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Benefits of diversification in EU capital markets: Evidence from stock portfolios

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A B S T R A C T

Although financial integration has tended to increase in the European Union (EU), it is not yet completed and investments remain mostly domestic and highly concentrated. While the economic literature provides several explanations for the high level of home equity bias, it is inefficient from the point of view of investors. Using only available information when allocating portfolios, we examine the benefits of stock diversification within the EU over the period 2012-23. We find that investors from several EU countries significantly improve their Sharpe ratios by investing more in Central and Eastern European Countries (CEECs) and that optimal portfolios perform better in periods of low and medium volatility. Moreover, diversification gains are compatible with maintaining the same average level of institutional quality and political risk as in national reference portfolios. Investors would therefore benefit from easing cross-border investments within the EU and further developing equity markets in CEECs.

1. Introduction

Although financial integration has tended to increase in the European Union (EU) since the creation of the Economic and Monetary Union (Gucciardi, 2022; ECB Committee on Financial Integration, 2022) due to an easier access to equity markets (De Santis and Gérard, 2006) and a reduction in transaction costs within the EMU (Haselmann and Herwartz, 2010), it is not yet completed and investments within the EU remain mostly domestic and highly concentrated. The intra-EU equity home bias for euro area (EA) countries dropped from 90.3% in 2009 to 81.9% in 2019, while it remained almost unchanged in non-EA Member States of the EU at around 96% (European Commission, 2021).[2] As regards trading stocks more specifically, Geranio and Lazzari (2019) confirm the persistence of a home bias in the euro area. While the economic literature provides several explanations for the high level of home equity bias,[3] according to standard finance theory it is inefficient from the point of view of investors that should be able to improve the performance of portfolios beyond the best performing single asset[4] (Markowitz, 1952). In this paper, we apply some modernised versions of this approach to the stock market portfolios in order to determine whether European investors could have benefited from more cross-border diversification within the EU in the past years by comparing optimal allocation models with realistic reference portfolios.

More generally, from an economic point of view, the lack of financial integration and international diversification is inefficient. First, larger intra-EU exposures could strengthen resilience to economic shocks

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[1] The views expressed do not necessarily reflect those of the Banque de France or the Eurosystem.

[2] Appendix A presents an analysis at country level. The home equity bias is strong in all countries and the share of equity holdings in the EU (excluding domestic investments) remains small.

[3] The main explanation for the home bias are informational frictions increasing perceived risk (Gehrig, 1993), behavioural bias towards the local market (Brennan et al., 2005), hedging for home-specific risks that could affect investors' income streams, restrictions on foreign investments (e.g. capital controls, differences in legal frameworks, constraints on short sales), informational acquisition or difference in tax treatments (see Coeurdacier and Rey (2013) and Ardalan (2019) for a review).

[4] In this classical approach, historical series make it possible to estimate the moments of the distribution of returns and select the optimal allocation based on the portfolio's mean and variance.

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through the capital market channel of risk sharing. Dufrénot et al. (2021) show that portfolio income contributed to stabilising shocks in the long term after 2008, but Cimadomo et al. (2022) estimate that smoothing via the capital channel has decreased recently in the euro area to reach only one third of the level estimated for the United States. Second, the inefficient allocation of savings to investment tends to lower the potential economic output in the EU. In particular, the lack of financial integration can lower the innovation capacity by restricting cross-border opportunities for higher risk projects. In this respect, it is essential to foster cross-border investment in order to improve capital allocation and EU resilience.

