relies on an idea that is not fully grasped by the traditional factors. In addition to that, alpha reached the value of 1.93%, though it was not statistically significant at the level of 5%.

**Table 6.** Factor analysis of portfolio based on iShares Global Sector ETFs with three winning sectors

| Factors | Rm-Rf | SMB | HML | RMW | CMA | Annual Alpha | $R^2$ |
|---|---|---|---|---|---|---|---|
| Coefficient | 0.90 | -0.15 | 0.26 | 0.15 | 0.03 | 1.93% | 78.67% |
| t-stat | 23.159 | -1.321 | 2.428 | 0.987 | 0.207 | 0.952 | |
| p-value | 0.000 | 0.188 | 0.016 | 0.325 | 0.836 | 0.342 | |
| Factor Premium (BPS) | 92.30 | -10.76 | -10.77 | 33.41 | -3.73 | | |
| Factor Return | 83.07 | 1.57 | -2.77 | 5.11 | -0.12 | | |

*Source: Authors*

*Comparison of Different Factor Models*

Concerning our factor analysis, one can ask a question: was the Fama-French five-factor model the most appropriate choice? As mentioned before, we were expecting that the model would not perfectly explain the results that our portfolios achieved and that was particularly noticeable in the case of our US portfolio. We opted for a model with more factors so that there would be more opportunities to explain the attained results. However, the other options were also valid, especially because not many factors were statistically significant, so we decided to compare the five-factor model to the three-factor model, i.e. the original Fama-French model (presented in Table 7).

As it is clear from the data shown, the $R^2$ adjusted was only slightly different than the $R^2$ in all cases. The two models had virtually the same $R^2$ adjusted, though it was somewhat higher in the case of the three-factor model for both sets, which confirms that the RMW and CMA factors could have been omitted. This model also showed a higher level of alpha for the second set, but just like in the five-factor model, it was not statistically significant (the related p-value was 0.217, which is not shown in the table). However, the interpretation of results in the first set might have been affected by using a three-factor model, as it lowered the value of alpha and made it statistically insignificant at the level of 5% (it increased the p-value to 0.094).

**Table 7.** Comparison of Different Factor Models

| Name | Fama-French three-factor model | | | Fama-French five-factor model | | |
|---|---|---|---|---|---|---|
| | Annual Alpha | $R^2$ | $R^2$ Adjusted | Annual Alpha | $R^2$ | $R^2$ Adjusted |
| RS GD 3 – Fidelity U.S. | 5.14% | 66.4% | 65.9% | 5.25% | 66.5% | 65.6% |
| RS GD 3 – iShares Global | 2.40% | 78.6% | 78.3% | 1.93% | 78.7% | 78.1% |

*Source: Authors*

## CONCLUSION

Performance evaluation results of momentum portfolios relative to the equally weighted portfolio and the benchmark portfolio were similar in both investment opportunity sets. The sector momentum strategies outperformed the other two, as they achieved higher absolute returns. This conclusion remained the same even when the risk was taken into account, which was supported by the risk-adjusted measures. Therefore, these strategies could be used by investors to enhance their returns (assuming that the previous prevailing market conditions persist), whether they are focusing on the US market or prefer global investing.

However, the results do not suggest that any specific momentum strategy is the optimal one. Rather, it depends on the investment opportunity set that is used to form a strategy, as well as on the preferences of individual investors, e.g. the risk aspects that are the most important to them.

The factor analyses helped us understand the source of the achieved returns for the sector momentum strategies with three winning sectors. As expected, the market premium had the most significant role in influencing these returns. Furthermore, the Fama-French five-factor model did not fully attribute the performance of our portfolios to its factors, as they are not perfectly related to the sector momentum that was behind the strategy. Therefore, the model confirms that alpha was generated, especially in the first investment set.

The lack of statistical significance of some of the factors in the five-factor model led us to examine if the three-factor model was more appropriate. The results generally do not indicate that different models would have affected our previous conclusions significantly.

The findings are in line with the studies that were previously performed (Korenak and Pavlović, 2023 and Korenak, Balaban and Pavlović, 2024). In addition to that, the factor analysis further supported that a part of the returns cannot be tied to traditional factors, which suggests that sector momentum can be seen as a separate factor that could easily be deployed by investors through the use of sector ETFs.

Still, the study has certain limitations. First of all, it does not take into account the effects of transaction costs and taxes. Secondly, it is based on two limited investment opportunity sets, as well as on a limited time period. Thirdly, the study used geometrically decreasing weights, but did not examine whether that is the optimal approach. These limitations leave room for additional research in the future.

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PRELIMINARY REPORT

# Digital Development of Serbia Compared to Selected European Countries: A Comparative Analysis

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**ABSTRACT**
The aim of this research is to analyze the level of digital development achieved by sixteen European countries based on Microsoft's Digital Future Index from 2021. The countries analyzed in the report are classified into three groups: a) Digitally Advanced "Benchmark" Countries of Western Europe (the Netherlands, Denmark, Sweden, and Finland), b) Europe's Fast-Growing Digital Leaders (Czech Republic, Estonia, Malta, Slovenia, and Portugal), and c) Digital Followers of Central & Eastern Europe (Croatia, Hungary, Poland, Romania, Russia, Serbia, and Greece). By applying comparative graphical analysis, using a 45-degree line, the relationship between the Level of Digital Development and the Benefits of Digitization in these countries was examined. The findings indicate that economies with a relatively lower Digital Development Score achieved relatively higher Economic and Social Gains Scores. This highlights the need for more efficient management of digitalization factors in countries leading the digital development process. Furthermore, the inputs to the development of digitization and the economic and social results of achieved digital development were visually compared both for the three previously identified groups of European countries and specifically for the Republic of Serbia. The research findings demonstrate that the digital Followers of Central & Eastern Europe significantly lag behind the "Benchmark" countries of Western Europe and Europe's fast-growing digital leaders in terms of achieved digitalization levels. Serbia lags in the development of digital infrastructure, digital skills, the adoption of digital technologies, and the overall level of human capital development compared to other European countries.

**Keywords:** *digitization, development of digitization, Microsoft's Digital Future Index, Serbia, digital ecosystem*

**JEL Classification:** O10, O33, I25

## INTRODUCTION

For some researchers, the beginning of digitization and the digital revolution is connected with the invention of the microprocessor in 1973 and its mass use. Others, on the other hand, believe that the general digitization of numerous social and economic activities began in the 1990s with the invention of the Internet. In any case, the digitization process is identified as the most significant technological trend that radically transforms society and all economic activities without exception (Fitzgerald et al., 2014).

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The modern economy is in the midst of a deep transformation, supported by the strong development of digitization in all spheres of society (Nedić et al., 2014). The comprehensive digitization of the economy and society is changing people's lifestyles and areas of interest, while simultaneously redefining the key principles of companies' operations (Bataev & Aleksandrova, 2020).

Bukht and Heeks (2017) point to the need to distinguish three levels of content coverage of the category of digital development: a wider range (digitalized economy), a narrower range (digital economy), and the central part - the ICT sector (Figure 1).

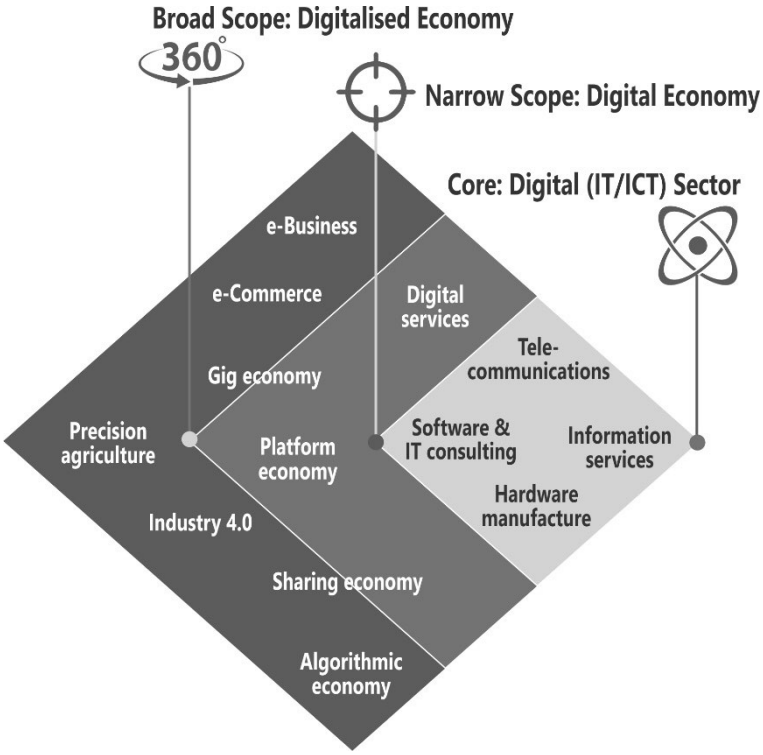


**Figure 1**: Ranges of digitization
*Modified from: Bukht & Heeks, 2017*

Digitization has the potential to increase productivity, facilitate access to new markets, create new industries and jobs, improve service delivery, enhance people's well-being, and enable more sustainable models of environmental protection (Singgalen et al., 2019). However, it can also introduce new sources of social exclusion, a greater concentration of wealth in the hands of a smaller number of economic subjects, and lead to the emergence of many new risks in terms of security and data protection, as well as increased energy consumption, among other challenges. The failure to advance in the digital transformation of the economy and society is inevitably connected to the slowing down of the economic growth of the country and the widening gap in competitiveness, along with the growth of inequality in the distribution of created value compared to technologically and economically leading economies.

Digitization is transforming the economy and society by enabling changes in models of interaction and social communication, business, production, and the provision of public services (Shkarlet et al., 2020). In the literature, it is often concluded that digital development enables the emergence of many business models that encourage innovation and efficiency, as this process improves connectivity, knowledge and experience, flexibility, and more (Bowman et al., 2018). This is how digital societies and economies are emerging, increasingly basing their activities

(education, healthcare, production, marketing, entertainment, etc.) on the combined use of various digital technologies.

Digitization generates new forms of value creation with the potential to increase productivity, competitiveness, well-being, and social inclusion while also promoting greater environmental sustainability (Lee et al., 2019). This value creation is based on knowledge generated from digital data obtained from production and consumption processes through intelligent systems that utilize advanced digital technologies.

The development of digitization favors the emergence of new business models for the provision of goods and services online (Dornberger et al., 2019). These digital platform models promote the generation and collection of data to offer new value in the provision of goods and services across various economic sectors. This transformation is facilitated by the adoption of advanced technologies such as fifth-generation (5G) mobile networks, the Internet of Things, cloud computing, artificial intelligence, virtual reality, big data analysis, and cognitive robotics.

Research has confirmed the positive effect of digitalization on economic efficiency (Gao et al., 2022; Niu et al., 2024). Digital transformation has become a necessary element for ensuring the sustainable economic development of many countries. Specifically, at the macro level, comprehensive digitization can shift the point of production closer to the production possibilities frontier, thereby increasing the allocative efficiency of the economy (Nambisan et al., 2019; Sanders et al., 2019; Mishra et al., 2022). Numerous studies have highlighted the positive impact of digitization on employment growth and the promotion of entrepreneurship (Zhang et al., 2022; Wu & Yang, 2022), as well as many positive changes in the structure of the industry (Wang & Chen, 2024).

The development of digitization results in numerous spillover effects and synergistic effects in mitigating disparities between urban and rural areas, regions, and industries. According to research, the advancement of digitalization in China has improved the entrepreneurial behavior of residents in rural areas, thus actively reducing development inequalities between cities and villages (Xie et al., 2020; Li, 2024). Moreover, through the synergistic effects of "industrial digitalization" and "digital industrialization," the development of digitalization fosters cooperative relationships along the entire production and sales chain. This creates a common industrial ecosystem connected by technological resources, driving the transformation and upgrading of industrial and supply chains, thereby promoting the coordinated development of individual industrial sectors (Vignaraja et al., 2016; An et al., 2024).

Without a comprehensive vision of digitization, positive impacts could turn into negative factors in terms of competitiveness, concentration, and inequality. For example, vulnerable segments of society could be marginalized in accessing online services, while a lack of digital skills could adversely affect employment opportunities. The net impact of digitization depends on people's awareness of the importance of digital transformation and timely policies to steer digitization toward sustainable development.

Integrating digital transformation efforts with productive development at the enterprise level is key. Digital development policies in the digital age should not be limited to production processes and structural changes. On the contrary, they should expand their sectoral focus, considering the transnational nature of digital flows and the inclusion of new strategic sectors, such as digital ecosystems. Similarly, social development policies in the digital age must adapt to this technological transformation by focusing on education and strengthening digital competencies and skills to ensure a larger pool of experts for the development and growing application of digital technology.

The aim of this research is to assess the level of digitization in the Republic of Serbia based on a comparison of the basic parameters of two key sub-indices that evaluate the drivers of digital development in individual countries and the socio-economic results of digital development.

Hypotheses:

**H1**: The level of digitization in the Republic of Serbia lags significantly behind the digitally advanced countries of Western Europe and most of Europe's fast-growing digital leaders.

**H2**: There are certain areas of digital development in the Republic of Serbia where results comparable to those of Central and Eastern European countries have been achieved.

Using Microsoft's Digital Future Index from 2021, this paper aims to present the key performance indicators of Serbia's achieved level of digital development in comparison with 14 European countries covered in the report, applying commonly used tools in comparative analyses. This is particularly important for shaping Serbia's development policy throughout this decade. It should be emphasized that the methodology for grouping countries based on their achieved level of digital development in this study is entirely arbitrary, as it has not been adopted from any other source but rather reflects solely the authors' approach to this issue.

## INDICATORS OF DIGITAL DEVELOPMENT OF COUNTRIES WITH AN EMPHASIS ON THE DIGITAL FUTURE INDEX

A number of indexes have been created for monitoring and comparing the development of digitization. One of the indicators that is often used in economic research is the ICT Development Index (IDI) published by the International Telecommunication Union (ITU). The IDI is a composite index that measures the development of information and communication technologies (ICT) among countries. The index consists of various criteria, such as the population's access to ICT, the use of ICT by the population, and the ICT skills of the population in the country (ITU, 2017).

The Digital Adoption Index (DAI), published by the World Bank, observes the application of digital technology in three key areas: businesses, government, and people (World Bank, 2016). This indicator is important for discovering how digitization affects the country's economy as a whole. However, DAI data were only available during the years 2014-2016, so they were not included in the scope of this study.

The E-Government Index (EGI) is published by the United Nations. The EGI measures the willingness and ability of national governments to use ICT in the provision of public services (United Nations, 2020). The index summarizes the provision of e-government services online and provides an overview of how well governments are embracing digital technologies. The EGI consists of three sub-indices: the Online Service Index (OSI), the Telecommunication Infrastructure Index (TII), and the Human Capital Index (HCI).

Since 2014, the European Commission has been monitoring the progress in the digitization of member countries by publishing annual reports of the Digital Economy and Society Index (DESI). Each year, the reports include country profiles, which help member states to identify areas for priority action at the EU level in key areas of digital policy.

The Digital Economy and Society Index (DESI) was developed by the European Commission in 2014 for the purpose of evaluating the development of member countries in the direction of digitization of the economy and society. Its composition consists of packages of relevant indicators structured in four dimensions: human capital, connectivity, integration of digital technology, and digital public services. The DESI index can range from 0 to 1, where a higher value indicates greater success in the field of digitization (European Commission, 2024).

As a measure of the reached level of the digitized economy, Microsoft promoted the Index of the Digital Future of Countries in 2021. It is a composite index based on over 1,000 data sources obtained from reliable public institutions. These sources include organizations such as the European Commission, the European Investment Bank, Eurofound, UNESCO, the World Bank, the OECD, the World Trade Organization, and the United Nations (Microsoft News Center Europe, n.d.).

The Digital Future Index models the relationship between the digital development of society as an input aggregate and the key outcomes of social development as an output aggregate. The index is based on 55 indicators, of which 43 are used to evaluate digital development, while 12 indicators refer to the evaluation of key outcomes of digital transformations. It can be said that the choice of indicators largely ensures a holistic view of the achieved level of digital transformations of individual national economies, as well as the impact of these transformations on social and economic results (Figures 2).

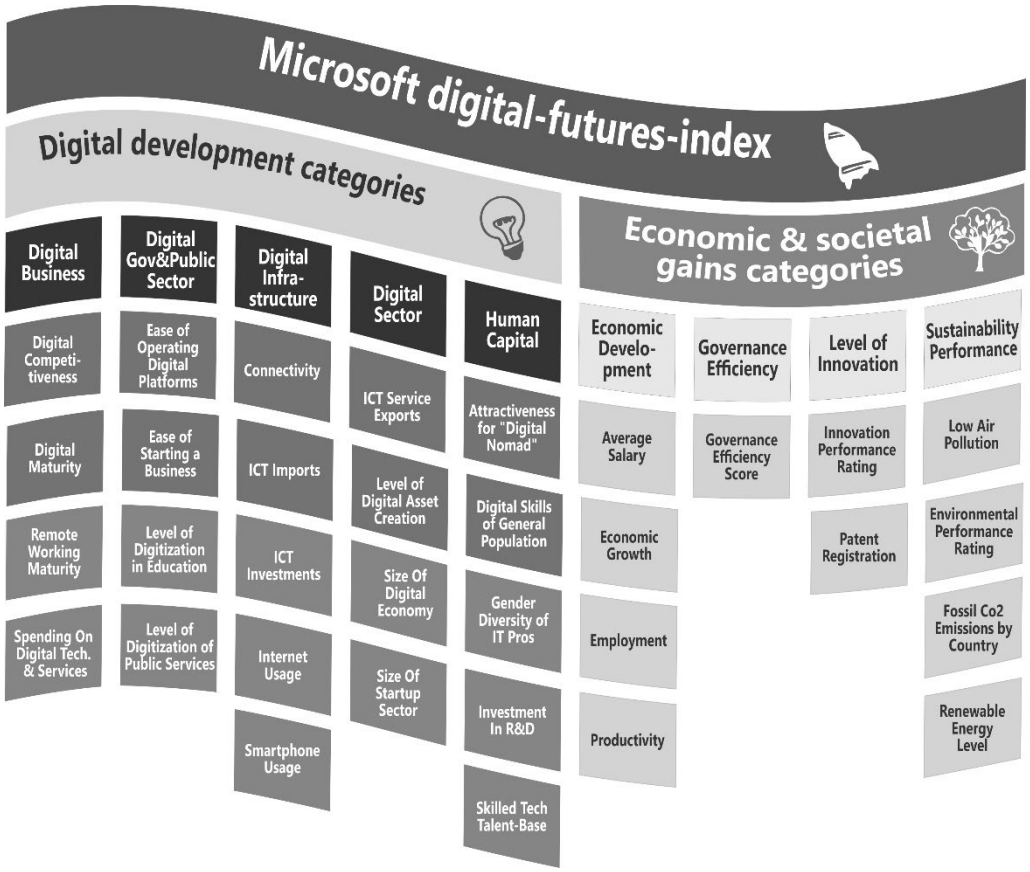


**Figure 2.** Structure of Microsoft's Digital Future Index

*Source: Authors, based on CEE Multi-Country News Center, n.d.*

Each category is divided into subcategories represented by one or an aggregation of two or more indicators. Incentive or input parameters define the potential and suitability of the environment for stimulating digital transformations in the economy, such as digital competitiveness, ease of starting a business, ICT import, ICT export, and the technical talent base. Outputs reflect the results of input indicators, including average salary, productivity, patent registration, air pollution levels, and evaluations of public administration efficiency.

The sixteen European countries present in the Report on the Digital Future are classified into three groups for the purposes of this research. The first group, referred to as "benchmark" countries, includes digitally advanced nations such as the Netherlands, Denmark, Sweden, and Finland. Generally, these countries achieve high results in all aspects of digital development. They are leaders in digital transformation, utilizing the most advanced technologies, maintaining developed digital infrastructures, and possessing high levels of digital skills among their citizens.

Another group, consisting of Europe's fast-growing new digital leaders, includes the Czech Republic, Estonia, Malta, Slovenia, and Portugal. These countries are undergoing a rapid digital transformation, showing significant progress in digital technologies and innovation, and achieving

good results in several key areas of digitization. Although they are not on par with benchmark countries, they demonstrate rapid growth in digitalization.

The third group includes seven countries labeled as advanced digital follower environments (learners) from Central and Eastern Europe: Croatia, Hungary, Poland, Romania, Russia, Serbia, and Greece. These countries are at different stages of digital transformation but generally lag behind more advanced European countries in terms of digital infrastructure, skills, and the application of digital technologies. Results in these countries are often lower compared to those of Western European and fast-growing digital leaders (Figure 3).

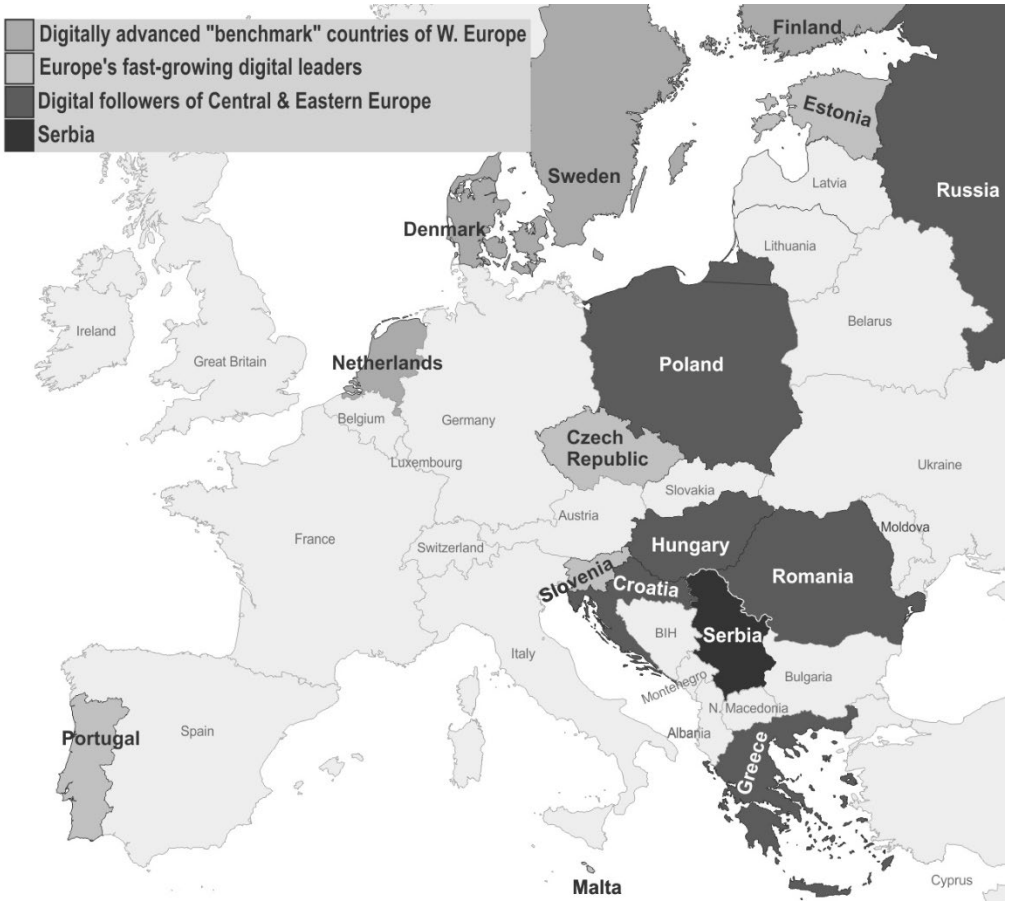


**Figure 3.** Countries Included in Microsoft's Digital Future Index

*Source: Authors, based on Microsoft News Center Europe, n.d.*

It should be noted that the selection of the 16 observed European countries by the creators of the Microsoft index is based on the assessment that these are national economies with significant capacity and potential for rapid further progress in the field of digitization. This selection allows the index to provide a comprehensive insight into the digital development of the selected European economies, taking into account the different contexts and specificities of individual regions.

## EFFECTIVENESS OF DIGITAL DEVELOPMENT IN SELECTED EUROPEAN COUNTRIES

The question of the economic efficiency of the digital transformation process in countries can be examined as the relationship between the factors of digital development and the socio-economic effects of the achieved level of digital development. Figure 4 illustrates the relationship between the factors of digital development and the socio-economic effects of digitalization in 16

European countries, classified into three groups based on their level of digitalization, according to Microsoft's Digital Future Index from 2021.

On the x-axis are digital inputs—indicators that reflect the level of investment in building digital capacity, such as investments in IT infrastructure, the number of qualified IT experts, and the availability of digital technologies and services. The y-axis represents the economic and social benefits of these investments, including increases in GDP, productivity, innovation, and improvements in living standards.