The question of the optimal portfolio allocation seems particularly relevant for the European Union, which exhibited a low level of corporate investment in some countries despite a large lending capacity in the last decade. Capital is supposed to flow from rich to poor countries according to standard neoclassical growth models, but this is not observed in practice (Lucas, 1990). Thus, according to Aizenman et al. (2007), up to 90% of the stock of capital in developing countries is self-financed. Explanations for the Lucas Paradox generally rely on the relaxation of the basic neoclassical model assumptions (Reinhardt et al., 2013): the lack of productive infrastructure (Causa et al., 2006), different capacities to use technologies (Eichengreen, 2003), information asymmetry, international capital market imperfections leading to frictions (Kalemli-Ozcan et al., 2010) and low institutional quality (Alfaro et al., 2008; Guiso et al., 2008; Osina, 2021). The European institutions strive to reduce such frictions and develop cross-border investments within Europe through the Capital Markets Union action plans, but these initiatives have not yet produced the expected results (European Commission, 2021). The existence of a large domestic bias and the smaller share of equity financing in CEEC companies than in euro area companies (Raposo et al., 2019) lead us to study the possible diversification gains that exist across EU countries.

In the context of growing concerns about the quality of democracy in some European countries and the intensification of geopolitical risk following the Ukraine war, investors may nevertheless be reluctant to increase their exposure to political risk in their portfolios. First, as documented by Smimou (2014), when instability linked to political risk increases, the optimal asset allocation can be revised in favour of home countries. However, the mitigation of political risk is a central source of diversification gains (Attig et al., 2023) and significant benefits can be achieved by including politically risky countries (Cosset and Suret, 1995). Second, as demonstrated by Guiso et al. (2008), a high level of trust[5] is particularly needed to attract investors in the stock market, which implies stronger investor protection and contract enforcement. Osina (2021) corroborates previous empirical evidence (Daude and Stein, 2007; Buchanan et al., 2012) and shows that rule of law, government effectiveness and political stability are among the most important institutional factors determining gross capital flow dynamics. Given that the level of trust in institutions to maintain a sound and stable financial system is identified as one of the main barrier to capital flows, we take into account this dimension in our optimisation models. We incorporate constraints on rule of law, voice and accountability, and political stability to ensure that diversification gains do not imply a decrease in the average institutional quality of investors' portfolios.

The main purpose of this study is fourfold: (i) to determine whether investors maximising their portfolio in real time could have potentially increased their gains over the last decade, which would provide real incentives for further equity portfolio diversification within the European Union; (ii) to measure the extent to which optimal portfolios alter geographic allocation, in particular to the benefit of CEECs; (iii) to assess how portfolio gains are impacted by the level of volatility on financial markets; (iv) to control that diversification gains can be achieved without affecting the average level of political risk, state of democratisation or respect for the rule of law in investors' portfolios.

We choose to focus on the EU in order to determine whether the Capital Markets Union – whose key motivations are greater diversification in funding and easier access to capital (European Commission, 2015) – would help improve portfolio performances. To do so, we compare the performance of current European portfolios with those of optimal portfolios. On the one hand, using the specific case of investments in listed shares, we construct a realistic geographical breakdown of such investments among the EU so as to determine realistic reference portfolios and to look into potential diversification gains resulting from maximisation strategies. On the other, we estimate optimal portfolios using the classical Markowitz (1952) mean-variance framework. However, as the precision of estimates for the original method decreases rapidly with the number of assets held in the portfolio (Jobson and Korkie, 1980),[6] we use several empirical approaches developed from the 1980s to the 2020s in order to obtain more robust estimators and improve the out-of-sample performances.

First, estimators shrinking towards the sample mean are used to improve the portfolio selection and avoid suboptimal choices related to uncertainty about parameter values. Jorion (1986) shows that shrinking the mean towards a "grand mean" of the minimum variance portfolio improves the portfolio selection problem. Numerous methods have since been developed in the same vein. For instance, DeMiguel et al. (2009) measure the out-of-sample performance on the US equity market of 14 different models, including several shrinkage portfolios, such as the Bayes-Stein shrinkage portfolio or a mixture of equally weighted and minimum-variance portfolios. They find that none of the optimal portfolios considered outperforms the equally weighted portfolio. However, using a dataset including 40 US industry indices, Jiang et al. (2019) demonstrate that out-of-sample performance of the minimum variance portfolio can be improved by combining the minimum variance and equally weighted portfolios. More recently, Lassance et al. (2022) use an independent component analysis (ICA) which helps to reduce the returns' kurtosis. Using a shrinkage portfolio combining minimum-risk and IC-risk-parity portfolios, they find better out-of-sample performances than several benchmark portfolios in terms of Sharpe ratios, tail risk and assets' turnover.