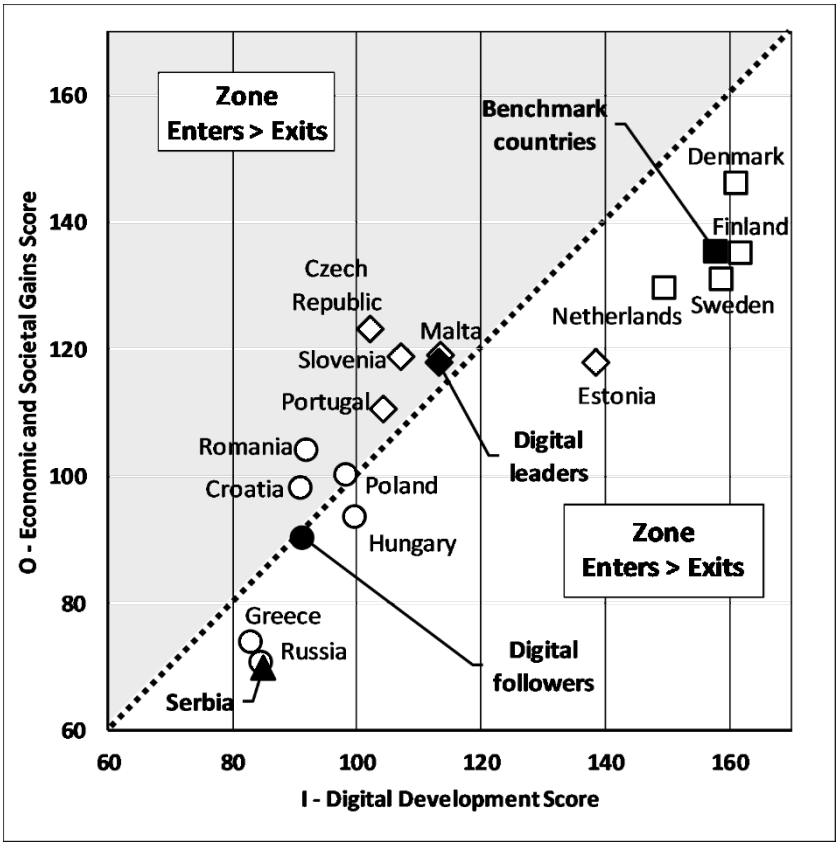


**Figure 4**: Level of Digital Development and Benefits of Digitization

*Source: Authors, based on the CEE Multi-Country News Center database, n.d.*

Countries in the zone where investments are < results (upper left side) achieve relatively greater economic and social effects compared to total investments in the development of digitalization of the economy. This may indicate efficient use of digital resources, where even smaller investments lead to relatively larger benefits. The countries in this zone are: the Czech Republic, Slovenia, and Portugal. Romania and Croatia are close to this threshold, implying that their level of digitalization brings proportional or even higher returns on investment.

Countries in the zones where investments in drivers > digital results (bottom right side of Figure 4) have high investments in the development of the digital economy, but they have not yet reached the level of economic and social benefits that would be proportional to their investments in digitalization development. This may indicate the need to optimize resources or align their digital strategy to increase the effectiveness of their investments. The countries in this group are: Denmark, Finland, Sweden, the Netherlands, and Estonia.

Borderland countries are located on or near the equilibrium line between digital inputs and outputs. These countries record proportional results in terms of investments and outcomes. These are the following countries: Poland, Hungary, Greece, the Russian Federation, and Serbia.

Based on the diagram, countries with lower investments (digital inputs) achieve similar or even greater benefits compared to those with higher investments, suggesting the need for better implementation and more effective management of digitization factors. The question arises as to why the most economically developed countries in the diagram show relatively weaker economic and social effects of digitalization compared to their large investments in the drivers of digitalization development.

The answer can be:

**a)** Market Saturation and Reduced Return on Investment

The most developed countries have already achieved a high level of digitization, making additional investments in digital infrastructure less effective at generating new economic benefits. For instance, once basic digital infrastructure (such as high-speed internet and widespread digital device usage) is in place, further investments in digitalization yield progressively smaller economic and social effects.

According to the economic theory of diminishing marginal returns, investing in resources that are already at a high level results in diminishing returns in terms of benefits. This means that countries that are already highly developed digitally do not achieve the same gains in digital economic and societal growth as countries that are at earlier stages of the digital transition.

**b)** Structural and Regulatory Factors

In developed countries, complex regulations may slow the application of digital technologies, even when there are significant investments in digitalization. For example, strict regulations on data privacy, consumer protection, or labor rights can hinder or slow the implementation of new digital solutions. Traditional economic sectors, such as industry or services, may resist the introduction of new technologies. In these countries, the adoption of digitization in traditional industries might be slower due to the need for a radical restructuring of existing production methods.

**c)** High Starting Base

Economically advanced countries already experience significant economic and social benefits from digitization. However, since they are at a high level, further growth becomes limited. Countries starting from a lower base can achieve relatively better results from investments in digitalization compared to more developed nations that are nearing the upper limits of their technological potential. Innovation in highly developed digital economies may also be more challenging, as many of the obvious and readily available benefits of digitization have already been realized. Moreover, these countries might be investing in research and development that will yield long-term benefits, which can impact the current correlation between digital development investments and their economic and social outcomes.

**d)** Social and Cultural Factors

Even with a high level of digital infrastructure, developed countries may face societal challenges in adapting to rapid technological advancements. For example, an aging population or a traditional workforce may struggle with adopting new technologies, thereby reducing the economic benefits of digital investments. In these countries, there may also be a stronger emphasis on social aspects that are not always easily measured economically. For instance, investments in technology may not yield direct economic returns but may instead improve quality of life through better healthcare, a higher quality education system, or reduced inequality in the distribution of income and wealth. These benefits may not be fully captured by traditional economic indicators.

**e)** Transition to More Complex Technologies

The most developed countries are now investing in advanced technologies such as artificial intelligence, quantum computing, and cutting-edge research, the benefits of which may not be immediately apparent. These technologies demand significant investment and extended periods

for research and development, with the effects often becoming visible only after many years. As a result, in highly developed nations, additional investments in digital technology development do not necessarily lead to proportionally higher economic and social outputs. This is due to factors like market saturation, diminishing returns on investment, regulatory challenges, an already high starting base, and a focus on long-term innovation.

In contrast, countries at earlier stages of digital development have the potential to realize faster and more substantial benefits from their investments. These nations, by focusing on foundational digital infrastructure and technologies, can achieve more immediate and visible improvements in economic and social outcomes.

This raises an important question, as seen in Figure 2: How do digital leaders manage to achieve relatively high economic and social effects from existing investments in digitalization development?

The answer to the question raised earlier suggests that new digital leaders achieve relatively high economic and social results from their investments in digitalization due to the efficient use of digital resources:

**a)** Effective Application of Digital Technologies

Digital leaders integrate digital technologies across all sectors of the economy, including industry, services, agriculture, and the public sector. These countries use digital tools to optimize business processes, leading to greater productivity and efficiency, which, in turn, amplifies the economic and social effects of digital development. Automation and artificial intelligence enable leaders to improve efficiency in production, analytics, and decision-making, allowing them to rapidly scale economic and social benefits with relatively modest additional investments.

**b)** Focus on Research and Innovation

Digital leaders invest in innovative startups, research centers, and collaborations between the private sector and universities. These investments foster the continuous development of new technologies and solutions, driving economic growth. Furthermore, these countries often attract investment from international funds, venture capital firms, and global technology leaders, which bolsters their research and development capacities.

**c)** High Level of Digital Skills in the Population

Digitalization leaders invest heavily in their education systems, ensuring that their workforce possesses advanced digital skills. A focus on science, technology, engineering, and mathematics (STEM) in educational programs enables the creation of a highly skilled workforce that can quickly adopt new technologies, thereby increasing productivity. Leaders in digitalization also promote a culture of lifelong learning and adaptation, allowing employees and businesses to keep pace with technological innovations, maximizing the benefits.

**d)** Support for Entrepreneurship and Small Businesses

Digitalization leaders support small and medium-sized enterprises (SMEs) through digital transformation programs, subsidies, and training. SMEs that embrace digital technologies experience significant gains in productivity and competitiveness, contributing to overall economic growth. Additionally, these countries often develop digital platforms that facilitate easier access to markets, financing, and new customers for SMEs, thus enhancing both social and economic outcomes.

**e)** Digitally Driven Government and Public Services

Digital leaders frequently implement digital public services that enhance government efficiency, reduce costs, and improve service quality for citizens. E-government, e-health, and digital education platforms, for example, provide faster and more cost-effective access to services. These countries also promote open data and transparency through digital technologies, helping to combat corruption, build public trust, and foster sustainable social development.

**f)** International Integration and Digital Cooperation

Digital leaders integrate their economies into global digital value chains, allowing them to capitalize on international markets for greater economic benefits. These nations play key roles in setting global standards for digitalization, enabling them to align their digital strategies with international rules and markets, thereby maximizing the returns on their digitalization investments.

**g)** Favorable Business Climate for Digital Innovation

Digital leaders create regulatory frameworks that foster innovation and adapt to the fast-changing dynamics of the digital landscape. These frameworks make it easier to start and manage digital businesses and adopt new technologies. By offering tax incentives and subsidies for digital transformation, governments help businesses invest in digital infrastructure without straining their budgets.

**h)** Agility and Adaptability in Policy

Digital leaders are adept at quickly adjusting their strategies to align with emerging digital trends and technologies. For example, recognizing the rapid potential of 5G networks, cloud computing, or blockchain solutions allows them to realize significant benefits ahead of other countries. Strong collaboration between government, tech companies, and academic institutions enables these leaders to fully exploit the potential of new technologies through partnerships and joint initiatives.

## THE POSITION OF THE REPUBLIC OF SERBIA IN RELATION TO THE COUNTRIES INCLUDED IN THE DIGITAL FUTURE INDEX

The effectiveness of the digitalization process in the economy of the Republic of Serbia, in comparison to the other 15 European countries classified into the three previously defined groups, can be illustrated as a ratio between investments in the development of digitalization and the economic and social benefits derived from such investments. This relationship is depicted in Figure 5.

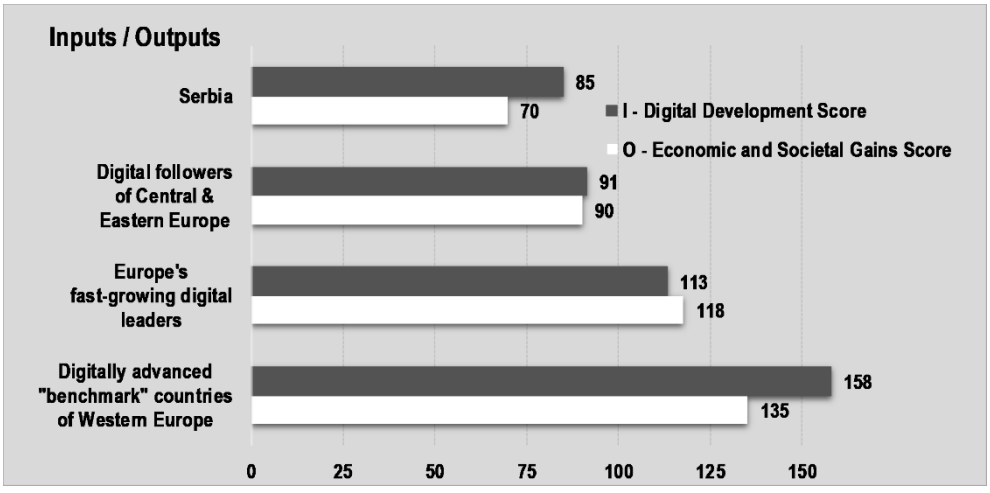


**Figure 5.** Comparative Presentation of Inputs to the Development of Digitization and the Economic and Social Results of Achieved Digital Development

*Source: Authors, based on the CEE Multi-Country News Center database, n.d.*

Based on the data and analysis presented in Figure 5, it is evident that Serbia significantly lags behind in overall investments in digital development and the associated benefits compared to other European countries. Specifically, Serbia's entry sub-index for digital development stands at 85, markedly lower than the average of the leading benchmark countries in Western Europe

(158) and the new digital leaders in Europe (113). Furthermore, when compared to the average of Central and Eastern European countries, Serbia's index of 91 indicates a deficiency in digital infrastructure and a lack of investments in digital technology.

The gap becomes even more pronounced in the output sub-index, which measures the economic and social benefits of digitization. Serbia's score of 70 is considerably below the averages of Western Europe (135) and the new digital leaders in Europe (118). This indicator suggests that Serbia has yet to fully capitalize on the potential of digital development, in contrast to both Western European countries and those in Central and Eastern Europe.

A further analysis of the five key categories of digital development, as defined by the Microsoft Digital Future Index, reveals that Serbia has fallen behind in recent years across all areas, with the exception of the development of the Digital Sector, when compared to the leading countries in Western Europe as well as those in Central and Eastern Europe (see Figure 6). The most significant gaps are observed in the categories of digital business, digital infrastructure, and human capital, where Serbia shows considerably lower results. These areas are crucial for successful digital development; therefore, it is imperative for Serbia to make substantial improvements in these segments to enhance its competitiveness with leading European countries in the realm of digital advancement.

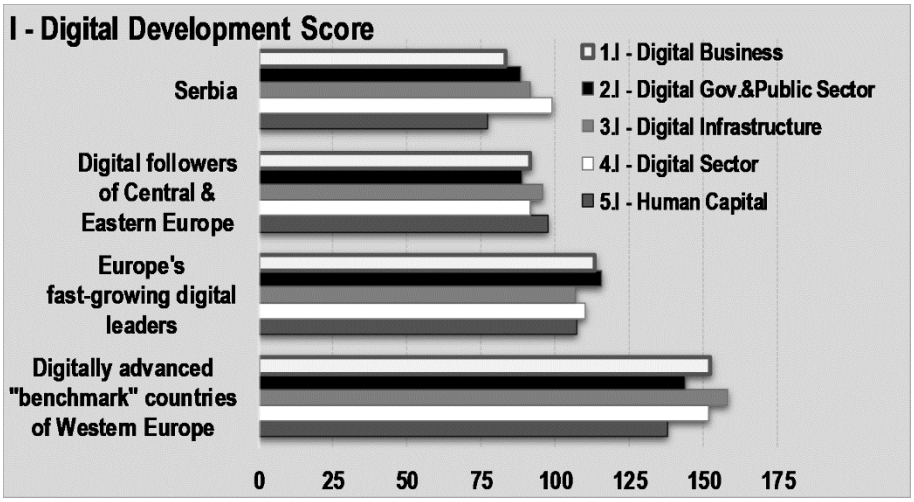


**Figure 6.** Comparative presentation of the value of individual digitization areas

*Source: Authors, based on the CEE Multi-Country News Center database, n.d.*

Although Serbia is relatively well-positioned in the digital sector, with a score exceeding the average of the Central and Eastern European digital followers, serious interventions are required in other categories. Particularly concerning is Serbia's position in the area of human capital, where the lag is most pronounced. Insufficient investments in education and the development of digital skills pose significant obstacles to enhancing Serbia's competitiveness in the European digital market.

If the necessary improvements are not made in these critical areas, there is a genuine risk that Serbia will fall further behind in the digital transformation process, potentially resulting in long-term negative consequences for the economy and society as a whole. Prioritizing the enhancement of human capital, the improvement of digital infrastructure, and the support of digital businesses must become central to Serbia's development strategy in order to narrow the existing gap and facilitate sustainable digital progress.

According to the data presented in Figure 7, Serbia trails behind leading "benchmark" countries in Europe across all categories of economic and social benefits, as measured by the Microsoft Digital Future Index. The most significant deficit is observed in management efficiency, where

Serbia's results are considerably lower compared to the new digital leaders in Europe and the average of digital follower countries in Central and Eastern Europe. This indicator highlights a serious shortfall in administrative capacity and effectiveness, potentially linked to the inadequate modernization of administrative processes and ineffective measures against corruption.

Furthermore, Serbia's economic development and innovation levels are below average, signaling an urgent need for increased investments and reforms in these areas. Without adequate support for innovation, Serbia risks further stagnation in global competition, which could limit its economic growth and development. Additionally, Serbia demonstrates significantly weaker performance in sustainability compared to digital follower countries in Central and Eastern Europe. This situation underscores the necessity for substantial investments and reforms in management, innovation, and sustainable development to improve Serbia's standing on the European stage and foster greater economic and social progress.

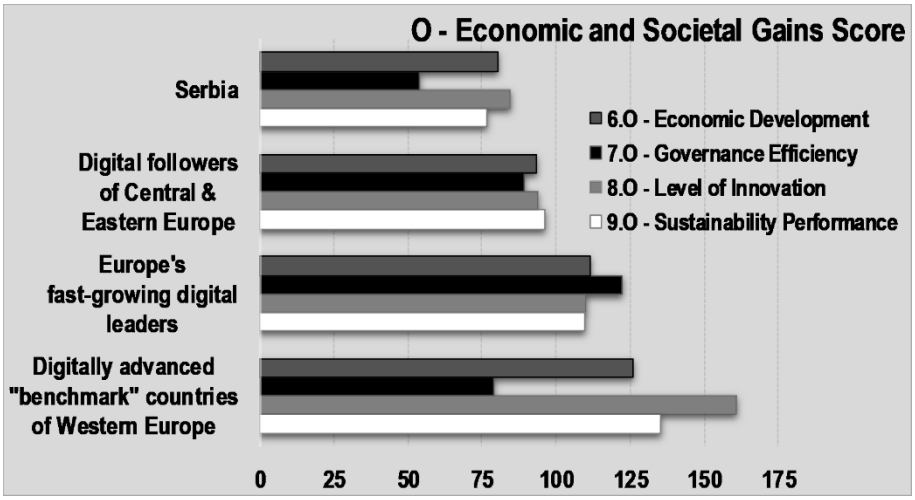


**Figure 7.** Comparative Presentation of the Values of Categories of Economic/Social Results as Output

*Source: Authors, based on the CEE Multi-Country News Center database, n.d.*

Several factors contribute to the relative position of the Republic of Serbia in relation to the three selected groups of European countries within the digital economy domain. Primarily, the lack of institutional reforms in public administration and an ineffective fight against corruption significantly undermine governance effectiveness and impact overall economic development. Additionally, insufficient systemic investments in fostering economic innovation, education, and research and development activities further hinder progress.

The low competitiveness of Serbia's economy is largely attributable to an inadequate business environment and insufficient infrastructure development. Moreover, inefficient sustainable and responsible business policies may further weaken Serbia's position relative to other European countries concerning digital development.

To analyze Serbia's standing in relation to the average values of the three groups of countries, the next phase of this research will involve a detailed examination of individual attributes within the previously presented categories of the Digital Future Index, as illustrated in Tables 1 and 2. This approach will provide deeper insights into specific weaknesses and identify potential areas for improvement.

**Table 1.** Comparative Presentation of All Attributes of Digital Development as Input

| Attribute name | Digitally advanced "benchmark" countries of Western Europe | Europe's fast-growing digital leaders | Digital followers of Central & Eastern Europe | Serbia |
|---|---|---|---|---|
| 1.1-Digital Competitiveness | 155.74 | 121,568 | 86.00667 | 76.09 |
| 1.2-Digital Maturity | 141,633 | 110.218 | 94.99167 | 78.95 |
| 1.3-Remote Working Maturity | 125,083 | 104.078 | 96.81833 | 98.75 |
| 1.4-Spending On Digital Tech & Services | 155.06 | 109,936 | 93.50833 | 89.28 |
| 2.1-Ease of Operating Digital Platforms | 147,705 | 123,948 | 84.55333 | 72.99 |
| 2.2-Ease of Starting a Business | 137.6 | 106,852 | 93.48333 | 104.81 |
| 2.3-Level of Digitization in Education | 122,613 | 106,036 | 94.58167 | 102.3 |
| 2.4-Level of Digitization of Public Services | 143.358 | 117,994 | 88.49667 | 79.06 |
| 3.1-Connectivity | 141.153 | 107,696 | 95.29333 | 89.76 |
| 3.2-ICT Imports | 152.68 | 98.22 | 97.13667 | 126.14 |
| 3.3-ICT Investments | 163,708 | 106,906 | 95.89333 | 90.17 |
| 3.4-Internet Usage | 153,793 | 109,638 | 95.80333 | 77.02 |
| 3.5-Smartphone Usage | 157,905 | 107,786 | 96.62333 | 81.39 |
| 4.1-ICT Service Exports | 122.79 | 93.214 | 98.97 | 140.14 |
| 4.2-Level of Digital Asset Creation | 151,058 | 113,522 | 90.76167 | 87.87 |
| 4.3-Size Of Digital Economy | 150.27 | 116.308 | 88.73 | 86.11 |
| 4.4-Size Of Startup Sector | 152.423 | 110,982 | 92.59333 | 89.57 |
| 5.1-Attractiveness for "Digital Nomad" | 141.175 | 101,742 | 105,275 | 59.63 |
| 5.2-Digital Skills of General Population | 152,478 | 116,494 | 88.96 | 83.83 |
| 5.3-Gender Diversity of IT Pros | 116.263 | 89,892 | 101.8283 | 139.57 |
| 5.4-Investment In R&D | 130.198 | 107.22 | 101.5483 | 54.62 |
| 5.5-Skilled Tech Talent Base | 113,983 | 106,772 | 93.14 | 107.36 |

*Source: Authors, based on CEE Multi-Country News Center, n.d*

Based on the analysis of digital input indicators, Serbia demonstrates varied performance in aspects of digital development; however, it significantly lags behind leading European countries in many key areas. Notably, Serbia's scores in digital competitiveness, digital maturity, and internet usage are concerning, given the critical importance of these factors for comprehensive digital development.

Particularly alarming is Serbia's position regarding investments in research and development, where it records a score of 55 - significantly lower than the average score of 130 for the leading "benchmark" countries in Western Europe. Additionally, Serbia's attractiveness for digital nomads is low, with a score of 60, compared to the Western European average of 141. When compared to the other two groups of observed countries, Serbia's results are also subpar, with scores of 107 and 102, respectively.

These weaknesses underscore the urgent need for Serbia to implement measures aimed at enhancing its research and development landscape and creating a more favorable environment

for digital nomads. Improvements in these areas could be pivotal in strengthening Serbia's competitiveness within the digital ecosystem. This situation serves as a crucial signal for public policymakers to prioritize increasing investments in research and development and to formulate stimulating policies that would attract digital nomads, thereby enhancing the country's digital maturity and competitiveness.

Despite its challenges in various areas of digital development, Serbia possesses certain advantages that cast it in a more favorable light. For instance, Serbia exceeds the leading countries in the region in both the import of ICT, with a score of 126, and the export of ICT services, scoring 140. These figures indicate a robust presence in the international trade of IT products and services. Such advantages suggest that Serbia holds significant potential for further development in the digital economy, particularly through the strengthening of its IT sector (Figure 8).

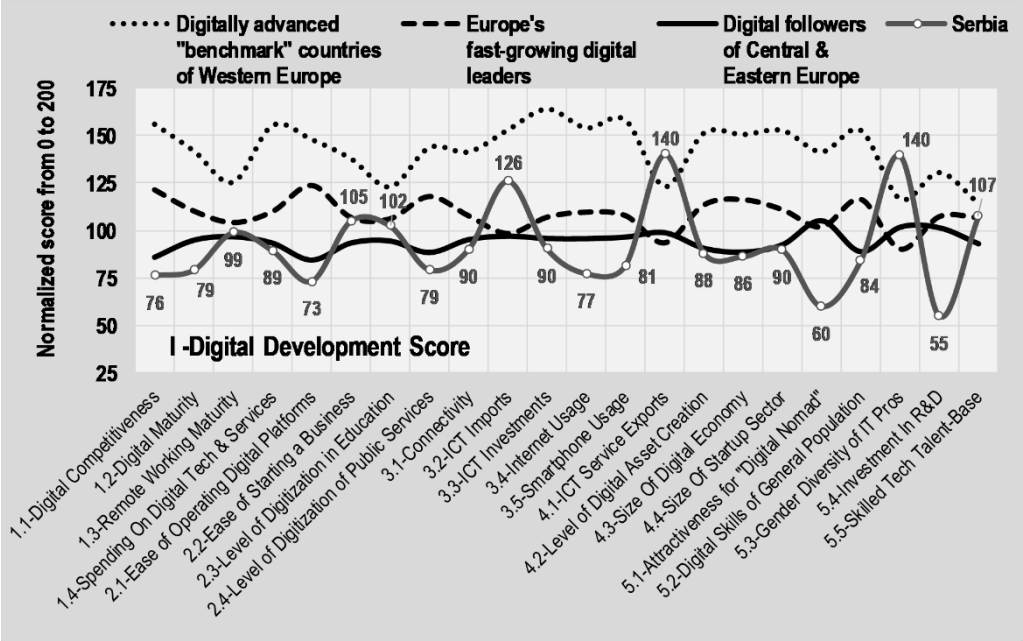


**Figure 8.** Diagram of Digital Development Attributes

*Source: Authors, based on the CEE Multi-Country News Center database, n.d.*

Serbia also demonstrates a high level of gender diversity among IT professionals, scoring 139. This figure serves as a significant indicator of inclusiveness and balance within the technology sector. Additionally, Serbia boasts a solid base of qualified technical talent, with a score of 107, which provides a strong foundation for further advancement and innovation within the IT industry.

However, for Serbia to enhance its competitiveness in the global digital market and better harness the potential of the digital economy, it is imperative to improve results across most other areas. This necessitates increasing investment in research and development, strengthening digital infrastructure, and fostering a more conducive environment for digital innovation and business. Establishing a balance between existing advantages and necessary improvements is crucial for the successful digital development of Serbia.

**Table 2.** Comparative Presentation of All Attributes of Economic/Social Results as Output

| Attribute name | Digitally advanced "benchmark" countries of Western Europe | Europe's fast-growing digital leaders | Digital followers of Central & Eastern Europe | Serbia |
|---|---|---|---|---|
| 6.1-Average Salary | 162,555 | 106,566 | 97.24 | 83.81 |
| 6.2-Economic Growth | 58,035 | 106.28 | 90.80 | 123.77 |
| 6.3-Employment | 100.6125 | 114.184 | 95.81 | 54.28 |
| 6.4-Productivity | 160.1275 | 112,764 | 93.21 | 76.91 |
| 7.1-Governance Efficiency | 78.7375 | 122.136 | 89.21 | 54.05 |
| 8.1-Innovation Performance | 157.0725 | 119,256 | 87.48 | 78.84 |
| 8.2-Patent Registration | 162.5975 | 100.96 | 100.94 | 89.55 |
| 9.1-Low Air Pollution | 141.8025 | 119,382 | 90.11 | 62.49 |
| 9.2-Environmental Performance | 150,715 | 117,364 | 90.71 | 68.95 |
| 9.3-Fossil CO2 Emissions | 99.4825 | 96,098 | 102.31 | 105.59 |
| 9.4-Renewable Energy | 136.8525 | 101.006 | 99.69 | 96.86 |

*Source: Authors, based on CEE Multi-Country News Center, n.d.*

Based on the analysis of economic and social output indicators, Serbia exhibits significant lags compared to the averages of the observed groups of countries, particularly pronounced in several key economic and social outcomes. The country faces serious challenges concerning average wages, productivity, employment, and management efficiency, with its results trailing behind those of leading European nations. For instance, Serbia's average salary score is 84, which is considerably lower than the average score of the group of new digital leaders in Europe (106) and that of digital followers in Central and Eastern Europe (97) (see Figure 8). This situation underscores the urgent need for improved economic policy and enhanced competitiveness within the Serbian economy to elevate living standards and attract foreign investments.

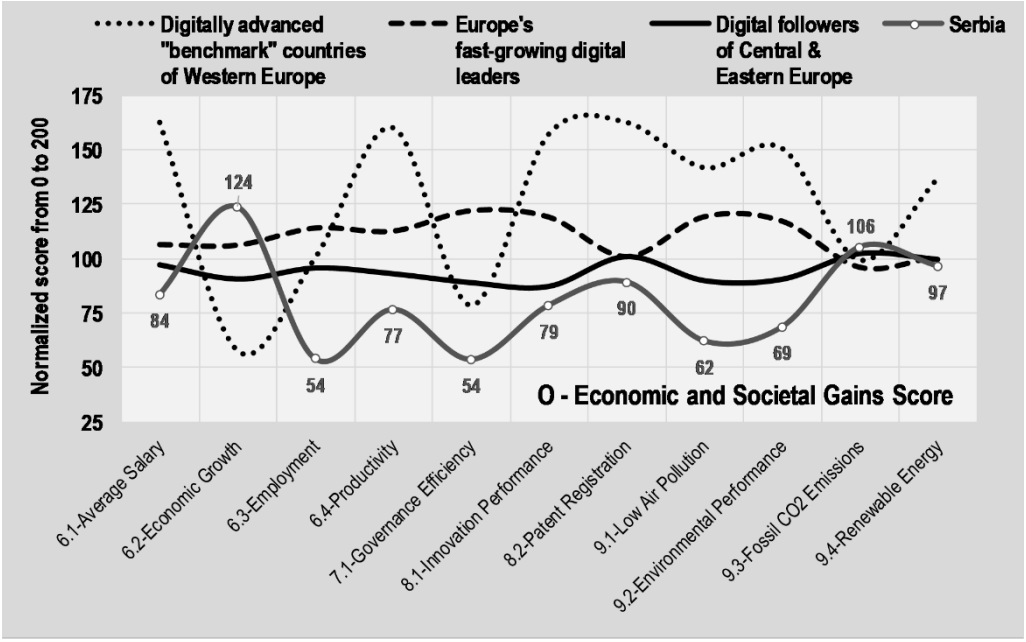


**Figure 9.** Chart of Economic/Social Performance Attributes for Cluster 2 Countries

*Source: Authors, based on the CEE Multi-Country News Center database, n.d.*

Moreover, Serbia's performance in environmental indicators is concerning, with scores of 68 for environmental performance and 62 for air pollution. These figures reveal significant weaknesses in Serbia's environmental and sustainable development policies. It is evident that Serbia must implement urgent measures to align its environmental standards with European sustainability norms.

On the other hand, Serbia is relatively well-positioned according to the indicator measuring the reduction of fossil CO2 emissions, with a score of 105. This is a positive development in the context of global environmental standards and sustainability, indicating progress in implementing certain measures toward a green transition. While Serbia is achieving commendable results in areas such as patent registration and the utilization of renewable energy, significant challenges still need to be addressed to enhance competitiveness and sustainability. Comprehensive improvements in productivity, innovation, and environmental performance could substantially elevate Serbia's position on both the European and global stages, enabling the country to fully harness its economic potential and contribute to international efforts in combating climate change.

The analysis demonstrates that Serbia lags behind Western European countries, which are at the forefront of digital transformation, in all key aspects of digital development. These results confirm that Serbia is unable to reach the level of digitization exhibited by these advanced nations. Although some progress has been made in various areas, Serbia continues to fall behind in most critical indicators of digital development when compared to Europe's rapidly growing digital leaders. These leaders are making faster advancements in digital technologies and infrastructure investments, thus confirming the hypothesis of Serbia's relative lag. In some respects, Serbia is comparable to the digital followers in Central and Eastern Europe, indicating that in certain areas - such as economic indicators and innovation - Serbia can be compared with countries in this group. Nonetheless, significant challenges persist in many key areas.

Based on the conducted analysis, hypothesis H1 was confirmed: the level of digitization in the economy of the Republic of Serbia is indeed lagging behind that of the digitally advanced countries in Western Europe and most of the rapidly growing digital leaders in Europe. Additionally, the research validated hypothesis H2, indicating that there are specific areas of digital development in the Republic of Serbia where results comparable to those of the digital follower countries in Central and Eastern Europe have been achieved.

The Strategy for Digital Skills Development 2020–2024 (Government of the Republic of Serbia, 2020) and the Action Plan for the Implementation of the Digital Skills Development Strategy in the Republic of Serbia 2021–2022 (Government of the Republic of Serbia, 2021) serve as the foundation for the further development of digitalization in the country. The "Digital Serbia" Strategy for the period 2025–2027 is a document that defines key initiatives for the accelerated development and global positioning of Serbia's digital ecosystem. The strategy focuses on: a) developing globally successful startups through mentorship, community building, and access to capital, b) promoting the application of AI technologies and enhancing digital skills, c) fostering a new generation of experienced entrepreneurs, and d) strengthening international cooperation and improving the regulatory framework for innovation (Digital Serbia Initiative, 2025).

## CONCLUSION

The Republic of Serbia is currently navigating the path of digital transformation but faces significant challenges in comparison to economically and digitally more advanced European countries. While progress has been made in certain segments of digitalization, such as the IT sector and e-government initiatives, Serbia continues to lag behind the leading nations of Western Europe in terms of overall digital infrastructure, integration of digital technologies within the economy, and the digital literacy of its population. Although Serbia exhibits moderate growth when compared to Europe's fast-growing digital leaders, it is imperative to accelerate digital reforms to narrow the gap with these more advanced countries.

An analysis of Serbia's standing relative to three observed groups - digitally advanced "benchmark" countries in Western Europe, fast-growing digital leaders, and digital followers in Central and Eastern Europe—reveals significant shortcomings in key areas of digital development, economic performance, and social outcomes. Notably, Serbia records considerably lower scores in digital competitiveness, productivity, management efficiency, average wages, and employment compared to leading European nations. This underscores the urgent need for comprehensive reforms and increased investments to close the gap with more developed European counterparts.

Conversely, Serbia does exhibit positive trends in certain domains, such as economic growth, where it even surpasses some of the new digital leaders in Europe. Additionally, the country shows commendable progress in reducing fossil CO2 emissions and increasing the utilization of renewable energy sources. These aspects serve as bright spots in Serbia's overall development, indicating potential that can be further harnessed through targeted policies and strategic initiatives.

To enhance its position relative to other European countries, Serbia must prioritize the improvement of digital infrastructure, boost innovation levels, enhance environmental performance, and strengthen capabilities in patent registration and the development of the startup ecosystem. Investments in research and development, alongside efforts to cultivate a skilled technical workforce, are essential for achieving long-term sustainability and competitiveness within the European market.

It is necessary to identify financial sources that would further support the improvement of the country's digital infrastructure, particularly in segments where, according to the results of this research, Serbia performs significantly worse compared to the digitally leading European nations. This situation highlights the urgency of increasing investments that are crucial for reducing the still-existing digital gap between Serbia and its more developed European partners.

Through economic development policy instruments, the state must act to enhance the digital literacy of the population, despite the fact that Serbia has made some progress in developing its digital ecosystem and moving closer to digitally advanced European economies. The development of the digital ecosystem contributes to increased productivity, the creation of new jobs, and the promotion of innovation. Countries with well-developed digital ecosystems achieve better positioning in the global market thanks to innovative products and services.

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PRELIMINARY REPORT

# Corporate Taxation and Subsidy Distortions as Barriers to Private Domestic Investment in Serbia

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**ABSTRACT**

This paper examines the structural barriers to private domestic investments in Serbia, with a particular focus on the role of corporate taxation and subsidy policy. The analysis combines descriptive empirical data, comparative legal assessment, and institutional diagnostics to explore why domestic investments have remained persistently low relative to both foreign direct investments and levels observed in comparable EU economies. Using Eurostat and World Bank data for the period 2013–2022, the paper documents that total investment growth in Serbia has been primarily driven by rising FDI inflows and increased public investments, while domestic private investments have remained weak. Despite a relatively high fiscal effort devoted to investment incentives, including both tax-based instruments and direct subsidies, the design and allocation of these measures appear to disproportionately benefit large investors – most often foreign. The paper contextualises Serbia's statutory and effective corporate tax rates within EU norms and identifies significant structural asymmetries in incentive accessibility between firms of different sizes. It also develops a classification of corporate tax incentive regimes in selected EU member states and Serbia, based on the structure and conditions of tax-based investment support, which is used to assess Serbia's position relative to prevailing EU practices in the design of fiscal incentives. Institutional barriers, including legal uncertainty and administrative inefficiency, further constrain domestic investments. The findings suggest that Serbia's current investment model is unlikely to support sustainable long-term development unless policy is rebalanced to improve the investment climate for domestic firms. The findings inform policy recommendations aimed at rebalancing incentive structures and strengthening institutional and financial conditions for domestic investments.

**Keywords:** *domestic investments, FDI, investment incentives, corporate taxation*

**JEL Classification**: E22, H25, H32

## INTRODUCTION

Domestic private investments play a critical role in promoting long-term economic development by driving capital accumulation, productivity gains, and employment growth (Ranđelović & Đorđević, 2024; Turan, 2023). Between 2013 and 2022, investment levels in Serbia remained relatively low, consistently below the 25% of GDP threshold typically recommended for sustainable convergence, and lagged behind both New Member States (NMS) and older EU members. In the second half of the observed decade, investment activity began to accelerate, primarily due to the success of foreign direct investment (FDI) attraction strategies and increased

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public infrastructure spending (Marjanović, 2018; Marjanović et al., 2020). In contrast, domestic private investment remained underwhelming (Eurostat, Author's calculations).

While previous research identifies low institutional quality and insufficient domestic savings as major constraints on investment (Arsić et al., 2019; Petrović et al., 2019; Ranđelović & Đorđević, 2024), Serbia's corporate tax regime is generally deemed competitive (Arsić & Ranđelović, 2021; Marjanović, 2018). This paper argues that the observed divergence between FDI and domestic private investment outcomes cannot be explained by general business conditions alone. Rather, it stems from the targeted application of corporate tax incentives and direct subsidies that have disproportionately favoured large and typically foreign investors. In that sense, corporate taxation incentives in Serbia seem to be an outlier in the context of EU countries. Furthermore, empirical evidence indicates that institutional deficiencies, particularly in legal enforcement and corruption, affect FDI to a much lesser degree (Branković et al., 2024), suggesting that FDI may be relatively insulated from such constraints. Although FDI inflows have contributed positively to Serbia's macroeconomic performance, evidence of strong positive spillovers remains limited. In light of mounting labour market pressures, there is also a need to reconsider the potential crowding-out effects of FDI on domestic capital formation.

Methodologically, the paper combines a structured literature review with a descriptive institutional and fiscal analysis of investment policy in Serbia between 2013 and 2022. It incorporates available investment data disaggregated by ownership structure and policy instrument (tax, subsidies) to assess whether existing incentive regimes disproportionately favour large (foreign) investors. In addition, it provides a qualitative assessment of regulatory asymmetries and institutional conditions that may shape divergent investment responses between domestic and foreign firms.

## THEORETICAL BACKGROUND AND LITERATURE REVIEW

Investment theories offer various explanations for firm behaviour, reflecting differences in how capital costs, expectations, and external conditions are interpreted. Keynesian theory links investment to expectations of future returns, shaped by uncertainty rather than savings. Accelerator models posit that firms invest in response to output changes, although rigid adjustment assumptions limit their realism. Tobin's Q connects investment to the ratio of market to replacement value of capital, while financial liberalisation models, such as McKinnon-Shaw, argue that deep financial markets and higher real interest rates encourage investment by expanding available capital. More recent approaches incorporate irreversibility and risk, suggesting that uncertainty can delay investment until greater clarity is achieved.

Among these frameworks, the neoclassical theory of investment (Jorgenson, 1971) remains the most widely tested and empirically supported (Arsić et al., 2019). It explains investment as a function of output and the user cost of capital, which reflects interest rates, taxation, depreciation, and risk. For Serbia, Arsić et al. (2019) propose an adjusted version of this model to better capture the role of subsidies, tax incentives, and institutional uncertainty:

$$C = \frac{(r+\delta)(1-k-s)}{(1-t)(1-\theta)}\gamma \qquad (1)$$

In this formula, the user cost of capital (C) directly depends on the interest rate (r) and the depreciation rate (δ), both of which increase costs as they rise. Similarly, the corporate income tax rate (t) and the dividend tax rate (θ) exert upward pressure on the cost of capital. Conversely, tax incentives per unit of investment (k) and granted subsidies (s) reduce the overall cost. However, risks and uncertainties (γ) associated with the market and business environment increase the user cost of capital, reflecting the broader macroeconomic and institutional conditions in which firms operate.

The neoclassical model implies that investment can be stimulated by reducing its cost, including through tax instruments (t, θ and k from Eq. 1). Tax incentives, such as reduced corporate income tax (CIT) rates, tax holidays, and import duty exemptions, are intended to lower the user cost of capital and alleviate liquidity constraints, especially for larger, capital-intensive projects (James, 2013). These measures are particularly relevant in attracting mobile investors and export-oriented investments, which tend to be more sensitive to variations in effective tax rates (Grubert & Mutti, 2000; James, 2013).

Empirical studies consistently support the sensitivity of investment to the effective average tax rate (EATR). Bellak and Leibrecht (2006) find that a 1-percentage-point reduction in the EATR across Central and Eastern Europe was associated with a 4.4% increase in FDI inflows. Devereux (2006) stresses that EATRs influence discrete location choices, while statutory rates mostly affect profit-shifting behaviour. Djankov et al. (2010), using cross-country data on EATRs, find a significant negative relationship between corporate tax rates and both aggregate investment and entrepreneurial activity. The adverse impact was especially strong in the manufacturing sector and among firms with fewer financing alternatives, suggesting that tax structures can shape not only investment levels but also the sectoral allocation of capital.

Evidence from Serbia further corroborates the importance of tax incentives in shaping FDI behaviour. Marjanović et al. (2020) and Marjanović (2018) report that tax reliefs—particularly in the form of CIT incentives for exporters, employment-based deductions, and free-zone benefits—are considered decisive by both medium-scale and large investors. Their surveys find that investors who committed over 100 million euros to Serbia place the highest value on employment-related tax incentives. These findings are consistent with the notion that tax preferences, if well-targeted, can reinforce investor commitments in key sectors. However, literature also stresses the risk of redundancy. James (2013) finds that in a wide range of developing countries, over 70% of investment projects receiving incentives would have proceeded even in their absence, raising questions about the opportunity cost of foregone revenue.

Empirical literature generally supports the view that subsidies can positively influence investment volumes by reducing the cost of capital (s from Eq. 1) and addressing liquidity constraints. Kállay and Takács (2023) found that subsidies directly increase firm-level profits through income transfers. Chinetti (2023) shows that innovation spending tends to rise among subsidy recipients, especially in medium-to-large enterprises in traditional sectors, though the evidence on long-term productivity gains remains limited. Nonetheless, two important caveats should be noted. First, subsidies, whether in the form of direct grants or foregone tax revenue, carry an opportunity cost and may distort resource allocation by placing certain firms in an advantageous position relative to others. Second, in settings marked by weak institutional quality, subsidies are often deployed to offset investment risks, but their actual effectiveness in stimulating investment is uncertain. James (2013) warns that incentives used as a substitute for reliable institutions may fail to generate new investment, particularly in resource-based or protected sectors. Similarly, Owens (2005) emphasises that transparent and predictable regulatory frameworks often matter more than tax and subsidy incentives themselves. In the context of South-Eastern Europe, improvements in governance and legal predictability have had a stronger effect on perceived investment attractiveness than fiscal incentives alone.

Although not explicitly included in the neoclassical investment model, institutional quality significantly shapes investment outcomes by influencing the predictability, transparency and enforceability of economic rules. A stable and credible institutional environment reduces transaction costs, enhances investor confidence and increases the effectiveness of policy instruments such as tax incentives and subsidies. Jovanović et al. (2023) find that governance indicators such as regulatory quality and corruption perception do not significantly affect FDI inflows, suggesting that foreign investors are relatively insulated from these constraints. Similarly, Marjanović et al. (2024) report that legal security and enforcement are important for

foreign investors, but the degree of sensitivity varies across investor type and project size. Branković and Sarajčić (2024) further show that, in Serbia, there is no long-run causal relationship between regulatory quality and greenfield investment, indicating a limited role for institutional improvement in shaping FDI behaviour. However, regulatory quality is found to contribute positively to economic growth in the long run. In slight contrast, Minović et al. (2020), using panel data for the Western Balkans, identify a one-way causal relationship from political stability and rule of law to FDI inflows, suggesting that institutional quality can play a more direct role in attracting investment under certain conditions.

Two additional factors not captured in the neoclassical model, which assumes perfect capital mobility and market efficiency, are domestic savings and access to finance. A positive relationship between savings and investment is a core principle of economic theory (Solow, 1956; Feldstein & Horioka, 1980). However, the presence of savings alone does not guarantee increased investment, as access to finance remains one of the main challenges, particularly for smaller companies, which often face higher borrowing costs, limited collateral options, and restricted access to external funding (Ofosu-Mensah Ababio et al., 2022; Sahahe Emran et al., 2007). Recent findings suggest that in lower institutional quality settings, real interest rates may still influence investment, but the effects are unstable and context-dependent (Bucevska & Merdzan, 2024). This highlights the importance of both adequate savings and effective financial systems for translating available capital into productive investment.

Foreign direct investment can affect domestic investment through both positive spillovers[1] and crowding-out effects. Inflows of foreign capital are often seen as a key channel for introducing new technologies, managerial practices and access to global markets, which can enhance domestic productivity and encourage local firms to upgrade. Such positive effects are typically observed when foreign firms develop linkages with local suppliers or stimulate competitive pressure. Pilbeam and Oboleviciute (2012) find a strong crowd-in effect of FDI in the EU12 countries, where foreign investment contributed to the growth of domestic investment by boosting technological diffusion and encouraging modernisation. In contrast, they observe a crowding-out effect in older EU member states, where foreign firms displaced domestic ones by exploiting superior resources and market access. Similarly, Jude (2019) finds that greenfield FDI in transition countries may initially crowd out[2] less efficient domestic firms but can later generate crowd-in effects as foreign affiliates integrate more deeply into local economies.

These effects are highly context-dependent and often shaped by institutional quality and sectoral patterns. In settings with weaker regulatory environments or where foreign investment is concentrated in sectors already occupied by local firms, negative effects are more likely. Kandilarov (2019) and Musabelliu (2019) illustrate that poor institutional conditions in Bulgaria and Albania have limited the potential of FDI to stimulate domestic investment, while simultaneously raising competitive pressures on local firms. The sectoral structure of FDI also matters. De Backer and Sleuwaegen (2003) and Farla et al. (2016) stress that high-tech investments are more likely to yield spillovers through knowledge transfers and joint ventures. Conversely, when FDI competes directly with domestic enterprises in saturated markets, the risk of crowding-out increases. Mišun and Tomšk (2002) report that Hungary and the Czech Republic experienced net benefits from FDI, whereas Poland observed the displacement of local investment. Agosin and Machado (2005) conclude that the developmental impact of FDI is strongest when it targets underdeveloped sectors and avoids overlapping with domestic production. Wooster and Diebel (2006) find that crowding-out is particularly pronounced in capital-intensive industries, where the entry of foreign firms often forces domestic rivals to exit.

[1] Indirect benefits or costs that investment activity in one firm or sector generates for others, often through knowledge transfer, supply chain linkages, or labor mobility.

[2] A situation where increased investment or activity by one group (e.g., foreign investors) displaces or limits the capacity of another group (e.g., domestic firms) to invest, often due to resource competition or market saturation.

These findings suggest that both the origin and sectoral orientation of FDI, alongside institutional capacity, are central to determining its impact on local investment dynamics.

## METHODOLOGICAL APPROACH AND SCOPE

This paper combines elements of comparative institutional analysis, fiscal policy assessment, and descriptive empirical analysis based on official macroeconomic data. It draws on multiple data sources to examine the structure of investment and incentive regimes in Serbia and selected EU member states, with a focus on the period from 2013 to 2022. In particular, the paper aims to assess the extent to which the current design of Serbia's corporate taxation and subsidy system diverges from the evolving corporate taxation frameworks observed across EU member states.

Investment structure is analysed using Eurostat data on gross fixed capital formation by institutional sector. Domestic private investment is not reported as a separate category and is therefore derived as the difference between total private investment and net foreign direct investment inflows. FDI data are taken from the World Bank (FDI Net Inflows, balance of payments). Corporate tax data include statutory corporate income tax (CIT) and withholding tax (WTR) rates, sourced from the European Commission's Taxes in Europe Database v4, and supplemented by estimates of forward-looking effective average tax rates (EATR) for selected countries. Comparative data on direct subsidies and state aid are compiled from the European Commission's State Aid Scoreboard, as well as annual reports of the Commission for State Aid Control of Serbia. The legal and policy frameworks governing investment incentives in Serbia are analysed based on primary legislation and regulations. The comparative legal framework for EU member states is based on information from the Taxes in Europe Database v4 (last accessed on 10th December 2024) and country-specific corporate taxation profiles published by PricewaterhouseCoopers (PwC), last accessed on the same date. Based on these data, a typology of corporate tax incentive regimes was developed for selected EU member states and Serbia, reflecting the nature and structure of tax-based investment incentives. The classification relies on three main criteria: (1) the availability of investment-related corporate tax incentives; (2) the existence and magnitude of investment size thresholds for eligibility; and (3) whether the relative generosity of incentives progresses or regresses with increasing investment size.

Although the analysis does not employ econometric techniques or claim direct causal identification, this is consistent with the objective of the paper, which is to examine structural patterns in Serbia's investment environment through legal, fiscal, and institutional analysis. The approach is grounded in descriptive data and comparative policy frameworks, aiming to identify distortions[3] and asymmetries that influence domestic private investment. While cross-country comparisons are used to contextualise Serbia's incentive regime, they are illustrative rather than explanatory and do not control for macroeconomic or legal heterogeneity. The focus is limited to Serbia and selected EU member states, and the conclusions are intended to provide additional perspectives on investment policy, particularly in transition economies.

## STYLISED FACTS AND DISCUSSION

The analysis is structured in four stages. First, trends in investment activity in Serbia are examined using disaggregated Eurostat data on public, domestic private, and foreign direct investment flows. These trends serve to establish the empirical context and to identify structural features of Serbia's investment environment. For analytical clarity, *foreign direct investment* and *large-scale investment* are treated as broadly overlapping categories, as are *domestic private investment* and *SMEs*. While this simplification does not fully capture the diversity of firms, it reflects the prevailing segmentation in Serbia's investment structure and informs the subsequent

[3] Deviations from efficient market outcomes caused by policy interventions, such as subsidies or tax incentives, which alter the allocation of resources or competition conditions.

discussion. Second, Serbia's corporate income tax regime is assessed. This includes a comparison of statutory and effective tax rates with those of selected EU member states, in order to position Serbia within the broader fiscal environment. Based on these data, a typology of corporate tax incentive regimes is developed for selected EU member states and Serbia, reflecting the nature and structure of tax-based investment incentives. The structure of Serbia's tax incentives is then analysed, with particular attention to differences in accessibility across firm size and type, and compared to mechanisms in place within the EU. Third, the composition and allocation of direct subsidies are analysed using state aid data, in order to evaluate their contribution to market distortions and asymmetric investment incentives. Finally, broader explanatory factors are considered that may account for the observed patterns of low domestic private investment, including institutional quality, domestic savings, access to finance, and potential crowding-out effects of foreign direct investment.

### (a) Investment dynamics in Serbia

Over the past decade (2013–2022), investment in Serbia has consistently remained below levels typically associated with sustainable long-term growth. Total investment was under the 25% of GDP threshold commonly cited in development literature as necessary for convergence (World Bank, 2019), and lagged behind both the new EU member states (NMS)[4] and older EU members (Figure 1, left). This persistent underperformance has been linked in the literature to structural and institutional weaknesses that constrain productive investment (Medić et al., 2024; Petrović et al., 2019).