A second strand of literature relies on constrained estimators to improve the out-of-sample performance of optimal portfolios. The most common constraint is to impose non-negative portfolio weights. A number of strategies rely on that short selling constraint but Jagannathan and Ma (2003) show that, when imposed on the minimum-variance portfolio, the sample covariance matrix performs as well as the covariance matrix based on shrinkage estimators. The maximum share detained in each asset can also be constrained to limit concentration in only a few ones. The in-sample mean-variance optimisation approach with positive weight constraints based on market capitalisation weights is followed by McDowell (2018). He finds that there are potential benefits for some EU countries and that weakening the constraints increases the potential gains of diversification.

Previous empirical studies on potential benefits of equity portfolio diversification often yield mixed results depending on countries, methods used to optimise portfolios and benchmark portfolios. Early studies highlighted the existence of strong (ex-post) gains from international portfolio diversification[7] for US investors (Grubel, 1968; Levy and Sarnat, 1970), but they suffered from various methodological problems and, in particular, these diversification gains were not proven

[5] Trust is defined here as the subjective probability of being cheated by equity issuers and by institutions.

[6] The estimated efficient frontier can therefore be sub-optimal and often lead to extreme portfolios (with highly concentrated investments).

[7] They assume that portfolios follow perfectly the stock market indices of each country (and therefore do not practice optimisation between the stocks in the indices). The majority of studies on international investments adopt this approach.

to be statistically significant.[8] When testing whether optimal portfolios performed statistically better than the observed ones, Bekaert and Urias (1996) and Britten-Jones (1999) could not reject the hypothesis that the domestic market portfolio and the optimal allocation have the same performances. Conversely, Li et al. (2003) find significant diversification gains and show that, despite the ban on short-selling in some emerging countries, diversification gains remain large (whether in terms of risk reduction or return improvement). De Roon et al. (2001), using their own test, argue that diversification gains in emerging markets are not necessarily significant when considering a short-selling ban. More recent studies report significant benefits from international diversification strategies for UK investors (Fletcher and Marshall, 2005; Fletcher, 2018), investors in developing countries (Driessen and Laeven, 2007; Chiou, 2008) or investors in some developed and emerging economies (Hodrick and Zhang, 2014). However, McDowell (2018) finds that return-to-risk benefits from diversification are not significant for many investors, although the portfolio minimising variance can significantly reduce volatility in most cases.

As regards European investors, Buch et al. (2010) compute optimal portfolios for banks located in France and Germany and compare them to banks' actual cross-border assets from 1995 to 99. They find that French and German banks over-invest domestically and benefit from more cross-border diversification. Jacobs et al. (2014) assess optimisation models out-of-sample by both imposing constraints in the optimisation process and shrinking the estimated input parameters to mitigate the impact of correlation errors. They show that optimisation strategies do not provide significant improvements over simple asset allocation strategies for European investors on four regional equity indices of North America, Europe, Asia and emerging markets. McDowell (2018) finds significant diversification gains for some EU countries (Austria, France, Ireland and Italy) when the level of weight constraints is relaxed. There is therefore no clear consensus in the literature on the best method for optimising portfolio allocation, which appears to depend on the nature of the sample considered (location, period, type of assets, and frequency).

Previous empirical studies often refer to the local country index or to heuristic portfolios as a benchmark to determine whether optimisation improves portfolio performance. To start with, considering the high home bias observed in many countries, the optimal portfolio can be compared with a portfolio consisting only of domestic assets (Fletcher and Marshall, 2005; Driessen and Laeven, 2007; Hodrick and Zhang, 2014; Fletcher, 2018) – in our case it means comparing it with the performance of the national index. Although this can be an initial interesting point of comparison, it seems inadequate to compare a combination of assets, which offer potentially large diversification benefits with a single index.