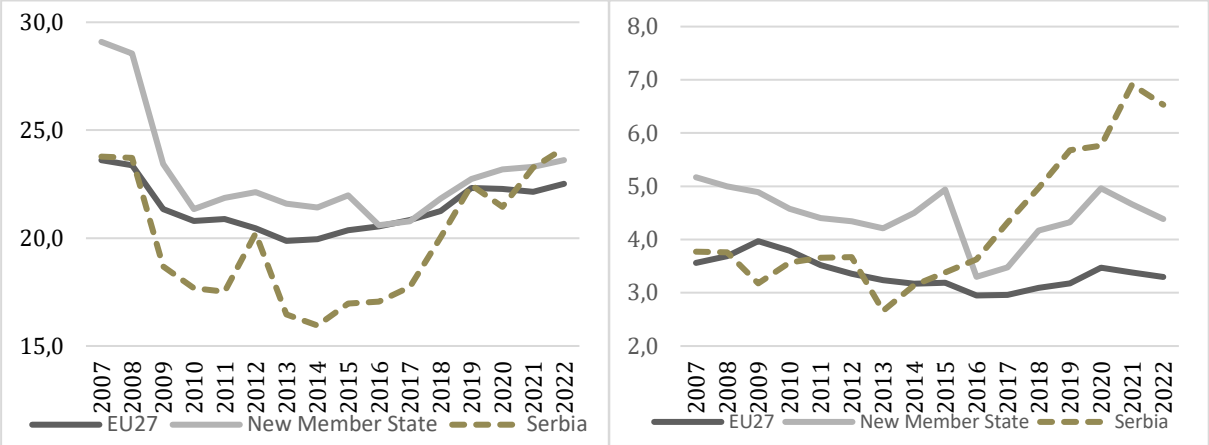


**Figure 1.** Total investments (left) and public investments (right) in %GDP

*Source: Eurostat (Investments by institutional sectors), Author's calculations*

The composition of investment over this period reveals additional structural concerns. Public investment in Serbia remained considerably below the NMS average until 2016, but subsequently accelerated, surpassing 6% in the 2021-2022 subperiod – well above both comparator groups (Figure 1, right). By contrast, total investment only modestly increased, suggesting that much of the observed growth was public-sector driven, with private investment contributing less to the overall rise.

The composition of investment offers a more differentiated picture. After prolonged stagnation in the first half of the decade, total investment began to rise around 2015, driven initially by a recovery in FDI and, from 2018 onward, by a marked increase in public investment (Figure 1,

[4] New EU member states (NMS) refer to the countries that joined the European Union during the enlargement waves of 2004, 2007, and 2013, namely: Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia, and Slovenia (2004); Bulgaria and Romania (2007); and Croatia (2013).

right; Figure 2, left). Public investment in Serbia eventually surpassed that of the NMS average, peaking at over 6% of GDP in 2021 and 2022 (Figure 1, right). FDI inflows also remained comparatively strong, often exceeding the NMS average after 2015.

By contrast, domestic private investment exhibited a weaker trajectory. It remained subdued throughout the period, with limited responsiveness to the overall increase in total investment. It consistently fell below the levels observed in comparable countries such as the Czech Republic, Romania, Lithuania, and Poland, measured as a share of GDP (Figure 2, right). A modest uptick is visible in the final two years of the series, which may reflect both Serbia's relatively muted economic contraction during the COVID-19 crisis and the effect of temporary support measures. These measures were predominantly and appropriately directed at SMEs, and included tax deferrals, grants in the form of minimum wages, and favourable lending schemes aimed at addressing illiquidity (Lazarević-Moravčević & Kamenković, 2021). However, even in 2022, Serbia remained in the lower tier of NMS in terms of domestic private capital formation.

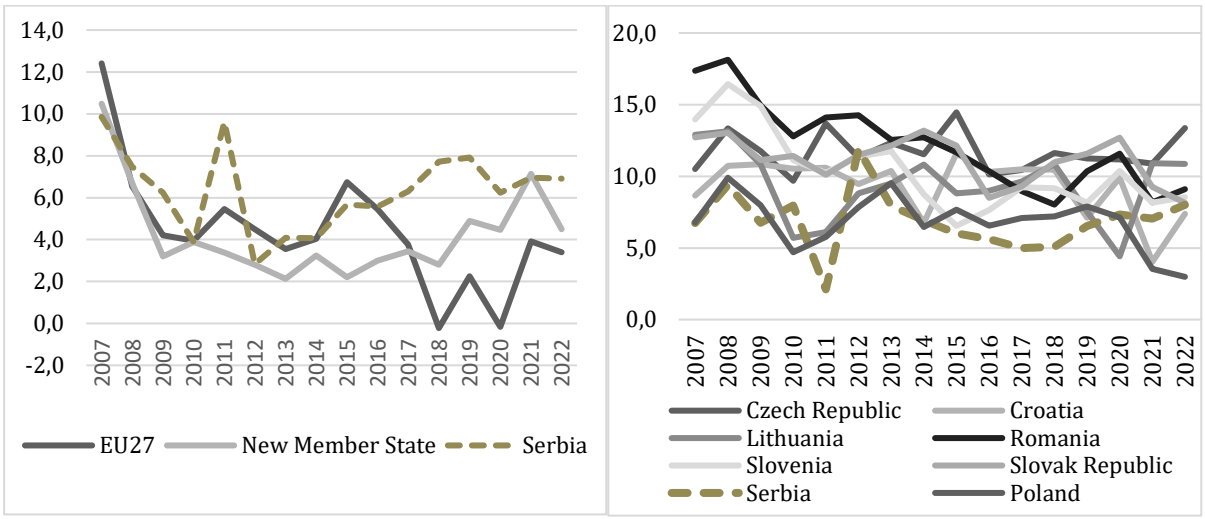


**Figure 2.** FDI net inflows (left) and domestic private investments (right) in %GDP

*Source: Eurostat (Investments by institutional sectors), FDI (World Bank, FDI Net Inflows); Author's calculations*

This composition suggests a structural imbalance in Serbia's investment recovery. The growth in total investment was not underpinned by a broad-based expansion of domestic private capital, but rather by inflows of foreign capital and public sector spending. While the role of foreign capital is significant, it cannot support long-term development if domestic (and public) investment is insufficient or misallocated (Marjanović et al., 2021). The observed asymmetry raises questions about the allocation and effectiveness of investment incentives and the broader enabling environment for domestic enterprise investment.

The overall lack of domestic investment potential in the early 2010s must be acknowledged. As in other Western Balkan countries, Serbia increasingly relied on foreign capital to compensate for limited domestic investment capacity (Marjanović et al., 2020). In this context, investment incentives became a central tool of economic policy. Between 2014 and 2022, Serbia allocated an average of 1.32% of GDP to subsidies, compared to 0.79% in NMS and 0.39% in older EU member states (Figure 3). Direct subsidies accounted for 64% of Serbia's total incentive expenditure, with tax incentives making up a further 21%—a distribution broadly consistent with regional practice. Despite this relatively high fiscal effort and success in attracting foreign capital, domestic private investment remained weak, suggesting that the structure or allocation of incentives may not have been well aligned with the specific constraints that the domestic economy faces.

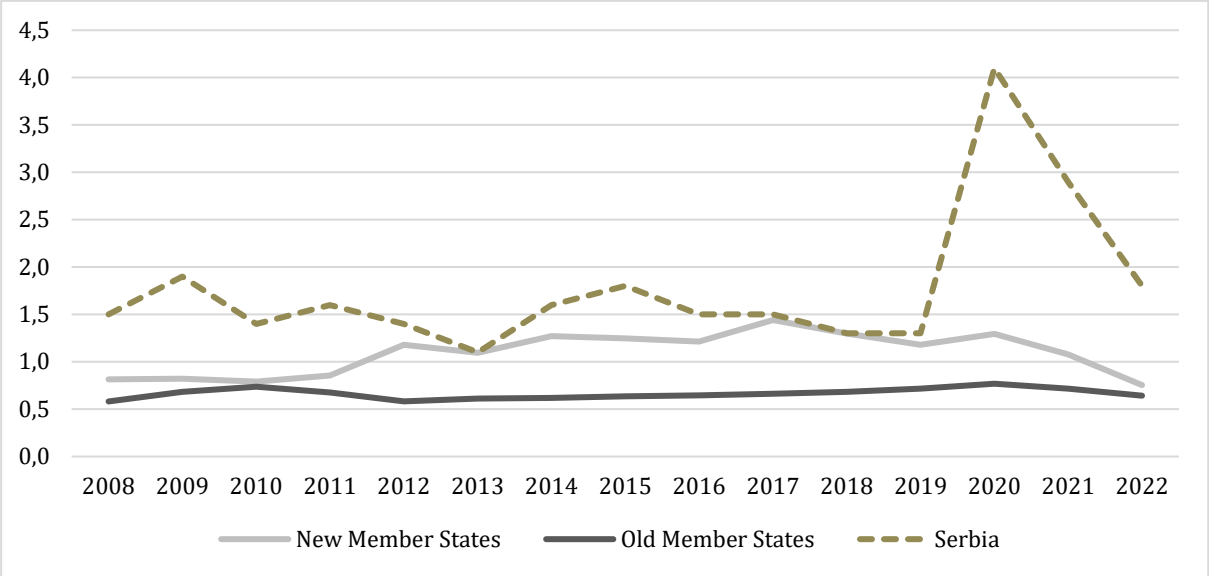


**Figure 3.** Total state aid (% of GDP)

*Source: European Commission, State Aid Scoreboard (European countries); Commission for State Aid Control of Serbia (Serbia); Author's calculations*

Several potential explanations emerge, including preferential targeting toward large or foreign investors, limited accessibility for SMEs, and persistent institutional barriers. Domestic private investment in Serbia has long been constrained by factors such as legal uncertainty, unequal market conditions, and inefficiencies in the judiciary and public administration. These structural weaknesses reduce the effectiveness of incentive policies and limit the capacity of local firms to invest, while maintaining a dependence on subsidies to attract foreign capital (Arsić et al. 2019). These stylised facts provide the empirical foundation for the subsequent sections, which examine Serbia's tax and subsidy regime in a comparative context and discuss broader structural constraints on private domestic investment.

## (b) Corporate Income Tax and Related Incentives

According to Equation 1 and empirical evidence (Arsić et al., 2019; Marjanović, 2018), higher statutory corporate income tax rates (CIT) and withholding tax rates (WTR) negatively impact investment levels. With a CIT rate of 15% and a WTR of 20%, Serbia maintains some of the lowest rates in Europe (Figure 4), making it difficult to justify the difference between private investment rates in Serbia and the EU. However, statutory rates alone do not provide a complete picture. Instead, Forward-looking Effective Average Tax Rates (EATR) offer a more accurate measure of the effective tax burden on corporate investments, as they incorporate not only statutory rates but also provisions such as capital allowances and tax incentives.[5]

Although EATR is not systematically calculated for Serbia, given the CIT rates and existing tax benefits (to be analysed further below), Serbia's EATR is most likely within the corridor set by Lithuania (12.7%) and Croatia (14.8%). This places Serbia among the most favourable CIT regimes in Europe across all investment types. In other words, corporate taxation in Serbia can be considered largely competitive (Arsić & Ranđelović, 2021; Arsić, 2019; Marjanović, 2018).

[5] Using a microeconomic model of a hypothetical investment, EATR reflects the average tax contribution while accounting for deductions such as interest payments. Typically, countries with tax incentives exhibit EATR below their statutory tax rate, making it a better approximation of the effective tax rate. The concept was developed by Devereux and Griffith (1998) and is widely used to facilitate cross-country tax comparisons (EU Tax Observatory).

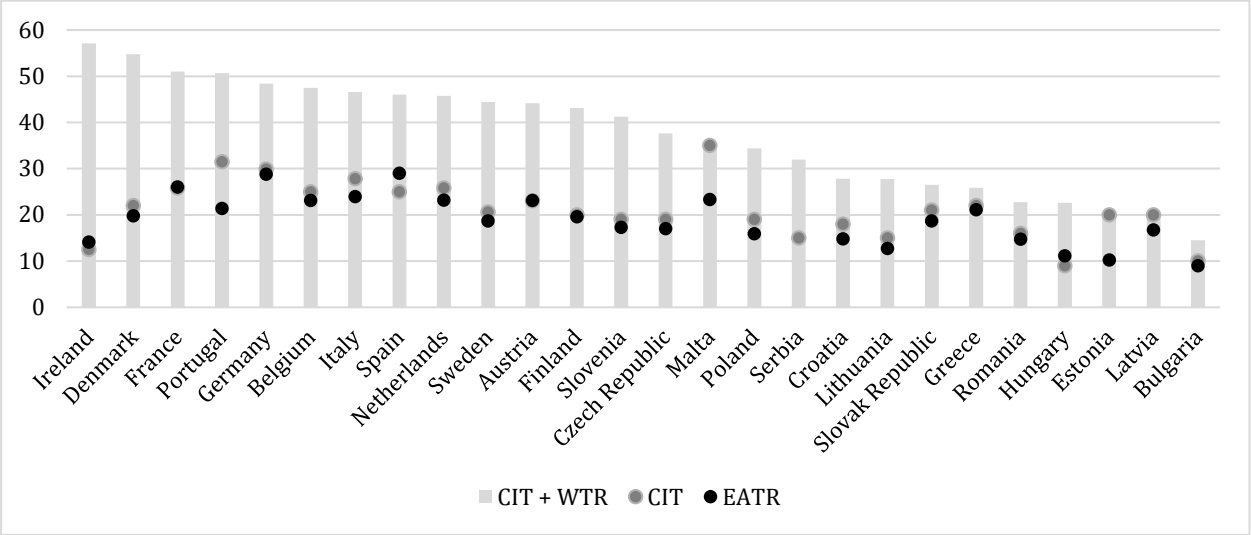


**Figure 4.** Statutory Corporate tax rates (CIT), statutory tax rates and withholding tax rates combined (CIT + WTR) and Average Tax Rates (EATR)

*Source: European Commission, State Aid Scoreboard (European countries); Commission for State Aid Control of Serbia (Serbia); Author's calculations*

However, effective tax rates differ significantly between the domestic economy (primarily SMEs) and FDIs due to the structure of fiscal incentives. In the early 2000s, Serbia introduced a series of tax incentives aimed at stimulating investment growth and increasing employment levels. While the emphasis was placed on attracting FDIs, given the scarcity of domestic capital following a decade of sanctions and economic downturns in the 1990s, incentives were formally available to companies of all sizes and origins of capital.

Two notable measures were introduced: (a) the tax holiday for large investments (regulated under Article 50 of the Legal Entity Profit Tax Law) and (b) the tax credit for SMEs (regulated under Article 48 of the same law). (a) The Serbian Tax Holiday provided a 10-year tax exemption for companies investing more than €8 million in fixed assets and employing at least 100 people. The incentive began in the first year the company reported a profit, with the reduction proportional to the size of the investment relative to the company's total fixed assets. This effectively allowed qualifying companies to benefit from significantly lower CIT rates. (b) The Serbian Tax Credit enabled taxpayers investing in real estate, plants, equipment, or biological assets for their primary activity to claim a tax credit of 40–20% of the investment value (higher percentages for smaller companies). However, this credit could not exceed 50–70% of the calculated tax liability in the year of investment (higher percentages for smaller companies). Additionally, any unused portion of the tax credit could be carried forward for up to ten years, offsetting up to 50–70% of the tax liability for each subsequent year (higher percentages for smaller companies). While these corporate income tax rules were not entirely symmetrical, they allowed both SMEs and FDIs to reduce their investment costs.

In 2013, Serbia's corporate taxation framework underwent a major overhaul (Law on Amendments to the Corporate Income Tax Law, 2013). This reform was primarily driven by the need to align Serbia's tax legislation with the EU acquis, particularly in the context of the Stabilisation and Association Agreement (SAA) and the Code of Conduct for Business Taxation (Stojanović & Nikolov, 2019). The emphasis was placed on eliminating fiscal practices deemed harmful to market competition.

In addition to external alignment, the government cited the need to increase public revenues as a key motivation for the reform (Government of Serbia, 2013). The official rationale emphasised that, under a low statutory CIT rate, existing tax credits were unlikely to exert a decisive influence on investment decisions and were instead viewed as a constraint on budgetary income. As a result, the statutory CIT rate was raised from 10% to 15%, and most investment-related tax incentives were abolished. Notably, the tax credit for SMEs (Article 48) was removed, while the tax holiday for large-scale investments remained in place (Article 50). This effectively created an incentive structure skewed in favour of large investors, while removing targeted support mechanisms for smaller domestic firms.

However, the assumption that tax incentives had little influence on investment behaviour is difficult to reconcile with empirical evidence gathered after the reform. Marjanović (2018), based on a post-reform investor survey, found that tax incentives, particularly those linked to corporate income tax, remained a significant determinant of investment decisions, even under the increased 15% rate. This finding is corroborated by Marjanović et al. (2020), who emphasise that foreign investors continued to value targeted incentives such as tax reliefs for exporters, operations in free zones, and employment-related benefits – measures predominantly accessible to large-scale projects.

While large investment projects in Serbia remained shielded by favourable tax treatment, their SME counterparts in the EU experienced a gradual decline in effective tax burdens. Between 2014 and 2022, the Effective Average Tax Rate (EATR) declined by approximately 2.0 percentage points in New Member States (NMS) and by 2.5 percentage points in older EU member states (Author's calculations based on EC EATR database). This divergence further widened the gap between the tax treatment of SMEs in Serbia and their peers across the EU.

A comparative analysis of CIT incentive structures in Serbia and selected EU countries reveals that Serbia's practice of offering substantial tax reliefs exclusively to large-scale investments is relatively rare in the European context. While most EU countries provide some form of CIT incentive, their design tends to reflect more diversified policy priorities, often balancing support across firm sizes or targeting specific development objectives. Serbia, by contrast, maintains a system almost entirely geared towards large foreign investors, reinforcing the structural asymmetry in its investment climate.

Out of the 26 observed countries (25 EU member states[6] and Serbia), 21 offer CIT-based investment incentives, while five (Austria, Denmark, Germany, Finland, France, Ireland, and Sweden) either do not implement general CIT incentives or restrict them exclusively to green sectors.[7] Based on the nature, accessibility and targeting of these regimes, countries have been classified into six distinct groups:

- **Pro Small (8 out of 26)**: Incentives are accessible to all firms but provide clearly more favourable terms for smaller investments, such as higher deduction rates or more generous carry-forward periods. Representative examples include Belgium, Italy, Portugal, Malta and the Netherlands.
- **Neutral (7 out of 26)**: Incentives are broadly accessible and equally applicable regardless of firm size, without structural bias. This category includes countries such as Greece, Slovenia, Estonia and Hungary.
- **Pro Large (3 out of 26)**: Incentives are technically available to all investors but disproportionately favour larger projects by design, through high thresholds or scaled benefits. Examples include Lithuania, Slovakia and Croatia.

[6] Cyprus and Luxembourg were excluded from the tax policy analysis due to their atypical tax systems and unique economic structures, which heavily rely on offshore financial services and tax optimisation strategies that are not directly comparable to Serbia's investment environment.
[7] Table with full data on CIT incentives for selected 25 countries is available in the Appendix.

- **Only Large (1 out of 26)**: Incentives are explicitly reserved for large-scale investments, often with strict eligibility conditions based on investment volume and employment. Serbia is the only country in this category.
- **Only Green (2 out of 26)**: Incentives are not generally size-based but are narrowly targeted at environmentally sustainable or energy-efficient projects. This applies to countries such as Finland, France and Sweden.
- **None (5 out of 26)**: No significant CIT incentives for investment are in place. Germany, Austria and Ireland are included in this group.

The observed divergence suggests that Serbia's CIT incentive system is not only skewed but also increasingly misaligned with prevailing European practice. The absence of institutional support for smaller investors contributes to a structurally uneven investment environment and reinforces the market asymmetries already documented.

As an additional measure, not directly targeting investments but rather addressing the varying capacities of different company sizes, 10 out of the 25 observed EU countries have adopted differential CIT rates specifically tailored for SMEs (see Table 1). These preferential regimes typically involve reduced rates applied either to a defined portion of taxable income (e.g., Belgium, France, Portugal) or to companies below a specific revenue threshold (e.g., Croatia, Poland, Slovakia). Some countries, such as Lithuania, offer significant tax relief during the initial years of operation, while others, like Romania, apply simplified revenue-based taxation systems for micro-enterprises, reducing administrative and compliance burdens. In contrast, the majority of EU countries, including Germany, Italy, and the Netherlands, do not provide reduced CIT rates for SMEs. Instead, they rely on alternative mechanisms, such as grants or sector-specific incentives.

**Table 1.** Differential tax rates in EU countries

| Country | Statutory CIT rate | Differential rate for SMEs |
|---|---|---|
| Belgium | 25 | 20% for SMEs (reduced on the first €100,000) |
| Estonia | 20 | Withholding tax rate: for natural persons - 20%, for legal entities - 14% |
| Spain | 25 | 23% for entities with turnover < EUR 1 million; 15% for newly created entities in the first two profitable years. |
| France | 25.8 | 15% on the first €38,120 of profit for companies with turnover < €10 million. |
| Lithuania | 15 | 0% for the first year and 5% thereafter for entities with fewer than ten employees and annual revenue under €300,000, subject to certain conditions |
| Portugal | 31.5 | 17% on the first €25,000 of taxable income; excess taxed at 21% |
| Romania | 16 | 1% on revenue for micro-enterprises with at least one employee; 3% for those without employees |
| Slovak Republic | 21 | 15% for revenues below EUR 60,000 |
| Croatia | 18 | 10% for revenues below EUR 1 million |
| Poland | 19 | 9% for net sales revenue < EUR 1.2 million |

*Source: Taxes in EU V4 database and Tax Observatory*

In conclusion, Serbia's tax incentive structure remains strongly biased toward large-scale and foreign investments. While broadly aligned with pro-investment objectives, this asymmetry leaves domestic SMEs under-supported, contributing to an uneven playing field. The result is a tax environment that amplifies market distortions, weakens the competitive position of local firms, and limits the broader developmental reach of fiscal policy.

### (c) Direct Subsidies

Subsidies[8] have also been significant in terms of both their size and their distortive effect, often biased towards FDIs in the case of Serbia. Similar to the tax incentive policy, subsidies have played an important role in Serbia's investment attraction policy since the early 2000s. According to Stojanović and Nikolov (2019), the Law on Foreign Investments adopted in 2002 was asymmetric in its treatment of domestic versus foreign investors. This asymmetry persisted until 2015, when the law was replaced with the Law on Investments. The criteria were first specifically defined in the Regulation on the Conditions and Methods for Attracting Direct Investments in 2016 (*Official Gazette of the Republic of Serbia*, No. 110 of December 30, 2016) and later refined in the Regulation on Determining Criteria for Awarding Incentives for Attracting Direct Investments in 2019, with two subsequent amendments in 2023 (*Official Gazette of the Republic of Serbia*, No. 1/2019, 39/2023, and 43/2023).

Although the number of programmes is relatively large, they can be grouped into three main categories. (a) Incentives for attracting direct investments: One of the main characteristics of these regulations has been the combination of minimal investment thresholds and requirements for new employment, both subject to the geographic location of the investment. In the first two iterations, the minimal threshold was set at €100,000 and ten new employees for underdeveloped municipalities (those with less than 40% of Serbia's average development level), with higher thresholds for more developed municipalities. In 2023, the categorisation of municipalities was abandoned and replaced with a simplified framework based on Serbia's three NUTS2 regions. The minimal thresholds were set at €500,000 and 50 new employees for Belgrade, €400,000 and 40 employees for the Vojvodina region, and €300,000 and 30 employees for the rest of the country. (b) Support for SMEs: The Law on Investments also provides a legal basis for programmes supporting SMEs, including initiatives implemented by the Development Agency of Serbia for equipment procurement, SME integration into Global Value Chains (GVCs), and other forms of technical assistance. (c) Other subsidy support programmes: These target specific business functions and include initiatives from the Development Fund of Serbia (e.g., entrepreneurship development encouragement programmes), the Innovation Fund (e.g., innovation activity support), and the National Employment Agency (e.g., on-the-job training programmes).

Despite the breadth of these programmes, subsidy-based schemes collectively favour FDIs. (a) Although the thresholds were considerably lower than those for the corporate income tax holiday, SME participation in these programmes has remained very low. Data on subsidies disbursed under the Law on Investments show a consistent bias towards FDIs (Figure 5). While Bojović and Obradović (2018) estimate that subsidy volumes under the preceding programme (2012–2016) were comparable to those observed in 2017–2018, SMEs received only about 12% of the total subsidy volume during the observed period, despite a modest increase in their share to around 18% between 2021 and 2023. (b) Programmes implemented by the Development Agency of Serbia, though specifically targeted at SMEs, remain limited in scope. For example, the equipment procurement support programme has been allocated between €7 and € 12 million annually, while the GVC integration support programme has reached only a very small number of companies. (c) Subsidies from the Development Fund of Serbia are primarily directed towards start-up entrepreneurs, often in personal services sectors (e.g., beauty salons, bakeries, craft trades). These subsidies are generally low in value and cannot be considered genuine support for investment generation in the traditional sense. Similarly, programmes of the Innovation Fund focus on innovation and R&D rather than traditional investment projects, and initiatives by the National Employment Service are similarly limited to large investments and their investment-generation for smaller companies is therefore also restricted.

Despite their relevance, SME-focused programmes remained modest in scale. The overall volume of support allocated to these initiatives during the observed period was limited and

[8] This category includes direct grants, interest subsidies, reimbursable grants, debt write-offs and subsidized services.

broadly aligned with the modest allocations made through the Development Agency of Serbia. While these programmes address important gaps in access to finance and technical assistance, they do not substantially alter the structural asymmetry in subsidy distribution, which continues to favour FDIs over domestic firms.

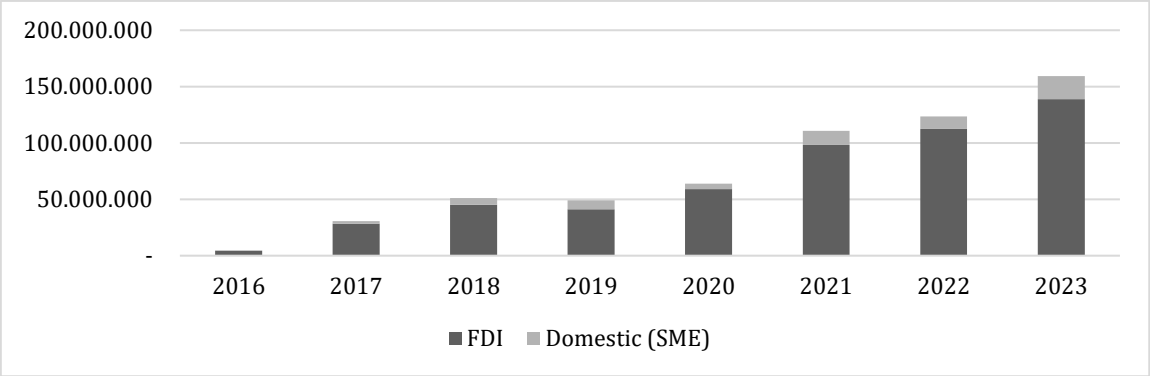


**Figure 5.** Subsidies paid under the Law on Investments from 2015 in EUR (effective from 2016)
*Source: Ministry of Economy, Author's calculations*

Taken together, the subsidy component of investment incentives in Serbia still exhibits a significant bias towards FDIs. The imbalance between SMEs and FDIs has been widely recognized (The World Bank, 2018; European Commission, 2021, 2022, 2023) and, according to CEVES (2024), SMEs have been receiving between 17% and 25% of total direct subsidies. When tax incentives are included alongside subsidies, the distribution ratio becomes even more disproportionate, standing at approximately 1:10—with €50–60 million allocated to SMEs compared to around €500 million directed towards FDIs (CEVES 2024[b]). This substantial disparity signals the existence of a significant distortion in market competition, where the financial and structural advantages granted to large, predominantly foreign enterprises place domestic SMEs at a considerable disadvantage. Such imbalances not only limit the capacity of SMEs to compete on equal footing but also restrict their potential contributions to economic diversification, innovation, and long-term sustainable growth.

## (d) Institutions, Interest Rates, Domestic Savings and Crowd-Out

The quality of Serbia's institutional environment has been repeatedly identified as a major deterrent to investment (Arsić et al., 2019; Pontara et al., 2025; Petrović et al., 2019). Reports by the Doing Business initiative, the European Commission, and the World Economic Forum consistently point to regulatory unpredictability, weak rule of law, and administrative inefficiency as key weaknesses. These factors have been widely recognised as discouraging investment more broadly (Dawson, 1998; Mauro, 1995; Minović et al., 2020). At the same time, the institutional setting remains structurally uneven: large firms and foreign investors are often better positioned to navigate or bypass these constraints, benefitting from direct access to decision-makers and favourable state treatment (CEVES, 2019; European Commission, 2021).

Recent empirical studies support this perception of a dual business environment. Evidence from Serbia suggests that legal and institutional factors such as property rights, law enforcement, and judicial confidence remain important to foreign investors (Marjanović et al., 2024); however, the influence varies by investment type, with larger and more embedded investors facing fewer practical constraints. Jovanović et al. (2023) and Branković and Sarajčić (2024) report that core governance indicators, including regulatory quality and corruption perception, do not significantly shape FDI inflows, implying that foreign capital may operate under conditions detached from the regulatory burdens experienced by domestic firms. Khalid (2024) adds that in low-quality institutional settings, corruption may initially function as a facilitative mechanism for

FDI, though with adverse long-term effects. Notably, the World Bank's Control of Corruption score for Serbia declined from -0.33 in 2013 to -0.46 in 2022, despite stable levels of foreign investment, further suggesting that governance deterioration has not deterred foreign capital but may have deepened the institutional asymmetries facing domestic enterprises.

Access to finance is also recognised as an important determinant of domestic investment. SMEs face higher borrowing costs compared to large or foreign-owned companies, which are often able to draw on external financial resources through their parent groups. The financial system is shallow and highly bank-centric, while domestic credit activity has remained approximately 15 percentage points of GDP below the average for Central and Eastern Europe (Arsić et al., 2019). These structural weaknesses are reinforced by a limited capital market and underdeveloped institutional investors. Recent findings indicate that, in weaker institutional environments such as Serbia's, real interest rates may still matter for investment decisions, but their effects are less stable and more difficult to isolate (Bucevska & Merdzan, 2024).

Domestic savings also play an important role in generating domestic investments by providing the necessary capital for expansion, innovation, and resilience against economic shocks. Economic theory consistently emphasises the positive relationship between domestic savings and investments, suggesting that higher savings rates should naturally lead to increased domestic investment levels (Solow, 1956; Feldstein & Horioka, 1980), a finding largely consistent with the broader empirical literature (Anyanwu, 2006; Fowowe, 2011). However, despite a notable increase in Serbia's gross savings rate from around 5–6% in the early 2010s to 16% in 2022, this growth has not been fully reflected in domestic investment activity. A similar pattern is observed in the broader CEE and SEE region. Bucevska and Merdzan (2024) find that although gross domestic savings are positively associated with investment, the relationship does not reach statistical significance, suggesting that institutional weaknesses may limit the extent to which savings translate into productive investment.

While FDIs have contributed positively to Serbia's macroeconomic stability, export capacity, and employment generation (Marjanović et al., 2020; Marjanović et al., 2021), its broader economic effects are more limited. Serbia-specific research indicates that FDI has not led to widespread linkages with the domestic economy. Delević (2020), based on municipal-level data, finds that financial subsidies for FDI have not generated significant indirect employment or spillovers. Instead, job creation is confined to the subsidised firms, and there is no measurable crowding-in effect on the wider economy. Bucevska et al. (2024), examining trends across Central, Eastern, and South-Eastern Europe, similarly find that while FDI raises overall investment, it does not stimulate additional domestic investment beyond the value of the foreign inflows.

Finally, the potential for crowding out remains relevant. Inflows of foreign and domestic investment often interact, producing both competitive pressures and positive externalities. In weaker institutional contexts (Kandilarov, 2019), or in sectors already populated by local SMEs (Jude, 2019), FDI can displace domestic actors. Since 2010, most FDI in Serbia has flowed into the automotive sector. While this has not resulted in direct market displacement, it has intensified competition in the labour market. Given growing labour shortages, especially for skilled workers, this may raise employment costs and limit the investment potential of domestic firms.

## CONCLUSION

Between 2013 and 2022, total investments in Serbia remained below the threshold typically associated with sustained economic growth, with domestic private investment persistently lagging behind. Despite steady inflows of FDI and an increase in public investment, especially in the second half of the observed period, investment activity among SME-driven domestic firms remained subdued, pointing to potential structural constraints. Several factors may have contributed to this outcome.

First, although Serbia's CIT regime appears competitive in terms of statutory rates, it is heavily skewed towards large-scale investments through investment-linked tax incentives. A typology developed in this paper places Serbia among a small group of countries offering substantial CIT incentives exclusively to large investors, with no comparable provisions for smaller enterprises. This contrasts with most EU countries, where incentive structures tend to be more balanced or SME-oriented. The resulting asymmetry in tax treatment may have contributed to a distorted investment environment that fails to support broad-based private sector growth. Meanwhile, EATRs declined by approximately 2.0 percentage points in New Member States and 2.5 percentage points in older EU member states over the same period, while remaining largely unchanged in Serbia, suggesting a growing divergence in the effective tax burden faced by firms operating in different national contexts.

Second, the allocation of direct subsidies mirrors these patterns. While SME-oriented programmes exist, the overwhelming share of subsidy funds has been channelled to large-scale and foreign projects (World Bank, 2020; Delević, 2020). These asymmetries raise questions about the long-term allocative efficiency and domestic investment potential of current policies. Although institutional weaknesses are frequently cited as barriers to investment (Arsić et al., 2019; Pontara et al., 2025), recent empirical evidence suggests that governance quality does not significantly affect FDI inflows (Jovanović et al., 2023; Branković & Sarajčić, 2024; Khalid, 2024), pointing to the presence of a dual regulatory environment in which foreign investors are relatively insulated from the constraints faced by domestic enterprises.

Third, access to finance continues to pose structural limitations. Borrowing costs for domestic SMEs remain high, and financial intermediation in Serbia is underdeveloped compared to regional benchmarks (Arsić et al., 2019). Fourth, while gross domestic savings rose to 16% of GDP by 2022, the relationship between savings and domestic investment does not appear statistically significant in Serbia or comparable South-East European countries, likely due to weak institutional transmission mechanisms (Bucevska & Merdzan, 2024). Fifth, although FDI has contributed positively to exports and employment (Marjanović et al., 2020; 2021), its broader developmental impact remains limited. Spillover effects have been modest (Delević, 2020), while competitive pressures in the labour market, particularly for skilled workers, may have constrained domestic firms' capacity to expand.

Policy recommendations:

1. Rebalance tax and subsidy incentives to include structured, size-sensitive support for SMEs, particularly in tradable sectors.
2. Improve institutional coherence and regulatory transparency, with a focus on reducing disparities between domestic and foreign investors.
3. Strengthen financial intermediation, including the development of non-bank financing channels and targeted SME credit support schemes.
4. Systematically evaluate FDI-related externalities, including spillover potential, labour market effects, and the efficiency of tax expenditures.

Further research could examine more granular firm-level interactions, particularly the indirect effects of FDIs on domestic firms, the dynamics of crowding-in or -out in labour markets, and the potential for vertical integration or supplier linkages between foreign and domestic companies.

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Databases used:
Taxes in Europe Database v4 (https://ec.europa.eu/taxation_customs/tedb/#/home)
World Bank Open data database (https://data.worldbank.org/)
EU Tax Observatory (https://www.taxobservatory.eu/)
Eurostat (https://ec.europa.eu/eurostat/web/main/data/database)

## APPENDIX: EVALUATION OF TAX INCENTIVE REGIMES FOR INVESTMENTS

To evaluate the nature of tax incentives for investments across selected countries, a qualitative grading system was developed. The system categorized countries into six distinct groups based on the structure, accessibility, and focus of their tax incentive regimes:

1. Only Small – Incentives exclusively target smaller investments, offering no substantial benefits for larger projects.
2. Pro Small – Incentives are available to all sizes of investments but offer more favorable terms for smaller investments, such as higher credits or longer periods.
3. Neutral – Incentives are equally accessible and beneficial to investments of all sizes, without evident bias toward small or large projects.
4. Pro Large – Incentives are available for all investments but are designed to provide greater benefits to larger projects.
5. Only Large Investments – Incentives are exclusively designed for large-scale investments, often with high thresholds for eligibility, leaving smaller projects unaddressed.
6. Only Green– Incentives are specifically targeted at investments in environmentally friendly or energy-efficient projects, with no broad applicability to other types of investments.
7. None – No significant tax incentives are available.

The classification was based on a comprehensive review of national tax policies, focusing on factors such as thresholds for eligibility, maximum and minimum credit rates, targeted sectors, and whether specific schemes favoured certain business sizes or industries. Each country was assigned a grade that reflects its policy emphasis. Results are presented in the box below:

| **Country** | **Tax Incentives** | **Evaluation** |
|---|---|---|
| Malta | - Business Development Scheme: Up to €300,000 in tax credits or grants for projects including digital transformation and environmental actions, covering up to 75% of eligible costs.<br>- Smart & Sustainable Investment Grant: Up to €100,000 for sustainability or digitization investments, covering up to 50% of eligible costs.<br>- Target: Accessible to both SMEs and large enterprises, with a slight bias for the former. Specific schemes are tailored to different business sizes and sectors. | Pro small |
| Belgium | - General Track: 10% or 20% deduction for qualifying digital investments (SMEs only).<br>- Targeted Track: 40% deduction for SMEs or 30% for non-SMEs on eligible fixed assets (list to be published).<br>- Technology Track: 13.5% (one-off) or 20.5% (spread) deduction for R&D-related fixed assets with low or no environmental impact.<br>- Eligibility: Investment types must meet conditions, and regional aid exclusions apply. | Pro small |
| Bulgaria | - Tax Exemptions for Investments: Up to 100% CIT exemption for investments in regions with high unemployment.<br>- Incentives for Specific Sectors: Tax exemptions and reductions for investments in manufacturing, R&D, and key industries. | Neutral |
| Czech Republic | - Investment Incentives: Corporate income tax credits available for qualifying investments (20-40% of eligible costs for large companies, 30-50% for medium and 40-60% for small).<br>- Energy-Saving Technologies: Tax-based incentives for investments in energy-efficient technologies. | Pro small |
| Germany | None | None |

| Country | Tax Incentives | Evaluation |
|---|---|---|
| Denmark | - Generally, no tax incentives. Exceptions for introduction of $CO_2$ tax to incentivize green investments. | Only green |
| Estonia | - Deferred taxation on reinvested profits: Corporate profits are taxed only upon distribution, allowing indefinite deferral of tax on reinvested earnings, which can be viewed as a tax incentive promoting reinvestment and economic growth. | Neutral |
| Greece | - Diverse tax incentive system: Tax exemptions for strategic investments available for various industries and investment sizes, generally neutral regarding business size.<br>- Tax credits/exemptions: Up to 50% of eligible investment costs for strategic investments. | Neutral |
| Spain | - Investment Tax Credits: Typically range from 10% to 25% for eligible fixed asset investments.<br>- Regional Incentives: Additional tax credits may apply, potentially up to 40%, in economically disadvantaged areas. | Pro small |
| Finland | None | None |
| France | - Only for green industry. Green Industry Tax Credit (C3IV): 20% of eligible investments, increased to 25%-40% depending on location, up to €150 million per company (or €350 million in specific areas). | Only green |
| Hungary | Tax credits available for a 13-year period (beginning once the investment is completed or the next year) in the CIT returns over a maximum of 16 years from the following year of the original application. In any given tax year, the tax incentive is available for up to 80% of the tax payable but is limited, in total, to the state aid intensity ceiling. Thresholds are relatively low, making investment incentives universally accessible. Incentives also available for investments in energy efficiency. | Neutral |
| Ireland | None | None |
| Italy | - Tax Credit ranging from 5% to 50%, heavily tilted towards smaller investments (up to 2 million EUR, while larger investments are considered to be 10 million or more). | Pro small |
| Lithuania | - Investment Project Incentive allows for a 100% deduction of qualifying long-term asset costs (2009–2028). Tax holiday of up to 20 years for large investments (€20 million+) and 150+ jobs. Slight favouring of large investments. | Pro large |
| Latvia | - Effectively a 100% tax credit on CIT while withholding tax is considered CIT. Special Economic Zones (SEZs) offer additional tax benefits, favouring larger investments. Overall, the system is mostly neutral. | Neutral |
| Netherlands | - Small-Scale Investment Allowance (KIA): Provides deductions for business assets, favouring smaller investments. Environmental and Energy Investment Allowance: Deduction of 27-45.5% of investment cost in energy-efficient assets from taxable profits. Overall system favours smaller investments. | Pro small |
| Portugal | - RFAI: Deduction of 30% for qualified investments below €15 million and 10% for investments above that threshold, capped at 50% of CIT due. Reinvestment Relief: 50% relief on capital gains reinvested in fixed assets. Overall system favours smaller investments. | Pro small |
| Romania | - Full tax exemption on reinvested profits (0% CIT rate for reinvested profit): CIT exemption for profits reinvested in technological equipment, computers, and software. | Neutral |
| Sweden | - Only limited tax incentives for green industries are with no broad-based tax credits or exemptions. State aid primarily disbursed through grants | Only green |

| Country | Tax Incentives | Evaluation |
|---|---|---|
| Slovak Republic | - Investment deduction based on reinvestment percentage: 15% for investments 1-20M EUR, 25% for 20-50M EUR, 50% for over 50M EUR. Slovakia sets a high threshold (EUR 1M) for eligibility, making it unique in the EU. | Pro large |
| Slovenia | - 40% deduction of investments in equipment, intangible assets, digital transformation, and green technologies, capped at 63% of pre-tax profit. Overall, neutral system favouring both small and large investments. | Neutral |
| Croatia | - 50% to 100% CIT rate reductions over 5 to 10 years, depending on investment size: EUR 50K+ for micro (50%), EUR 150K+ for small/medium (50-75%), EUR 3M+ for large (100%). Slightly favours large investments overall. | Pro large |
| Austria | None | None |
| Poland | Tax exemptions in Polish Investment Zone (PIZ): 10-15 years, capped at 10-50% of eligible costs for large enterprises, 20-70% for SMEs depending on region; up to 100% of CIT. Favors smaller investments overall | Pro small |
| Serbia | 10-year tax holiday exclusively for large investments exceeding EUR 8 million and creating at least 100 jobs. The system is explicitly designed for large-scale investments, with no equivalent incentive for SMEs. | Only large |

*Source: Author's compilation from European Commission Taxes in Europe Database V4[9] and PwC online taxation guides for corporate income taxation and related incentives[10]. Further clarifications and cross-checking was conducted through analysis of guidance documents by the respective development agencies of each country.*


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[9] Last accessed on 10th December 2024: https://ec.europa.eu/taxation_customs/tedb/#/home
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PRELIMINARY REPORT

# Flexible Work Arrangements and the Hybrid Work Model: Attitudes of Employees in the Scientific Research Sector in Serbia

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**ABSTRACT**

The paper analyses the advantages, disadvantages, and possibilities of implementing flexible work models in modern organisations, focusing particularly on the hybrid work model. The aim of the research is to identify the key benefits of the hybrid work model and examine the attitude of employees in the scientific research sector in Serbia regarding this relatively new and innovative concept. By using the desk research method and the empirical approach, the main advantages of flexible work models have been analysed, as well as the key challenges managers face during the implementation. The research findings indicate a growing popularity of the hybrid work model across various sectors, including scientific research in Serbia. Due to its numerous benefits, the model has been actively adopted by employees in the field of social sciences and humanitieshis.

**Keywords:** *flexible work arrangements, the hybrid work method, job satisfaction, productivity, scientific research sector, flexibility*

**JEL Classification**: L20, M54

## INTRODUCTION

Flexible work arrangements are becoming a key part of business strategies of an increasing number of companies, a new standard of business operation providing greater agility and adaptability to modern market demands. The rapid adoption of new work models is caused by a number of factors, mostly due to the development of modern information technology, globalisation, and the positive experiences gained during the COVID-19 pandemic.

Modern technologies play a major part in the implementation of flexible work arrangements, enabling easier communication, collaboration, and access to resources from any location. The application of new technologies, especially generative artificial intelligence, leads to significant changes in business operations and has a positive impact on sustainability (Komatina et al., 2024).

The growing trend of introducing new work models, along with the aforementioned ones, is also driven by changes in employee expectations, particularly the increasing demand for higher levels of work flexibility (Hunter, 2019; Lazarević-Moravčević, 2024). Given the benefits of remote work, employees have shown resistance to returning to traditional work environments after the COVID-19 pandemic.

The popularity of flexible work arrangements has expanded since the global workforce now predominantly consists of Generation Z and Millennials, i.e., the generations that have grown up

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in a technologically advanced environment. Not only does Generation Z aspire to great professional success, but it also strives to align jobs with its values, including social responsibility, inclusiveness, and sustainability. This generation can be seen as a key driver of change, bringing new expectations and demands regarding preferred working conditions, career development, and interpersonal relationships in the professional environment.

Flexible Work Arrangements (FWA) imply a wide range of models and work approaches tailored to modern business needs and employee expectations. These models can include flexibility of working hours, the freedom to choose work location, reduced working hours, a combination of remote and in-office work (the hybrid work model), job sharing, and other forms of work organisation. Despite their differences, all of these models depart from traditional work practices, bringing significant changes to the way business is structured nowadays.

Flexible work arrangements enable a higher degree of flexibility in terms of place, time, and the way in which work activities are performed. Types of flexible work schedules can be categorized based on four key dimensions: 1) the flexibility of *when* work is performed, referring to the timing and scheduling of tasks; 2) the flexibility of *where* work takes place, such as the physical or virtual location; 3) the flexibility regarding *how much* one works, encompassing variations in workload or working hours; 4) the flexibility in *work continuity,* including the possibility of taking short, or long-term breaks or leaves from work (Kossek & Michel, 2011).

New work models that allow a higher level of flexibility, unlike traditional approaches, have become the norm and common practice in many organisations. Due to numerous benefits offered to employees, employers and society as a whole, flexible work arrangements are becoming one of the basic factors for improving productivity, employee satisfaction, and business sustainability in the modern environment. New work models, including remote and hybrid work, have proven to be able to support sustainable development goals. Moreover, before the COVID-19 pandemic, these work practices were available to only a small portion of the workforce and were often considered an "elitist phenomenon" (Hopkins & Bardoel, 2023). However, the pandemic accelerated the adoption of flexible work arrangements, making these models accessible to far more employees.

Although flexible work schedules offer many benefits, their implementation can be a complex and challenging process. In practice, the introduction of these models poses a significant challenge for management, especially in the context of effective employee management and maintaining productivity.

The aim of this research is to explore the key advantages of the hybrid work model and to analyze the attitudes of employees in Serbia's scientific research sector, specifically within the fields of social sciences and humanities, toward flexible work arrangements. By combining desk research with an empirical approach, the study focuses on identifying the core benefits of flexible work models - particularly the hybrid model - as well as examining the main challenges that managers encounter during their implementation. The research starts from the assumption that, due to its numerous benefits, the hybrid work model meets specific needs and preferences of employees engaged in the scientific research sector in Serbia, in particular, in the field of social sciences and humanities.

The first part of the paper discusses the key advantages of flexible work arrangements, primarily the hybrid work model, as well as the challenges that management faces during its implementation. Special attention is paid to examining the trends, benefits, and obstacles encountered by the organisations that have adopted remote work practices and utilise the hybrid work model. The second part of the paper presents the results of the empirical research conducted from September to November 2024, focusing on the attitudes of employees in the scientific research sector in Serbia, especially in the field of social sciences and humanities, regarding flexible work arrangements. The conclusion summarises the key findings of the research, outlines limitations, and proposes directions for future analyses and studies.

## HYBRID WORK MODEL: ADVANTAGES AND CHALLENGES

Due to the fact that the hybrid work model represents a dynamic concept that requires adjustments to the specific needs of various activities, organisations, and individuals, this work model is not easily defined. Its clear definition is further complicated by the fact that the hybrid work model can involve various forms and work regimes, i.e., various combinations of locations and work schedules.

Fundamentally, the hybrid work model can be defined as an approach to work that combines traditional office work with remote work (Cook et al., 2020). As a relatively new phenomenon, which gained its popularity especially during the pandemic, the hybrid work model can be described as an arrangement in which employees divide their working time between working in an office and remote work which often involves working from home or other locations such as coworking spaces, libraries, cafes, etc. (Hopkins & Bardoel, 2023). According to Griva et al. (2025), hybrid work represents a socio-technical work arrangement mediated by digital technology, which enables collaboration among employees working in different temporal (e.g., synchronous and asynchronous) and spatial (e.g., in the office and at home) conditions. While remote work represents an entirely decentralised model relying exclusively on digital tools and online environments, the hybrid work model retains the office as an essential base for performing business activities, thus facilitating personal interaction and strengthening cohesion. As a matter of fact, the hybrid work model offers employees the possibility to work in the office on some days and from home on others throughout the week, providing flexibility in terms of workspace (location) and time (Krajčík et al., 2023). Therefore, it can be concluded that the hybrid work model integrates the advantages of traditional office work and remote work (Bloom, 2021; Uro, 2022), while simultaneously neutralising the drawbacks of both approaches.

Compared to the conventional office work, the hybrid model offers employees and employers a significantly higher level of flexibility, which, according to various studies and research, can positively impact employee behaviour, job satisfaction, commitment, engagement, and performance (Zafari et al., 2019; Weideman & Hofmeyr, 2020; Yang et al., 2023; Kelliher & Anderson, 2010; Jung & Yoon, 2021).

There are numerous reasons why employees prefer flexible work arrangements. These work practices provide more efficient use of working time by avoiding daily commuting to the office (Uru et al., 2022; Lazarević-Moravčević, 2024). One of the key advantages of flexible arrangements is saving time and money (Ipsos, 2022). A higher level of autonomy and freedom, i.e., the possibility for employees to independently create their work environment which suits their needs and determine their working time, can lead to increased satisfaction and productivity. Flexible work arrangements have a positive impact on achieving a work-life balance. Diani et al. (2024) maintain that a higher level of flexibility implies a higher level of life satisfaction. Flexibility in the workplace, the possibility of working from home office and organisational support can positively affect productivity, job satisfaction, and help create a healthy work-life balance (Yang et al., 2023), which can further result in reduced stress, increased well-being, and lower staff turnover (Austin-Egole et al., 2020).

On the other hand, Russell et al. (2009) point out that not all forms of flexible work arrangements have the same impact on achieving a work-life balance. While part-time work and flexible working hours reduce work pressure and conflict between work and personal life, working from home may increase stress levels and create conflict between these spheres (Russell et al., 2009).

As for employers, flexible work arrangements, including the hybrid work model, allow for cost savings and greater workforce availability. During the COVID-19 pandemic, a number of companies began implementing flexible remote work policies to reduce costs, support productivity, and enhance employee well-being (Hermann & Paris, 2020). By implementing flexible work policies, employers can reduce the need for office space and cut down infrastructure,

utilities, and maintenance costs (Grzegorczyk et al., 2021). Additionally, the implementation of flexible work practices and the hybrid work model decreases staff turnover, improves employee experience rating, and, as proven, has no adverse impact on performance or career advancement opportunities (Hopkins & Bardoel, 2024).

Certain studies underline that flexible work practices, specifically the hybrid work model, have the capacity to further enhance and develop intangible resources and positively impact business performance in the ICT sector (Radonić et al., 2021). Not only does this work model reduce staff turnover, but it positively affects job satisfaction (Bloom et al., 2022).

Extensive research confirms the positive effects of flexible work arrangements on the well-being of employees, employers, and society as a whole. Nevertheless, certain studies warn about potential negative consequences of these models, in particular, challenges posed by remote work. Challenges can arise in the areas of organisation and supervision, necessary support for employees in terms of training, equipment, and resources, reduced capacity to monitor performance, and security risks. Furthermore, employees can experience loneliness resulting from professional isolation during remote work (Pokojski et al., 2022). Some studies also highlight that remote work not only increases the risk of loneliness due to social isolation but also requires employees to develop stronger organisational skills. Moreover, remote work makes it more difficult to maintain a clear separation between work and family obligations (Klopotek, 2017). Remote workers often associate their homes with work duties, which can cause their workday to overlap with the time supposed to be dedicated to family responsibilities. It is not uncommon for employees who work from home to work longer hours, which often disrupts their work-life balance (Smoder, 2021; Buffer, 2022). Since remote workers (teleworkers) who do not frequently interact with colleagues and management may lose their sense of responsibility toward the organisation and the completion of their tasks, it is necessary to ensure continuous interaction among remote employees by implementing efficient online monitoring mechanisms and enabling employees to occasionally come to the workplace (Sholesi et al., 2023).

Due to the challenges posed by remote work, many companies**,** such as Google, Apple, Amazon, and Microsoft, decided after the pandemic to introduce a policy of partial return of employees to the office, i.e., to implement the hybrid work model. The hybrid work model significantly reduces the drawbacks of remote work. It is a model that provides employees with more flexibility while maintaining a certain level of control and stability for employers (Sokolić, 2022).

The hybrid work model allows employees to work from home but also to occasionally come to the office when required. These occasional office meetings positively impact the strengthening of team cohesion, the development of team spirit, and the improvement of communication and coordination among team members. This reduces many negative aspects of remote work, such as feelings of isolation and decreased responsibility toward the organisation, while still retaining the benefits of remote work. The hybrid work balances the freedom offered by remote work with the benefits of physical presence in the office, contributing to greater efficiency and employee satisfaction.

Although the implementation of the hybrid work model offers numerous advantages, its successful introduction is not a simple process. The effective implementation of the model requires a strategic approach, entailing dealing with various questions and challenges, such as how to optimally organise and coordinate remote work with office work; how to design an effective schedule that meets all employees' needs; and how to determine the appropriate work dynamics in terms of balancing the time spent at the workplace and home? (Lazarević-Moravčević, 2024).

The implementation of the hybrid work model can be realised in various ways, depending on the specific needs and goals of each organisation. There is no universal solution that would suit all organisations. Additionally, organizations should not expect the hybrid work model to evolve on its own (Shirma, 2023; Alasoini et al., 2025). Finding the appropriate option requires considering the situation from several perspectives, that is, taking into account numerous factors:

job characteristics, workplace culture, communication methods, employees' well-being, and current skills and knowledge (Hopkins & Bardoel, 2023). The feasibility and success of different work arrangements also depend on laws, organisational goals, job descriptions, along with individual preferences and needs (Eurofound, 2023). Hybrid work involves defining workspaces, choosing appropriate digital technologies to ensure continuous connectivity between the spaces, as well as establishing a precise time frame and schedule (Griva et al., 2025). Considering the above, it can be concluded that the implementation of this model requires additional technical and IT support, which, as a result, may create a need for the development and enhancement of employees' existing skills and knowledge. If the changes are carefully planned and implemented, a positive atmosphere can be created within the company, bringing about positive results for all parties involved in the process (Sokolić, 2022).

In practice, there are various modalities of hybrid work. Generally speaking, this concept has two basic forms: the office-centric and the virtual-centric model (Tippman et al., 2021). In the first type, office work is dominant, while remote work is an additional option. In contrast to the office-centric model, the virtual-centric model favours remote work. Based on these fundamental models, organizations can implement various variants of hybrid work: 1) Office First Hybrid Model - The office is the primary work location. Employees are allowed to work from home one or two days a week, but must spend the remaining days in the office; 2) Flexible Hybrid Model - The most flexible hybrid work option is when employees have the freedom to choose when to work in the office and when to work remotely, without any predefined rules; 3) Split Week Hybrid Model - The workweek is divided into set days for office and remote work, and employees must follow this schedule; 4) Week to Week Hybrid Model - In this approach, employees alternate between working remotely and working in the office on a weekly basis, with a pre-defined schedule; 5) Remote First Hybrid Model - Some organizations encourage employees to work primarily from home, with the office as a secondary option for occasional in-person meetings or collaboration.

The adoption of flexible work models has profound implications for all elements of organisational design, especially organisational structure and culture. These elements of organisational design have a significant impact on all segments of business, shaping employee behavior and influencing business outcomes (Lazarević-Moravčević & Mosurović Ružičić, 2023).

New forms of organisational structures should enable an easier transition to modern work practices while ensuring efficiency and effectiveness in business**.** Traditional organisational models, characterised by rigidity, hierarchical centralisation, and low agility, are unable to fully support the implementation of flexible work arrangements, including the hybrid work model. Therefore, changes need to be implemented in this domain towards establishing a model that fosters positive employee behavior and results in higher satisfaction and productivity (Novikova & Hamse, 2021).

The new approach to attracting and retaining employees, which is characteristic of flexible work arrangements, will lead to changes in organisational structure. Employees are physically separated, which implies new ways of control, but at the same time, greater freedom in work. Remote work makes it more difficult to monitor employee behaviour, reducing the effectiveness of traditional control mechanisms (Groen et al., 2018). This shifts power from the traditional authority based on position to a subtler level that relies on trust, emotional connections, and shared values (Sokolić, 2022). Successful implementation of the hybrid work model means that leadership needs to transition from control to trust, and special attention ought to be paid to ensuring fair inclusion of remote workers (Grzegorczyk et al., 2021). The implementation of hybrid work models requires leaders to develop innovative strategies that not only enhance employee engagement but also improve performance management processes and foster a healthy organizational culture. In this context, leadership and effective team management are recognized as critical factors for ensuring the long-term sustainability of hybrid work arrangements (Sakal, 2024).

In the context of hybrid work, the transformation of organizational culture requires a thoughtful and strategic approach by leaders, aimed at connecting employees who function in different physical and cultural environments. The key lies in fostering values such as trust, respect for diversity and inclusion of all team members, with clearly directed and open communication (da Silva et al., 2022).

In the hybrid work environment, it is vital to maintain and strengthen corporate culture despite the physical distance between employees. This can be achieved by making key cultural elements (vision, mission, company values) visible in the digital environment and encouraging informal communication through digital channels. In organisations striving to implement the hybrid work model, it is essential to provide ways to establish efficient communication among employees, regardless of their location. Certain studies highlight that transparent communication and consistent feedback are essential for maintaining employee engagement in hybrid work environments. In this context, clear communication practices, strong organizational support, opportunities for career development, and promotion of diversity emerge as key pillars for fostering a connected and motivated workforce (Ramachandaran, 2024).

Organisations need to provide appropriate tools, training, and support to employees to ensure their productivity and well-being, as well as social and emotional support. For effective collaboration in hybrid teams, it is crucial to be familiar with technology and use the right tools. Project management platforms, video conferencing, and real-time collaboration applications enable better communication and productivity. Leaders need to not only choose the right tools, but also provide the necessary training to use them (Sakal, 2024).

According to da Silva et al. (2022), the successful implementation of hybrid work requires fulfilling two key conditions. First, organizations must be technically prepared, which includes having adequate technological resources and support, such as computers, video conferencing equipment, and data storage devices. In addition, a crucial factor in the implementation of the hybrid work model is employees' attitude toward technology. In line with this, Tabor-Błażewicz (2022) argues that digital competencies represent the fundamental and essential set of skills required for effectively performing tasks within a hybrid work environment.

Based on the previous considerations, it can be concluded that the hybrid work model not only alleviates the negative aspects of traditional office and remote work but also optimizes the advantages of both approaches. This model offers employees a high degree of flexibility, allowing them to tailor their working hours and location to their individual needs and preferences, thus improving the balance between work and personal life. For organizations, the hybrid model facilitates more efficient resource utilization, reduces operational costs, and strengthens team cohesion and collaboration. However, its implementation comes with challenges, as it requires fundamental changes in how work is structured, how communication is managed among employees, and how teams are led. Despite these challenges, the hybrid work model stands as the optimal solution for modern organizations, offering the flexibility and adaptability necessary to respond to the dynamic shifts in the labor market.

## HYBRID WORK MODEL:ATTITUDES OF EMPLOYEES ENGAGED IN SCIENTIFIC RESEARCH ACTIVITIES IN SERBIA IN THE FIELD OF SOCIAL SCIENCES AND HUMANITIES

Due to the numerous advantages and benefits it can offer to both employees and employers, the hybrid work model is becoming an increasingly popular practice in many companies worldwide (Andrade & Andrade, 2023). Some studies indicate that this work model is the second most commonly used work model in Europe (Eurofond, 2022).

According to a 2022 Ipsos survey covering 93 countries and around half a million employees, remote work has become a fundamental part of work expectations. Approximately 68% of respondents prefer a hybrid model, while 24% want exclusively remote work. Only 8% of employees wish to return to the office. Research has also confirmed the popularity of this model

in the United States. According to the data from 2024 (Statista Research Department, 2024), approximately 54% of employees in the USA combine remote work with traditional office work. Studies also confirm that the hybrid work model prevails in metropolitan areas and regions with a high proportion of workers in the knowledge economy (McKinsey & Company, 2023).

Remote work is not entirely a new concept for employees in the science research field either (Janböcke et al., 2022). Flexible arrangements are becoming increasingly popular in scientific research due to technological advancements. During the pandemic, working from home became essential for maintaining business continuity, even in institutions focused on scientific research. Employees faced numerous challenges during this period, including balancing work and personal life, technological issues, and home distractions.

Research conducted during the pandemic demonstrated that the transition to remote work caused significant disruptions in research programs, resulting in the slowdown or suspension of numerous projects. The effectiveness of remote work was adversely affected by insufficient home office equipment, lack of structured routines, and limited access to high-speed internet. Furthermore, remote work contributed to increased feelings of isolation and fatigue, particularly among women with caregiving responsibilities (Gilmartin et. al., 2021). Other studies have also shown that remote work during the pandemic further highlighted gender disparities. Female scientists with children were significantly more burdened than their male colleagues, experiencing more frequent physical and mental health issues due to overload and isolation (Heo et al., 2022). Research in the field of social sciences indicates that the challenges faced by female researchers during the pandemic likely contributed to reduced productivity and a lower number of published papers (Cui et. al., 2022).

Despite offering numerous advantages, remote work is not suitable for all scientific fields, particularly those that face limitations in automation and remote management of experiments (Hunter, 2019). In scientific fields where remote or hybrid work is feasible, achieving positive outcomes in employee productivity and well-being depends on several key factors, including technological and managerial support, as well as strong interpersonal relationships (Franken et al., 2021).

While workplace flexibility has become a highly relevant topic in recent years, especially following the global changes triggered by the COVID-19 pandemic, research focused on remote work in the context of researchers is extremely limited. Most existing studies focus on the effects of remote work during the pandemic, a unique period marked by specific challenges such as organizational issues, emotional and psychological stress caused by physical distance, reduced interaction with colleagues, and uncertainty. However, there is a clear lack of studies analyzing researchers' experiences and attitudes towards remote work after the pandemic. This research gap is significant, as it is crucial to understand the long-term consequences of this change on researchers' work habits and preferences in the post-pandemic period.

The findings presented in this study fill this gap by providing insight into the post-pandemic changes and challenges faced by researchers. Although this paper partially relies on previously published data, it makes a significant new contribution by focusing attention on examining the attitudes of employees in the research community, particularly toward the hybrid work model. Through expanded analysis and interpretation, the paper enriches the existing literature with additional findings and specific insights. The research was conducted via an anonymous online survey from September to November 2024, with a sample of 353 researchers employed at institutes or faculties in the field of social sciences and humanities (Lazarević–Moravčević, 2024).

The research confirmed that flexibility is a key aspect of modern research work. Remote work is a widely practiced method in the scientific research field in Serbia, with around 67% of respondents (either completely or partially) using this work model.

From the perspective of employees in this field, remote work presents numerous advantages. The primary benefits identified are: 1) Flexibility in managing work hours - employees can tailor their work schedules to better fit their personal lives and peak productivity hours; 2) Enhanced

efficiency in time utilization - remote work often leads to less time wasted on commuting and more time available for focused work, allowing employees to accomplish tasks more effectively; 3) Increased concentration on work tasks - being in a personalized and comfortable environment can foster a higher level of focus, reducing distractions commonly found in traditional office settings (Lazarević-Moravčević, 2024).

The hybrid work model was identified as the most commonly implemented work practice among employees in the scientific research sector in social sciences and humanities.

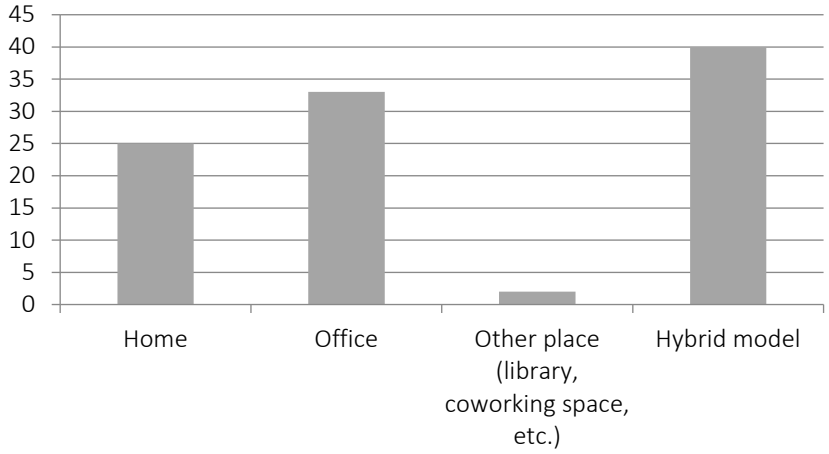


**Figure 1**. Primary work location for researchers in social sciences and humanities in Serbia (expressed in %)

*Source: Lazarević-Moravčević, M. (2024)*

The attitudes of the respondents on the hybrid work model are extremely positive, taking into account the entire sample size. The majority of researchers perceive the hybrid work model as the most suitable solution for scientific research activities. To be precise, more than half of the respondents (53%) completely agree, while 27% mostly support the view that the hybrid work model is the most effective for scientific research activities (Lazarević-Moravčević, 2024).

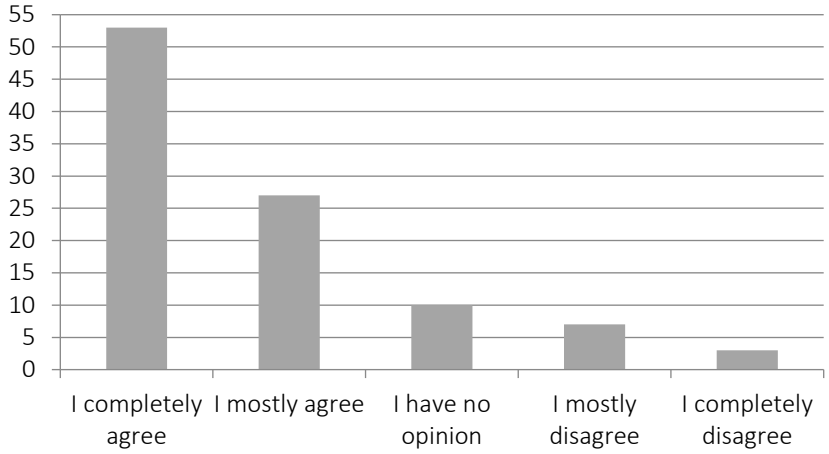


**Figure 2.** Distribution of respondents' views on the hybrid work model as the most suitable solution for scientific research activities (expressed in %)

*Source: Author's research*

The research also analysed the preferences of the respondents regarding the hybrid work model to identify differences in the attitudes between the female and male populations. The flexibility afforded by hybrid work can enable a more efficient balancing of professional and personal tasks. Based on the aforementioned position, this work model could be particularly functional for women, considering that gender roles in modern society still imply a disproportionate division of family responsibilities. However, the results of this study demonstrated that the concept is widely accepted among both women and men. Namely, researchers in the field of social sciences and humanities, regardless of gender, favor the integration of working from home and working in the office.

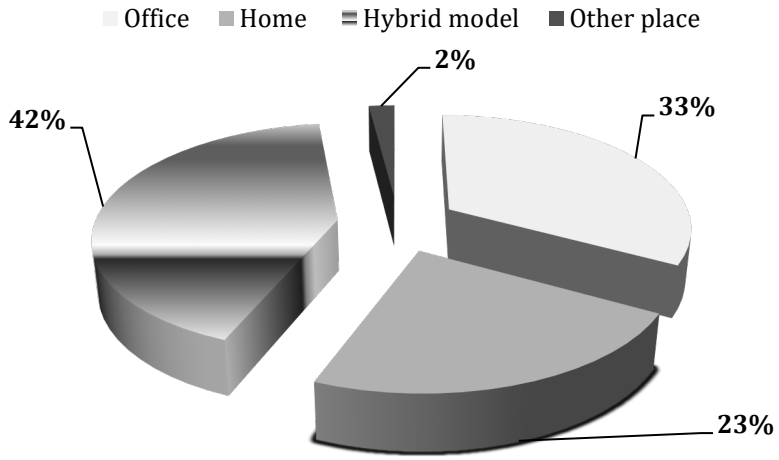


**Figure 3.** Primary work location for female researchers in the field of social sciences and humanities in Serbia

*Source: Lazarević-Moravčević, M. (2024)*

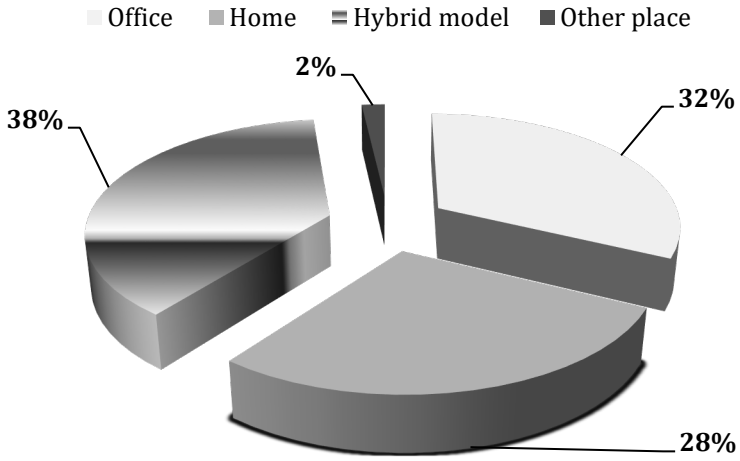


**Figure 4.** Primary work location for male researchers in the field of social sciences and humanities in Serbia

*Source: Lazarević-Moravčević, M. (2024)*

The research also indicates that the hybrid work model is the most preferred practice among the respondents in the age groups of 40-49 and 25-39. This group shows a greater tendency

toward combining remote and office work, suggesting their need for a higher level of flexibility. On the other hand, the researchers aged 50-59 tend to lean towards the traditional work environment, i.e., working from the office.

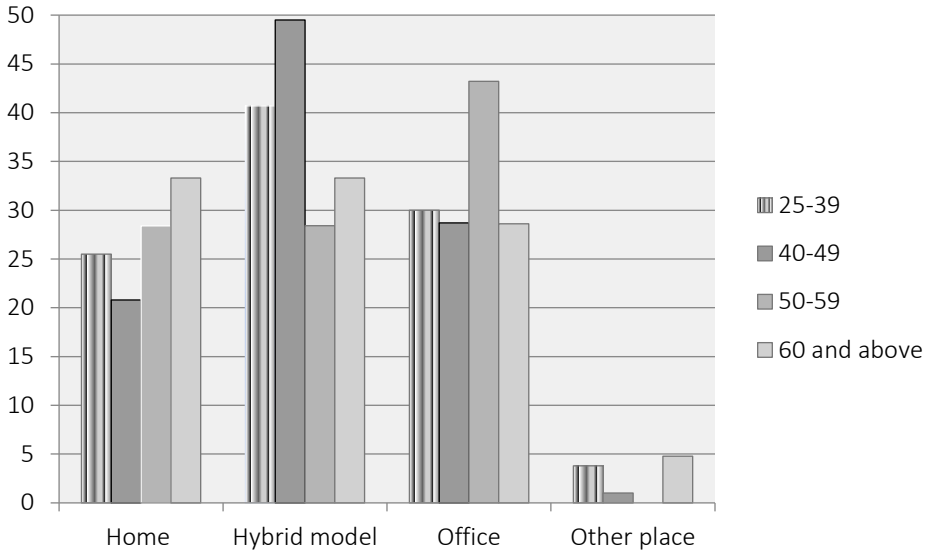


**Figure 5.** Primary work location for scientific workers in the field of social sciences and humanities in Serbia by age group (expressed in %)

*Source: Author's research*

It is assumed that, as new generations, particularly Generation Z, become increasingly involved in scientific research in Serbia, the trend toward flexible work arrangements will continue and intensify. The younger generation, particularly Generation Z, shows a strong preference for flexible working conditions (Bhat et al., 2024). This generation focuses on flexibility, creative tasks, technology, and work policies that offer not only material but also psychological satisfaction (Arar & Oneren, 2018). It has been proven that the freedom to choose the time, location, and work model has positive impact on the productivity of Generation Z employees (Febriana & Mujib, 2024), and that flexibility is one of the key factors contributing to the retention of employees from this group (Kgarimetsa & Naidoo, 2024).

The research demonstrates that flexibility is extremely important to employees in science. Additionally, researchers in the field of social sciences and humanities consider a combination of remote and office work, i.e., the hybrid work model, as the most suitable solution for performing their business activities. The assumption is that this work model meets the needs of researchers and is appropriate for this type of work for several reasons:

- Flexible work arrangements, such as the hybrid work model, allow employees to manage their time in a way that suits them best. This flexibility enables them to work during most productive periods, choosing their working hours - either early in the morning or late at night (Lazarević-Moravčević, 2024).
- A significant advantage can also be the more efficient use of working hours by eliminating daily commuting. By avoiding commuting, employees can better plan their activities. They are less exposed to stress, which can positively impact their mental health and productivity.
- The hybrid work model allows employees in the scientific research field to adjust their working hours and space according to personal needs. Flexibility in choosing work location, either from home or the office, contributes to a better integration of professional

and private life. The option to perform certain activities remotely (from home) provides more control over the work environment and helps eliminate or minimise distractions (noise, conversations with colleagues, meetings, etc.) typical of an office setting. This can contribute to greater concentration and focus, increased productivity, and reduced stress and tension.

Given the points discussed above, the hybrid work model provides researchers with both an optimal combination of freedom and autonomy while working from home and the benefits of team integration and collaboration when working in the office. The synergy can significantly contribute to increased satisfaction, motivation, and productivity.

## CONCLUSION

The analysis conducted in this paper examines the key features of the hybrid work model, with findings confirming that this model effectively addresses the drawbacks of both traditional office work and remote work. In fact, hybrid work has been recognized as a balanced approach that combines the best aspects of both models - physical presence in the office and the flexibility offered by remote work. By integrating various elements, the hybrid model provides increased flexibility and practicality, while simultaneously enhancing work efficiency (Andrade & Andrade, 2023).

The research identified numerous advantages of the hybrid work model, but also highlighted that implementing this relatively new work practice is a complex and demanding process. Implementing a hybrid workforce brings numerous challenges, such as communication problems, varying levels of technical literacy among employees, irregular working hours, and potential internal problems within teams (Putri et. al., 2023). Therefore, creating an effective hybrid system requires careful consideration of the strategic direction in which the organization wants to develop, as well as the types of challenges that need to be overcome. It is also necessary to keep in mind the fact that the advantages and disadvantages of a hybrid working model are often not immediately obvious, especially in the short term (Alassoini et. al., 2025).

Introducing a hybrid work model entails the transformation of all elements of organizational design, particularly organizational structure and culture. Viewed in the context of hybrid work implementation, leaders play a crucial role in the renewal of organizational culture. This primarily involves adopting a more flexible and sensitive approach to leadership. The strategic focus should be on strengthening connections among employees, regardless of their geographical location. By affirming values such as trust, diversity, and inclusivity, through proactive communication and fostering intrinsic motivation, it is possible to maintain a high level of employee engagement (da Silva et. al., 2022).

Empirical research has confirmed that the hybrid work model is highly supported by employees in the scientific research sector in Serbia, particularly in the fields of social sciences and humanities. The hybrid work model allows researchers to find the optimal combination of freedom and autonomy associated with working from home and the benefits provided by working in the office - collaboration, team integration, and effective communication.

The results of this research may have important implications for adapting the work environment to the needs of employees, especially in the scientific research sector. One of the key findings of the research is that the implementation of flexible and personalized work policies is becoming essential for institutions operating in the field of scientific research, given that productivity is maximized in work environments tailored to employees' needs.

This analysis also has certain limitations. Specifically, it does not provide an in-depth understanding of how the preferences of employees in the research sector of social sciences and humanities in Serbia regarding flexible work models influence their actual performance, level of engagement, workload, or work-life balance. The identified limitations will serve as a foundation for future research, where these aspects will be further examined and elaborated.

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ORIGINAL SCIENTIFIC PAPER

# The Effects of Strict Social Norms on Home Bias

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**ABSTRACT**

Despite the documented advantages of international portfolio diversification, investors tend to over-allocate to domestic markets, leading to exposure to home bias. This paper explores the behavioral explanation of this phenomenon by investigating the relationship between cultural tightness-looseness and equity home bias. Based on foreign portfolio holdings data from 28 of the most developed markets and over the period 2001-2022, we find empirical support using the OLS methodology that investors from culturally tighter countries register higher levels of home bias, compared to investors from looser countries. In cultures where stricter social norms are imposed and little deviation is allowed, investors exhibit higher confidence in domestic returns and associate international investments as more costly. Due to higher levels of innovation and fewer behavioral constraints, investors from looser countries overcome the cost associated with the unfamiliarity of foreign stocks, managing to better diversify their portfolios internationally. Additionally, we identify that financial education and economic openness of the investor country alleviate the effect stricter norms have on home bias. The significance of the study is reinforced by the robustness tests performed, such as employing alternative measures of both our dependent and independent variables and testing the identified relationships through different estimation methods. This paper contributes to the extensive literature on home bias by identifying the strictness of social norms as a key cultural determinant in shaping international portfolio allocation and exploring channels to mitigate its effect on home bias.

**Keywords:** *home bias; cultural tightness-looseness; foreign equity portfolio allocations; financial education; economic openness*

**JEL Classification:** C23, G15, G41

## INTRODUCTION

Following the recent significant acceleration of trade liberalization and financial integration, investors can benefit from the reduction of trade barriers and the deregulation of financial markets. However, the reduction in home bias occurs at a slower pace than globalization (Baele et al., 2007), a phenomenon that warrants further analysis on investors' tendency to tilt their investments toward the domestic market.

International portfolio allocation has been documented in the literature as influenced by a myriad of factors, both rational motives (Portes and Rey, 2005; Cooper et al., 2013) and behavioral ones (Aggarwal et al., 2012; Pradkhan, 2016). There is extensive literature endorsing the impact of investors' culture on shaping individual investors' preferences and behaviors, making it an important factor in financial decision-making. Studies like Anderson et al. (2011) and Beugelsdijk

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and Frijns (2010) confirm that culture, depicted through Hofstede cultural values, impacts equity home bias. These studies show that individualism (IDV) leads to lower levels of under-diversification, while uncertainty avoidance (UAI) serves as a costly obstacle to allocating capital to foreign markets. Cultural differences can be further interpreted as a lack of familiarity, as investors may feel disconnected from markets with different cultural practices, which can affect their willingness to invest internationally (Aggarwal et al., 2012).

In an attempt to move beyond cultural values as a sole indicator of cultural differences, and based on Pelto's (1968) introduction of the concept of social norms strength, Gelfand et al. (2006) find that cultural tightness looseness (CTL) - the degree to which societies enforce social norms and tolerate deviations - relates to variance within societies. Compared to cultural values which treat culture as homogeneous within national borders, CTL can capture the cultural diversity within a country as social norms are enforced differently across regions, social classes, and institutions. Following Gelfand et al. (2011), strong norms and sanctions are specific to tighter societies, while tolerance for deviating behavior and diversity corresponds to looser societies. CTL has been documented extensively in the literature as a predictor of economic behaviors (Gunia et al., 2011; Eun et al., 2015; Deckert and Schomaker, 2022).

Extensive literature has documented that financial literacy has taken up the form of human capital that investors leverage to increase the productivity of their financial capital (Lusardi et al., 2014). Various studies report that holding financial knowledge determines stock market participation (Lusardi et al., 2014; Chen et al., 2023). Guiso and Jappelli (2009) corroborated this idea by proving, using a representative sample of bank clients, that limited financial literacy leads to under-diversification. Furthermore, the study of Giofre (2017) empirically shows that education in finance diminishes the informational costs faced when investing in countries with weak investor protection standards. This implies that financially literate investors experience a reduced cost of potential informational asymmetries in such a framework, where the concept of diversification can shift the perspectives on risk aversion. This prompts us to explore whether country-level financial education provides knowledge that can transcend cultural norms by emphasizing rational financial behavior.

Despite the growth of financial globalization and broader access to global markets, certain countries continue to impose restrictions on foreign investment and limit the flow of international capital. Baele et al. (2007) empirically identified that trade openness reduces home bias, while Mondria et al. (2010) validate the explanatory power of two financial openness measures on equity home bias, showing that regulatory restrictions on capital account transactions, as well as the lack of international financial integration, can lead to overallocation on domestic markets. Cooper (2013) argues that while multiple factors are needed to explain equity home bias, economic openness and information asymmetries are among the most important. Given its significance in the equation that predicts home bias, we investigate whether the degree of a country's economic openness can moderate the effect that the strength of social norms can have on international portfolio diversification.

In this paper, we study the role of cultural tightness looseness, using Uz's (2015) measure of CTL to explain the phenomenon of home bias exhibited by 28 investor countries for the period of 2001-2022. Furthermore, given its documented significance in predicting home bias, we explore the moderating effects of investors' country-level financial education and economic openness on the relationship between home bias (HB) and cultural tightness-looseness (CTL). Our results show that investors from tighter countries are more exposed to home bias, and they can benefit from higher national-level financial education and greater economic openness to enhance their international portfolio diversification. These associations hold when controlling for previous determinants of home bias, such as economic development or certain Hofstede cultural dimensions, and are strengthened by a series of robustness tests, including alternative measures of principal variables and alternative estimation methods. To our knowledge, this study is among the first to empirically link CTL to investment biases, and the unique contribution lies in

examining how financial literacy can mitigate the impact of cultural constraints on portfolio diversification and how economic openness may facilitate a reduction in the barriers posed by cultural tightness.

The rest of the paper is structured as follows. Section 2 presents the hypotheses investigated in this study. Variables descriptions and statistics are described in Section 3, while Section 4 details the design of our study and relays the empirical results and the robustness checks. Section 5 concludes the papers.

## THEORETICAL BACKGROUND

At the onset of home bias exploration, French and Poterba (1991) relate that the overweighting of domestic stocks stems from investors being unclearly optimistic about home markets. In tighter societies, a sense of conformity may foster overconfidence in domestic markets. In such societies, investors might feel compelled to prefer domestic investments, striving to conform to widely accepted local standards and behaviors, thus increasing their exposure to HB.

The portfolio of a risk-averse investor is biased towards its own country stock due to the perception of safety given by domestic assets (Guiso et al., 2009). Furthermore, individuals from tighter societies perceive foreign markets as having higher informational costs due to narrow socialization (Arnett, 1995), reinforcing their preference for safety and predictability over novelty and uncertainty. Conversely, investors from looser societies are more willing to engage in risk-taking and innovative behavior (Gelfand et al., 2006), which can reduce their perceived informational barriers, leading to a more diversified equity portfolio.

Finally, the freedom to express themselves and a strong emphasis on values make individuals from culturally loose countries more rational than emotional when making investment decisions. Lubart (2010) identified a linear relationship between cultural looseness and IDV, which is usually associated with creativity and innovation. This link is also confirmed by Deckert and Shomaker (2022), where cultural tightness-looseness is correlated with a driver of economic performance: innovation. Investors from loose societies would benefit more from openness to innovation and individualistic traits, given that these induce a perceived information advantage and boost investors' confidence in foreign assets. In the light of these arguments, we postulate the following hypothesis:

**H1:** *Investors from culturally tighter societies tend to overallocate funds on domestic equity capital markets due to higher aversion to non-familiarity*.

Hofstede (2001) believes that, at a national level, education can be considered one of the key channels that perpetuate culture. Taras et al. (2010) aim to clarify this relationship by testing and confirming the hypothesis that the predictive power of personal values would be significantly stronger for individuals from countries with higher levels of financial sophistication. We expect that in countries with greater levels of education, investors have increased autonomy and freedom, making it easier for them to overcome the constraints of conformity imposed by tighter societies, which in turn determine overallocation on domestic markets.

As pointed out by the study of Cupák (2022), confidence in one's own financial knowledge, implicitly driven by financial education, can foster risky financial asset ownership. Based on a study concerning household financial decision-making, Korkmaz (2021) finds that financial literacy can stimulate risk-taking behavior regardless of the risk-averse level of individuals. Thus, we speculate that the uncertainty costs associated with international diversification, specific to tighter cultures, can be scaled down using the confidence from holding financial literacy.

We expect investors from countries with higher financial education levels to be more informed about the financial decision-making process, have a greater capacity to understand and evaluate

risk (Molina, 2023), and recognize the distinct advantages of international diversification. This enables them to be less constrained by the threat of non-familiarity with foreign stocks, thus experiencing lower HB.

**H2:** *Financial skills alleviate the effect of tightness on equity home bias.*

According to Nozick (1974), freedom permits economic, social, spiritual, and cultural experimentation, leading to new and better ways to solve problems and live peacefully with one another. Gelfand et al. (2006) argue that individuals in looser societies usually have a greater promotion focus, a greater preference for the cognitive style of innovators, and a tendency towards experimentation, trial, and error. Deckert and Schomaker (2022) endorse this proposition in their study where they find that cultural looseness harbors national innovativeness. Extending on this theory, we contemplate whether investors from societies with stricter social norms can benefit from higher degrees of country economic openness, and consequently, a more transparent flow of information, to overcome the preference to overinvest at home.

Welzel (2013) provides a compelling framework for understanding how economic openness can mitigate the reluctance of investors from culturally tight societies to allocate capital on foreign markets. His theory of human empowerment suggests that as societies become more economically integrated, they experience institutional, informational, and cognitive shifts that weaken traditional constraints on behavior, such as the ones endorsed by societies with pervasive social norms and low tolerance towards deviant behavior. Additionally, trade openness has been documented as a factor that determines change. It encourages cultural integration based on the premise that culture and economic processes interact, shaping and reinforcing one another in a way that they cannot be reduced to purely separate influences (Jones, 2006). A study by Stulz and Williamson (2003) highlights that the impact of culture, proxied by religion, on investor protection rights is tempered by openness. This leads us to believe that unrestricted cross-country capital flows may outweigh the reluctance towards foreign equity investments driven by cultural tightness. Investors from tighter cultures are expected to benefit from their country's economic openness, making them less resistant to change and foreign exposure. Based on these arguments, we postulate the following hypothesis:

**H3:** *Economic openness suppresses the effect of cultural tightness on the home bias level.*

## DATA AND STATISTICS

The main data source for the panel data of country-level portfolio allocation is the Coordinated Survey of Portfolio Investment (CPIS) by the International Monetary Fund (IMF). The CPIS database reports annual cross-country portfolio holdings of equity and debt securities in US dollars (millions). We constructed the domestic portfolio allocation shares by considering only the equity and investment fund shareholdings. The survey has been used extensively in prior studies centered around the topic of home bias (Cooper et al., 2013; Wei and Zhang, 2020).

The initial sample of countries comprised developed and emerging markets, following the MSCI ACWI index classification. Given the limited coverage of countries in the CPIS report and CTL scores and the necessity to exclude opaque holdings to offshore centers, the sample was narrowed down to 28 investor countries. As described below, we construct the measure of home equity biases using the annual cross-country portfolio holdings for the 2001–2022. Overall, we perform our empirical study on a total of 616 panel observations.

## Home Bias Measure

We have employed the home bias measure suggested by Ahearne et al. (2004) that has been used in various studies (Baele et al., 2007; Fidora et al., 2007; Bekaert and Wang (2009). This measure not only evaluates the gap between the benchmark allocation and the actual domestic allocation but is also normalized to account for the size of the market. The measure, computed using the formula relayed in Eq. (1), reflects how much an investor originating from country *i* tends to overallocate on their domestic market, relative to the allocation they should have at home according to the world CAPM, divided by the maximum possible size of home bias. Because all countries in our sample exhibit home bias, the normalized measure ranges from 0 to 1, with 1 indicating total home bias – where the home country invests exclusively in its own stocks.

$$HB_{i_{norm}} = (a_{i,i} - w_i)/(1 - w_i), \quad (1)$$

The actual domestic allocation ($a_{i,i}$) is computed as the amount of domestic equity holdings relative to the amount of all equity holdings of investor *i*, following the formula from Eq. (2) and the benchmark domestic allocation ($w_i$) is computed using Eq. (3).

$$a_{i,i} = (MC_i - FL_i)/(MC_i - FL_i + FA_i) \quad (2)$$

$$w_i = MC_i/\sum_i^W MC_i \quad (3)$$

While the CPIS database provides information on cross-country bilateral portfolio investments, information on domestic holdings was derived using the market capitalization of country *i* ($MC_i$) and the amount of equity capital inflows from foreign investors ($FL_i$). To obtain the total amount of equity holdings, we added the domestic holdings to the total foreign holdings as reported by CPIS. Following the Capital Asset Pricing Model (CAPM), where investors are expected to hold diversified portfolios with risky assets weighted by their market value, $w_i$ is the ratio between the stock market capitalization of the domestic country ($MC_i$) and that of all world markets. The data on country market capitalization was extracted from Refinitiv Datastream.

## Independent Variables

*Cultural Tightness Looseness*

To investigate how cultural differences affect HB, we employed the CTL measure from Uz (2015) as our main independent variable. Based on data from the 4th wave of the World Values Survey (WVS), conducted in 2000, this measure reflects the heterogeneity in values, norms, and behaviors. Thus, it is computed using the standard deviation construct. For index construction, the author measured the domain-specific index, the domain-general index, and the combined one. In our study, we opted for the combined one, which is built on questions relating to work, family, and religion domains for a group of 65 countries. This index represents the prime measure of CTL, given that it overcomes the limitations imposed by the other two indices and blends the best of the two worlds. If a culture has pervasive norms and sanctions deviance from these norms, it has a tight distribution around the mean, which pertains to tighter societies. On the opposite side, tolerance towards deviation from the norms stems from heterogeneity in social norms, prevalent in looser societies. The CTL index ranges from 3.1 (Indonesia) and 99,6 (France), where higher values reflect higher variance in norms, values, and behavior, as evident in loose nations.

The measure employed is superior to other measures documented in the literature, like the measure of Gelfand et al. (2011), since the latter merely assesses the perception of variation of social norms. As opposed to this measure, Uz's measure relies on the dispersion of actual

responses related to norms and morals, thus capturing cultural heterogeneity systematically (Uz, 2015).

*Financial Education*

We follow the study of Giofré (2017) in selecting our financial education measure and consider the *"education in finance*" indicator reported by the IMD World Competitiveness Yearbook, which is available for over 50 countries worldwide. The level of financial education is evaluated based on a survey of senior business leaders that provides an evaluation on a 0-10 scale for the statement "*education in finance does meet the needs of the business economy*". An investor originating from a certain source country is assumed to be more financially educated if the respective country registers a higher score for this indicator. The reliability of the measure is backed up by the study of Jappelli and Padula (2011). The study finds that the country rankings derived from the survey are comparable to measures of cognitive abilities at the individual level.

A shortcoming of such a financial education measure selection might be the fact that it is derived from a survey that evaluates the perception individuals have on the level of financial education rather than quantifying the respective level of knowledge and skills. As an alternative measure we employ the Standards & Poor's Ratings Services Global Financial Literacy Survey indicator that evaluates the financial knowledge based on four concepts: risk diversification, inflation, numeracy, and interest compounding. The measure has been extensively used in the literature to explain financial outcomes (Lusardi et al., 2014; Cupák, 2022).

*Economic Openness*

To measure the degree of financial openness, we use the Economic Freedom Index, EFW, provided by The Economic Freedom Network. The EFW index reflects the degree to which individuals are allowed to make their own economic choices free of constraints imposed by external forces. The measure is available for all 28 countries in our sample and the period between 2001-2021. We backfill the data for the year 2022 considering the history of scores, allowing for the closest observations to weigh more than the farthest ones. The index scores range from 0 to 9, where higher values reflect a higher level of country economic openness. The index has been widely used in the literature (Chan et al., 2005; Wallmeier and Isel, 2022).

Literature on economic openness distinguishes between two types of ways to assess a country's integration into the global financial system (Wang, 2022). Formal legal frameworks and policies that regulate the cross-border movement of capital reflect the *de jure* economic openness, which is our selected measure. *De facto* indices measure the realized extent of cross-border financial activities, measured by the volume of international capital flows, regardless of a country's regulatory stance on international capital mobility. As an alternative measure, we also employ a *de facto* indicator, using the sum of foreign portfolio assets and liabilities from the External Wealth of Nations Database (Lane and Milesi-Ferretti, 2007), scaled by nominal gross domestic product (GDP).

*Control Variables*

Drawing upon previous literature on home bias determinants, we control for these factors grouped into categories like: capital flow frictions (Cooper and Kaplanis, 1986; Ferreira, 2011), familiarity (Chan et al., 2005; Lane and Milesi-Ferretti, 2008;), behavioral factors (Morse and Shive, 2011; Wei and Zhang, 2020; Kim, 2022) and culture (Anderson et al., 2011; Beugelsdijk and Frijns, 2010; Pradkhan, 2016). The description of the variables and their source is presented in Table 1.

**Table 1.** Control variables overview

| Variable | Description and source |
|---|---|
| *Capital flow frictions* | |
| Exchange rate risk | The standard deviation of the 36-month moving average of the trade-weighted REER. Bank of International Settlements. |
| Outflow restrictions | Equity outflow restrictions for the source country. Fernández et al. (2016) |
| Economic development | Log of GDP per capita (current US$). World Development Indicators |
| Market correlation | Country market return correlation with world market, computed on the five-year history of monthly return data. Datastream. |
| Good governance | Sum of the percentile ranks of government effectiveness and control of corruption. World Governance Indicators. |
| *Familiarity* | |
| Geographical proximity | The log of the distance between the source country and the rest of the world is calculated using data from CEPII |
| Linguistic distance | Average weighted linguistic distance between the source country and the rest of the world. Spolaore and Wacziarg (2009) |
| Trade closeness | The ratio of total bilateral trade, given by the sum of imports and exports between the source country and the rest of the world relative to the source country's GDP. IMF (Direction of Trade Statistics). |
| Cultural distance | The Kogut and Singh (1998) composite index quantifies the cultural difference between the source culture and the rest of the world, based on Hofstede's and Schwartz's cultural dimensions. Author's calculations. |
| *Behavioral factors* | |
| Patriotism | Mean country score based on the question "How proud are you to be [substitute nationality]?". The author's calculations, based on WVS data. |
| Social trust | An indicator reflecting the country's level of social trust. Author's calculations on WVS data. |
| *Culture* | |
| IDV | Reflects a preference for a loosely knit social framework, the opposite of collectivism. Hofstede (2001) |
| UAI | Reflects an anxious attitude towards ambiguity and intolerance of unorthodox behavior and ideas. Hofstede (2001) |

## Descriptive Statistics

Table 2 provides a cross-country overview of the main variables in our study. HB and economic openness are presented as weighted averages across our sample period, while financial education reflects the time-invariant country level. On average, investors exhibit a home bias (HB) level of 67.47%. This reinforces the observation that investors are highly biased towards investing domestically and it can be observed that, on average, each country in the sample exhibits a home bias.

The highest levels of HB are recorded for India (99.88%) and Turkey (99.74%). At the same time, these are among the top 3 countries with the lowest economic openness level and are situated in the tightest quartile of the sample. On the other end, the Netherlands, with an average HB score of 29%, clearly leads as the least home-biased country, significantly outpacing the other investors in terms of global portfolio diversification. In terms of CTL, financial education and economic openness, the Netherlands also surpasses the median score.

**Table 2.** Summary statistics for HB, CTL, financial education, and economic openness

| Investor Country | HB (%) | CTL | Financial Education | Economic openness |
|---|---|---|---|---|
| Argentina | 75.51 | 75 | 4.77 | *5.78* |
| Austria | 41.55 | 75.8 | 6.53 | 7.91 |
| Canada | 63.29 | 84.6 | 6.99 | 8.20 |
| Chile | 70.62 | 86.8 | 6.69 | 8.04 |
| Czech Republic | 68.32 | 59.6 | 5.14 | 7.75 |
| Denmark | 42.88 | 65.5 | 7.82 | 8.17 |
| Finland | 49.58 | 74.5 | *7.90* | 8.08 |
| France | 63.61 | 99.6 | 5.99 | 7.70 |
| Germany | 46.83 | 82.9 | 5.55 | 8.03 |
| Greece | 82.56 | 58.3 | 5.28 | 7.06 |
| Hungary | 69.77 | 42.8 | 6.01 | 7.41 |
| India | *99.88* | 43.7 | 6.45 | 6.36 |
| Indonesia | 99.11 | *3.1* | 4.23 | 6.73 |
| Italy | 41.25 | 67.8 | 4.04 | 7.52 |
| Japan | 77.47 | 43.3 | 4.56 | 7.91 |
| Mexico | 93.20 | 74.7 | *3.77* | 6.97 |
| Netherlands | *29.08* | 74.2 | 7.16 | 7.93 |
| Poland | 92.43 | 42.8 | 4.22 | 7.06 |
| Portugal | 55.14 | 87.4 | 4.62 | 7.63 |
| Russian Federation | 99.10 | 57.2 | 4.75 | 5.99 |
| Singapore | 52.71 | 55.2 | 7.55 | *8.76* |
| South Africa | 85.72 | 67.6 | 4.01 | 6.82 |
| South Korea | 87.40 | 20.1 | 6.78 | 7.59 |
| Spain | 74.65 | 83.9 | 4.88 | 7.81 |
| Sweden | 48.11 | 87.9 | 7.24 | 7.90 |
| Turkey | 99.74 | 12.5 | 5.92 | 6.61 |
| United Kingdom | 46.34 | 89.3 | 5.00 | 8.27 |
| United States | 60.67 | 58.0 | 6.55 | 8.43 |
| *World average* | ***67.47*** | ***65.31*** | ***5.77*** | ***7.52*** |
| *Median* | *68.32* | *67.8* | *5.92* | *7.70* |
| *25th percentile* | *48.11%* | *55.2* | *4.75* | *7.06* |
| *75th percentile* | *85.72%* | *83.9* | *6.78* | *8.03* |

*Source: Author's computations*

## METHODOLOGY

This research aims to investigate the impact of CTL on HB through Ordinary Least Squares, OLS regression estimates, while controlling for an extensive set of explanatory variables categorized into three groups. The first group comprises time-varying variables for each country, such as capital frictions and market correlation, which may explain investors' preferences for domestic versus foreign assets over time. Prior research, such as the study by Chan et al. (2005), suggests that market participants respond swiftly to macroeconomic changes, supporting the use of current-period values. The second group includes time-invariant variables for country *i* relative to the world, such as proximity measures, which can impact the perceived level of familiarity, thus affecting the overall investment behavior. The third group encompasses time-invariant variables specific to country *i*, such as cultural values that influence investor sentiment toward international diversification.

Following the work of tangent studies of Bekaert and Wang (2009), Anderson et al., (2011), Pradkhan (2016), the framework equation for testing the validity of H1 can be expressed as:

$$HB_{it} = B_0 + B_1 CTL_i + B_2 X_{it} + B_3 Y_{wi} + B_4 Z_i + e_{it} \quad (4)$$

$HB_{it}$ represents the equity home bias of country i at time t, and $CTL_i$ denotes the cultural tightness-looseness level for country i. The control variables $X_{it}$ comprise the time-varying variables for country i, $Y_{wi}$ consists of time-invariant variables relative to the world for country i, and $Z_i$ includes cultural variables specific to country i. Finally, $e_{it}$ is the error term capturing unobserved factors affecting HB. We extend the above-mentioned equation to test H2 and H3 by considering a fourth group of interaction terms that capture the interaction effects between CTL and time-invariant financial education ($FE_i$) and time-varying financial education ($EE_{it}$):

$$HB_{it} = B_0 + B_1 CTL_i + B_2 (CTL_i * FE_i) + B_3 X_{it} + B_4 Y_{wi} + B_5 Z_i + + e_{it} \quad (5)$$

$$HB_{it} = B_0 + B_1 CTL_i + B_2 (CTL_i * EE_{it}) + B_3 X_{it} + B_4 Y_{wi} + B_5 Z_i + + e_{it} \quad (6)$$

Specific to our panel data structure, there are concerns regarding the residuals being correlated across time for a given cross-sectional unit or across cross-sectional units for a given point of time. Following the same approach as Chan et al. (2005) and Bekaert and Wang (2009) we employ heteroskedasticity robust standard errors, without clustering. To control year-to-year changes, we include year effects in all specifications employed in this study, thus mitigating time-specific influences, including autocorrelation problems.

## RESULTS AND DISCUSSIONS

### Role of Tightness-Looseness

Table 3 contains the OLS estimates, where we delve into evaluating how heterogeneity in social norms impacts HB through multiple specifications. We begin by reporting in Column (1) the indirect relationship between CTL and HB, suggesting that country-level cultural looseness leads to a decrease in HB, as indicated by the statistically significant 1% level coefficient of CTL. This confirms our assumption regarding the direction of the link between the two variables, and we further enhance our specification to investigate whether this relationship holds when adding other explanatory variables.

Column (2) contains the regression results for the specification, including the main model control variables where we refrain from including variables shaped by cultural factors in the first instance. We can highlight that CTL retains its sign and statistical significance when adding previously documented explanatory variables for HB. The signs of the coefficients for the control variables are in line with our expectations reflected in Table 3, and all of them are statistically significant, at least at the 10% threshold, except the market correlation measure.

The way individuals exhibit trust relates closely to cultural context. Anderson et al. (2011) and Pradkhan (2016) find robust evidence that cultural dimensions like IDV and UAI variation shape investment behavior. We extend our main model specification in Column (3) by adding the measures of social trust, IDV, and UAI to explore whether these are interfering with the explanatory power of CTL towards HB. The depicted estimates reinforce our H1 on the importance of CTL in explaining equity home bias, even when the specification controls for other cross-country cultural differences.

**Table 3.** Home bias and cultural tightness-looseness

| | Exp. Sign | Base model | Main model | Culture control | Actual weight | Stand. beta (%) |
|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) |
| CTL | - | -0.0053*** (0.0002) | -0.0030*** (0.0003) | -0.0031*** (0.0003) | -0.0030*** (0.0003) | -31.98 |
| Exchange rate risk | + | | 0.4050* (0.218) | 0.3547* (0.210) | 0.2657 (0.202) | 7.46 |
| Outflow restrictions | + | | 0.0955*** (0.019) | 0.0614*** (0.017) | 0.0635*** (0.018) | 10.83 |
| Economic development | - | | -0.0234** (0.010) | -0.0299*** (0.010) | -0.0077 (0.011) | -13.08 |
| Market correlation | + | | 0.07416 (0.050) | 0.1039** (0.048) | 0.0968** (0.050) | 9.01 |
| Government index | - | | -0.1274*** (0.024) | -0.0485** (0.024) | -0.0588** (0.025) | 8.72 |
| Average geographic distance | + | | 0.0844*** (0.016) | 0.0555* (0.030) | 0.0430 (0.031) | 6.73 |
| Linguistic distance to USA | + | | 0.0293*** (0.003) | 0.0232*** (0.003) | 0.0170*** (0.003) | 14.07 |
| Bilateral trade | - | | -0.2677*** (0.050) | -0.1939*** (0.046) | -0.1831*** (0.046) | -11.21 |
| Cultural distance | + | | 0.0421*** (0.006) | 0.0144*** (0.006) | 0.0145** (0.008) | 5.55 |
| Patriotism | + | | 0.0831*** (0.024) | 0.0965*** (0.028) | 0.0412 (0.030) | 9.64 |
| Social trust | - | | | -0.0019*** (0.0005) | -0.0016*** (0.0005) | -13.41 |
| IDV | - | | | -0.0007 (0.0008) | -0.0019** (0.0009) | -6.96 |
| UAI | + | | | 0.0015*** (0.0003) | 0.0020*** (0.0003) | 16.50 |
| *Year effects* | | *Yes* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Number of obs.* | | *638* | *616* | *616* | *616* | *616* |
| $R^2$ | | *0.4378* | *0.7329* | *0.7733* | *0.7503* | *0.7733* |

*The equations from Columns (1) – (5) are OLS regressions. The robust standard errors are reported in brackets. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

One can observe that in the culture control specification, the IDV coefficient is not statistically significant at the 10% level, and this outcome is not surprising. First, based on the variance inflation factor analysis[1], IDV is highly correlated with the other predictors in the model, which might distort the results. Secondly, past literature has provided conflicting findings about the impact of IDV on HB. The study from Beugelsdijk and Frijns (2010) suggests that IDV should lead to higher international diversification, while Anderson et al. (2011) find that IDV might encourage HB, though not statistically significant in all specifications employed. Finally, in a study debating the objectiveness of Hofstede's cultural dimensions and their predictive power, Minkov and Kaasa (2022) suggest that different cultural dimensions often reflect the same underlying constructs. IDV and CTL may be capturing related cultural traits.

We repeat our culture control specification by replacing the home bias measure with the actual portfolio weight allocated to domestic equity, following the same approach as Pradkhan (2016). The results available in Column (4) support the influence of CTL on equity investment allocation

[1] Not reported in the article but can be provided on demand.

behavior. At this juncture, it is also compelling to explore the economic significance of the explanatory variables. In Column (5), we compute the standardized weight for each predictor of the model, and we attest that one standard deviation change in the CTL is associated with a 31,98% standard deviation increase in HB. CTL exhibits a greater marginal effect on HB than other strong predictors like UAI, linguistic distance, or social trust.

Moving forward, we employ our main model specification considering the multicollinearity concerns associated with the culture control model.

## Moderators Role

*Interaction between CTL and Financial Education*

Extensive literature has reported on the importance of financial education in predicting stock market participation and specifically its diminishing effect on the investor's exposure to domestic equity bias (Bose, 2015). In this sub-chapter, we explore the moderating effect of financial education on the relationship between CTL and HB, thus testing the validity of our H2. Table 4, Columns (1) and (3) display the estimation results of including financial education measure as an additional explanatory variable and the interaction effect between CTL and financial education, respectively. We can highlight that CTL's coefficient is consistent throughout the specifications while maintaining its statistical significance at the 1% level. The results relayed in Column (1) confirm the decreasing effect financial education has on HB, which is in line with our sign expectations based on previous studies (Kimball and Shumway, 2010). Furthermore, in Column (3), we can see that the interaction effect is significant at a 1% level and has a negative sign, which confirms our H2. Financial education amplifies the effect CTL has on HB by decreasing investors' tendency to allocate funds disproportionately to domestic markets.

**Table 4.** Moderating Effects of Financial Education and Economic Openness on CTL–HB Relationship

| | **Financial Education** | **Economic Openness** | **Interaction term Financial Education** | **Interaction term Economic Openness** |
|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** |
| CTL | -0.0031*** (0.0003) | -0.0032*** (0.0003) | -0.0036*** (0.0002) | -0.0037*** (0.0003) |
| Financial Education | -0.0124** (0.005) | | -0.0155*** (0.005) | |
| Economic Openness | | -0.0323*** (0.012) | | -0.0200* (0.012) |
| Financial Education × CTL | | | -0.0009*** (0.0002) | |
| Economic Openness × CTL | | | | -0.0018*** (0.0005) |
| *Control variables* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Year effects* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Number of obs.* | *616* | *616* | *616* | *616* |
| $R^2$ | *0.7357* | *0.7231* | *0.7442* | *0.7299* |

*The equations from Columns (1) – (4) are OLS regressions. The robust standard errors are reported in brackets. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

In light of these results, we are interested in exploring the marginal effect of the interaction term at different levels of HB. On the left side, Figure 1 displays how financial education dynamically shapes the link between CTL and HB, where the color bands represent different levels of predicted HB. We can observe that investors from extremely tight societies become more home-

biased as financial education increases. This effect is applicable to the tighter countries from the sample like Indonesia and Turkey which are incidentally also the ones recording over 99% HB.

Going upwards to average values of looseness, one can notice that financial education does not yield any amplification effect on CTL to lower HB. Finally, the moderating effect is highly visible for looser countries where financial education manages to boost social norms variation and decrease the levels of HB. This effect is especially detectable for investors with lower-than-average financial education.

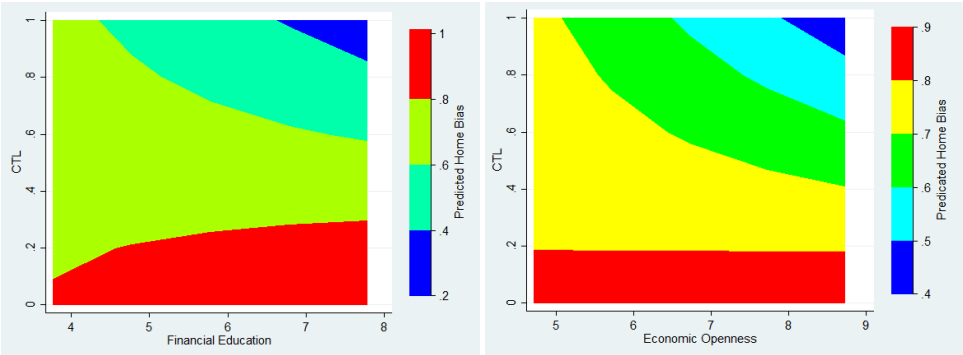


**Figure 1**. The average marginal effect of Financial Education and Economic Openness on HB for different levels of CTL[2]

*Source: Author's computations*

*Interaction between CTL and Economic Openness*

Financial openness has been nominated as a fundamental determinant of HB as empirically proven in the studies of Baele et al. (2007) and Mondria et al. (2010). Furthermore, a country's openness to international trade has been shown to act as a mitigator of cultural values on financial outcomes (Stulz and Williamson, 2001), which prompts us to explore whether economic openness mediates the relationship between CTL and HB. Table 3, Column (2) displays the estimates obtained when introducing the economic openness measure in our main model specification.

Corroborating previous studies, the coefficient of economic openness is negative and significant at the 1% level, relaying that country-level economic openness decreases the degree of HB. Column (5) reports the coefficient of the interaction term with CTL, which is negative and statistically significant. This evidence confirms H3 and suggests that the economic openness of the investor country can help individuals from tighter societies overcome the high perceived cost of investing in international markets. Furthermore, we can highlight that this effect is more consistent than the effect financial education exhibits on the CTL-HB link.

Complementary to the financial education effect discussion, we investigate the marginal effect of economic openness on HB for various levels of CTL. On the right, Figure 1 depicts the economic openness effect on HB, where we can spot a more defined linear relationship between the interaction terms and HB, except for the tightest countries. This relationship is highlighted at lower values of economic openness, as illustrated by the convex line between the yellow and the green contour, which implies that investors originating from countries with lower economic openness can benefit more from the diminishing effect of CTL on HB. The constant level of HB at low levels of CTL indicates that, in the absence of variation in social norms, economic openness loses its explanatory power and cannot improve international portfolio diversification.

[2] For an easier interpretation of the marginal effect results, the measure CTL has been rescaled to lie within the range between 0 and 1 throughout the study.

## Endogeneity

Going further, we examine whether our results are flawed by endogeneity. More relevant than the possibility of reverse causality between CTL and HB is the omitted variables bias and the error induced by having survey-based variables. To dismiss such suspicions, we instrument our main independent variable, CTL, using the measure of kinship introduced by Enke (2017). It represents an index of kinship tightness, which measures the extent to which societies are embedded in closely linked extended family structures. Tight kinship societies concentrate their trust and cooperation towards in-groups, while societies with looser kinship systems place lower emphasis on communal moral values and in-group favoritism, which allows them to develop broader institutions.

Table 5 Panel A reports the IV (2SLS) first-stage regression results, where Column (1) estimates confirm the strong negative relationship between CTL and kinship, relayed by the statistically significant coefficient. Panel B from Table 5 reports the second-stage regression results in the same column, showing that CTL's coefficient remains significantly robust in explaining HB. Furthermore, the table also reports the Cragg-Donald Wald F statistic which records values (159.90) well above the critical values (16.38), which confirms the power of the instrument selected.

We also discuss the possibility of endogeneity between HB and the employed moderators - financial education and economic openness. In the case of economic openness, we find no threat of endogeneity bias due to its low correlation with HB. However, for the financial education measure, we consider opting for an instrumental variable, given its high correlation with HB and the availability of a strong instrument: the PISA math scores discussed by Hanushek and Woessmann (2008). The test scores are considered the most informative indicator of financial skills prior to labor market participation, as they reflect 15-year-old students' cognitive skills in mathematics and science.

In Table 5, Columns (2) and (3), we report the IV (2SLS) regression results depicting the instrumenting of financial education using the cross-country average PISA math score. In a later step, we use the interaction between kinship and the PISA math scores as an instrument for the interaction effect between CTL and financial education. In both cases, the test scores are shown to be strong predictors of financial education, as evidenced by the results from Panel A. The test suggests, through the rejection of the null hypothesis, that there is sufficient correlation between the instruments and the endogenous variables. The diagnostic tests employed in our regressions confirm the strength of our instruments, and the model is not under-identified.

**Table 5.** HB, CTL and financial education: instrumental variable approach

| | **CTL** | **Financial Education** | **CTL and Financial Education** |
|---|---|---|---|
| | **(1)** | **(2)** | **(3)** |
| **Panel A: First-stage regression** | | | |
| Kinship | -49.7692***<br>(4.515) | -54.5374***<br>(3.840) | -56.6425***<br>(3.194) |
| Pisa Math scores | | 0.0120***<br>(0.002) | 0.0240***<br>(0.002) |
| Pisa Math scores * Kinship | | | -1.1500***<br>(0.164) |
| *Control variables* | *Yes* | *Yes* | *Yes* |
| **Panel B: Second-stage regression - Dependent variable = Home bias** | | | |
| CTL | -0.0033***<br>(0.0005) | -0.0065***<br>(0.0005) | -0.0069***<br>(0.0007) |

| | CTL | Financial Education | CTL and Financial Education |
|---|---|---|---|
| | (1) | (2) | (3) |
| Financial Education | | -0.0921*** (0.018) | -0.1340*** (0.018) |
| Financial Education × CTL | | | -0.0015* (0.0007) |
| *Cragg-Donald Wald F statistic (critical value)* | *159.90 (16.38)* | *25.859 (7.03)* | *14.013 (8.54)* |
| *Anderson canon. corr. LM statistic (p-value)* | *76.818 (0.000)* | *53.139 (0.000)* | *15.736 (0.000)* |
| *Kleibergen-Paap rk LM statistic (p-value)* | *121.49 (0.000)* | *40.46 (0.000)* | *21.84 (0.000)* |
| *Number of obs.* | *616* | *550* | *550* |

*The equations from Columns (1) – (3) are IV (2SLS) regressions. The robust standard errors are reported in brackets. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

## Robustness

*Alternative Measure of Home Bias*

In an empirical study where various HB measures were tested for validity, Cooper et al. (2013) criticized the normalized home bias measure, indicating that it contains a violation against its own premise. The authors highlight that assuming a maximum home weight of 100% implies that a country's wealth equals its market capitalization, an assumption that holds only in a hypothetical world where international investments are happening for the first time. They propose scaling the raw version of home bias with the maximum feasible home bias, as shown in the calculation below:

$$HB_{i_{Cooper}} = (a_{i,i} - w_i)/\sqrt{w_i(1-w_i)}, \quad (7)$$

**Table 6.** Robustness: Alternative home bias measure

| | Main model | Financial Education | Economic Openness | Interaction term Financial Education | Interaction term Economic Openness |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| CTL | -0.1311*** (0.012) | -0.0579*** (0.012) | -0.0660* (0.010) | -0.0689*** (0.011) | -0.1036*** (0.012) |
| Financial Education | | -0.4701** (0.202) | | -0.5009** (0.206) | |
| Financial Openness | | | -4.4402*** (0.832) | | -3.6782*** (0.819) |
| Financial Education * CTL | | | | -0.0239** (0.010) | |
| Financial Openness * CTL | | | | | -0.1397*** (0.027) |
| *Control variables* | *Yes* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Year effects* | *Yes* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Number of obs.* | *616* | *616* | *616* | *616* | *616* |
| $R^2$ | *0.6704* | *0.4761* | *0.5106* | *0.4803* | *0.5403* |

*The equations from Columns (1) – (5) are OLS regressions where the HB measure by Cooper et al. (2018) was employed. The robust standard errors are reported in brackets. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

We have reproduced the estimates of our main model specifications, as well as those including the interaction terms, using the alternative HB measure described above. The results reported in Table 6 suggest that our results are not dependent on the specific choice of HB measure. CTL remains a strong predictor of HB in this alternative specification, while financial education and economic openness alleviate the negative effect tightness has on international portfolio diversification.

*Moderator Alternative Measures*

Bellofatto et al. (2018) discuss the subject of measuring financial literacy that can reflect either an objective or subjective perspective. Our employed financial education measure is built on results that mostly rely on survey-based data, which solely captures the perception of financial literacy and not the actual financial competence of investors. To circumvent the issues related to our main selected financial education measure, we employ the S & P's Financial Literacy Survey indicator (Lusardi et al., 2014) that evaluates the actual financial skill level for each sample country based on fundamental concepts in finance.

Regarding our second moderator, we follow related literature (Mondria et al., 2010) and test whether our results are sensitive to the choice of financial openness indicator. We employ the *de facto* measure, based on the volume of a country's stocks of external assets and liabilities relative to its GDP, as introduced by Lane and Milesi-Feretti (2007). Our findings are maintained as reported in results from Table 7, reinforcing the validity of our H2 and H3 hypotheses by reproducing statistically significant coefficients for the interaction terms between CTL and financial literacy, as well as for the interaction term between CTL and the de facto measure of financial openness.

**Table 7.** Robustness: Alternative measure - financial literacy and financial openness

| | **Financial Literacy** | **Financial Openness** | **Interaction term Financial Literacy** | **Interaction term Financial Openness** |
|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** |
| CTL | -0.0021*** (0.0003) | -0.0028*** (0.0002) | -0.0028*** (0.0003) | -0.0033*** (0.0003) |
| Financial Literacy | -0.0016** (0.0006) | | -0.0013*** (0.0006) | |
| Financial Openness | | -0.0790*** (0.012) | | -0.0798*** (0.011) |
| Financial Literacy * CTL | | | -0.0001*** (0.00002) | |
| Financial Openness * CTL | | | | -0.0018*** (0.0003) |
| *Control variables* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Year effects* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Number of obs.* | *616* | *616* | *616* | *616* |
| $R^2$ | *0.7624* | *0.7420* | *0.7737* | *0.7459* |

*The equations from Columns (1) – (4) are OLS regressions where the alternative moderator's measures have been used. The robust standard errors are reported in brackets. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

Additionally, we were interested in exploring the marginal effects of these alternative measures on HB at different levels of CTL. Figure 2 displays the marginal effect of financial literacy and financial openness measures across different values of HB, showing results consistent with those obtained using the standard financial education and economic openness measures in the main results part.

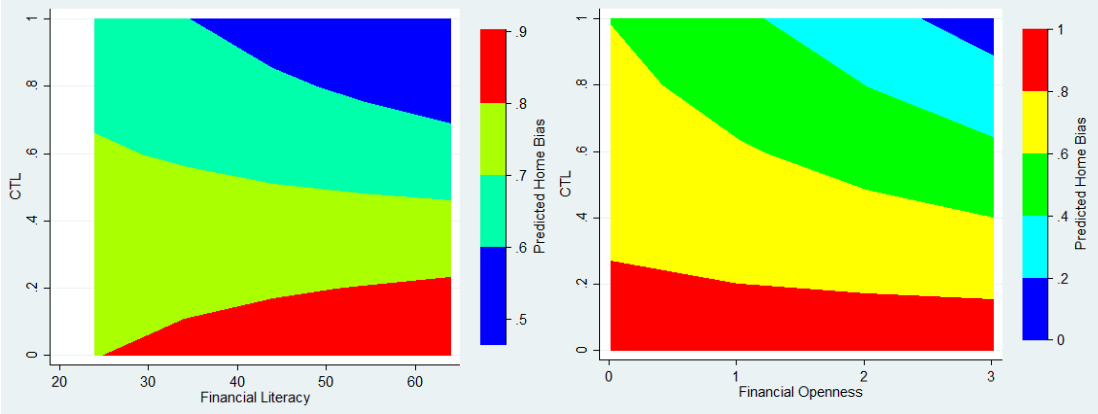


**Figure 2.** The average marginal effect of Financial Literacy and Financial Openness on HB for different levels of CTL

*Source: Author's computations*

## ALTERNATIVE METHODS

To strengthen confidence in our reported results, we employ several alternative estimation methods. Since our main independent variable, CTL, is time-invariant, it does not contribute to explaining the within-group variation in the time-varying HB variable. To address this, we re-estimate our specification in Table 8, Panel A, using random effects, following Bose (2015). Bounded outcomes often suffer from heteroskedasticity. We follow Gyu (2022) and transform our main measure of HB to range from – ∞ to + ∞ and test whether a log-linear relationship between the predictors and the log-odds of the endogenous variable provides a better fit than a linear relationship in the original scale, as presented in Panel B. Finally, to overcome the lack of time variance in our main independent variable, we follow Giofré (2017) and Kim (2022) and test the robustness of our results using the feasible generalized linear squared regression (FGLS) method as relayed in Panel C. The maintained sign and significance of the coefficients reported in Table 8 support our previous findings.

**Table 8.** Robustness: Alternative methods

| | **Main model** | **Interaction term Financial Education** | **Interaction term Economic Openness** |
|---|---|---|---|
| | **(1)** | **(2)** | **(3)** |
| **Panel A: OLS with random effects** | | | |
| CTL | -0.0037***<br>(0.001) | -0.0061***<br>(0.001) | -0.0060***<br>(0.001) |
| Financial Education * CTL | | -0.0005*<br>(0.0003) | |
| Economic Openness * CTL | | | -0.001**<br>(0.0005) |
| **Panel B: Logit transformed home bias** | | | |
| CTL | -0.0335***<br>(0.003) | -0.0346***<br>(0.002) | -0.0351***<br>(0.002) |
| Financial Education * CTL | | -0.0053***<br>(0.002) | |
| Economic Openness * CTL | | | -0.0018*<br>(0.001) |
| **Panel C: FGLS** | | | |
| CTL | -0.0025***<br>(0.0004) | -0.0035***<br>(0.003) | -0.0037***<br>(0.0004) |

| | Main model | Interaction term Financial Education | Interaction term Economic Openness |
|---|---|---|---|
| | (1) | (2) | (3) |
| Financial Education * CTL | | -0.0003*<br>(0.0001) | |
| Economic Openness * CTL | | | -0.0007*<br>(0.0004) |

*The equations from Columns (1) – (2) are OLS regressions while column (3) employs FGLS method. The robust standard errors are reported in brackets. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

## CONCLUSION

In this paper, we explored the influence of cultural value heterogeneity within countries, measured through the strength of social norms, on the investors' bias to deviate from the benchmark allocation by overinvesting in domestic markets. Using foreign portfolio holdings data from investors in 28 countries over the period from 2001-2022, we tested and validated three main hypotheses using the OLS framework. We found empirical support that investors from culturally tighter countries experience higher degrees of equity home bias channeled through aversion towards foreign stocks and the perceived unfamiliarity. On the opposite end, investors from looser countries manage to overcome the cost associated with unfamiliarity through means of higher risk-taking behavior and openness to cultural exchange. Additionally, we identify that financial education and economic openness at the aggregated country level can act as moderators on the relationship between CTL and HB and corroborate on their power to alleviate the impact of homogeneity of social norms on increasing HB levels.

We evaluated the robustness of our results by employing alternative proxies both for our dependent and independent variables, thus proving the gravity of our hypotheses. Furthermore, we applied different estimation methods to account for the lack of variability in our measure of CTL and ensured the validity of the causal inferences made in our regression analysis by instrumenting CTL through the measure of kinship and financial education through the PISA math scores.

Overall, the empirical results support the implication that investors from societies with stronger norms are more prone to over-allocate to domestic equity markets. This relationship is alleviated by higher financial education and economic openness of the source country. As far as we are aware, this is the first study to explore the association between CTL and HB with an in-depth focus on the moderators of this relationship. Furthermore, this paper follows recommendations from previous studies, such as Kirkman et al. (2016) that criticized the use of Hofstede's cultural values, opting for measures that more effectively capture the cultural diversity within a country, namely CTL.

While this study provides valuable insights into the role of CTL in shaping international portfolio allocation, several limitations should be acknowledged. First, the measure of CTL is time-invariant, which restricts the ability to introduce fixed effects to control for omitted variable bias, a limitation that also applies to the financial education measure. Second, our analysis focuses exclusively on 28 developed markets, which limits the generalizability of our findings. Given that developing markets often exhibit different institutional frameworks and cultural dynamics, future research could explore how CTL affects international portfolio allocation in these contexts. Finally, we recognize that the multicollinearity issue resulting from using both CTL and IDV in our regressions could be mitigated using alternative approaches. For instance, Minkov and Kaasa's (2022) approach suggests redefining dimensions to separate distinct cultural effects. As a future research direction, we could explore whether a principal component analysis or factor analysis could extract a composite cultural factor that retains meaningful variation while avoiding multicollinearity. Furthermore, the study paves the way for future research with a larger dataset,

both by expanding the country sample—particularly to include developing markets—and by incorporating additional asset classes such as debt instruments, real estate, and alternative investments. This would allow for a deeper examination of whether cultural influences extend beyond equity markets and shape broader portfolio diversification strategies.

The results provide meaningful policy implications. Specifically, policymakers should interpret our estimates as an acknowledgment of the power that cultural variation exerts over financial outcomes and promote cross-cultural awareness and integration. Additionally, both governments and portfolio managers should promote global investment education. Governments should integrate international diversification concepts into financial literacy programs, while portfolio managers should actively educate clients on the benefits of global diversification and help address perceived risks, particularly in tight countries with strong cultural constraints on risk-taking. Furthermore, regulators in culturally tight markets should work on reducing psychological and bureaucratic barriers that deter investors from participating in foreign markets.

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