Our study investigates four main research questions. Do diversification gains exist when using a more realistic benchmark? Can the investors on stock markets improve their gains by diversifying more their portfolios within the EU using only available information at the time of decision? Does a reduction in investment barriers contribute to a better allocation of equity investments by reducing the home bias? Do larger stock markets in some areas lead to greater diversification opportunities within the EU?

Our contribution is fourfold. First, we determine whether investors could have better allocated their EU portfolios using realistic assumptions to optimise performances. On the one hand, we define optimal portfolios following the three strands of literature mentioned previously and compare them to a realistic reference portfolio based on bilateral cross-border asset holdings observed in the past decade. On the other, we use out-of-sample estimates that simulate real time decisions for individual investors. Second, we focus on the European Union stock market to investigate the potential impact of the development of the Capital Markets Union undertaken by the European Commission in 2015 on the gains of investors seizing the opportunity to diversify their portfolios. We use the daily returns of listed equities held in EU countries, which are well-defined and established for a large number of countries and enable us to obtain a clear picture of gains including both price performance and income from cash distribution. These data provide a well-defined and more precise measure of performances at country level as compared to measures based on the returns of closed-end funds, which usually reflect performances over larger geographical areas (Bekaert and Urias, 1996; Fletcher, 2018). Third, we study the performances of the optimal portfolio depending on the tightness of weight constraints and on the level of uncertainty on stock markets. Fourth, we introduce constraints on the level of institutional quality and political risk in portfolios and asymmetric characteristics of risk to check the robustness of our results.

Over the period 2012-23, we show that under realistic assumptions it would have been possible for investors of seven countries (Austria, Belgium, Germany, Italy, Poland, Portugal and Spain) to achieve significantly higher performances by reducing their domestic bias and investing more in other European countries, in particular in CEECs. The diversification strategies would require increasing the size of equity markets in some countries such as CEECs, where they remain less developed (Lehmann, 2020), and easing cross-border investment in the EU through initiatives such as the Capital Markets Union. We find that the upper bound on portfolios' weight and the level of uncertainty on stock markets impact the Sharpe ratio. Finally, we show that results hold when introducing constraints on the portfolio to keep at least the same average level of institutional quality and political risk as in the reference realistic portfolio or when taking into account investors' concerns about downside risks, except for Germany where gains can only be partially confirmed.

After a presentation of the data (2) and the methodology used (3), we examine the potential benefits of diversifying investments in listed shares in the EU (4). We then discuss the robustness of our results (5) and conclude (6).

2. Data

2.1. Listed share returns, GDP, market capitalisation and non-financial data

In order to account for the dynamics of equity market returns, as is commonly the case in literature on international diversification gains (Li et al., 2003; Hodrick and Zhang, 2014; DeMiguel et al., 2009; McDowell, 2018), we focus on listed shares using Morgan Stanley Capital International (MSCI) total return indexes obtained from Datastream. Total returns include both price variations and cash repayments (cash dividend payments or capital repayments).[9] They are available for 21 countries[10] for the period from January 1, 2009 to June 30, 2023 (3783 observations). Table 1 presents some descriptive statistics for the annualised returns over the period. Following previous studies, we assume that each portfolio sticks to national stock market indexes. We exclude optimisation between stocks inside an index in order to obtain robust and significant results. The 1-month Euribor rate from the ECB is

[8] Huberman and Kandel (1987) later proposed a first econometric test to check whether the addition of active N significantly improved the efficient frontier and thus to verify the existence of diversification gains.

[9] Income from regular cash distributions or capital contribution reserves is reinvested in the index and contributes to the total index performance.

[10] Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, Netherlands, Poland, Portugal, Romania, Slovenia, Spain and Sweden. The selected time span enables us to include nine out of 11 Central and Eastern European countries: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Lithuania, Poland, Romania and Slovenia.

Table 1
Summary statistics of the annualised returns of listed shares for fully domestic portfolios and the realistic reference portfolios.

Country	Cap_i (%)	Domestic MSCI indices			Realistic reference portfolios			
		Mean (%)	Standard Deviation (%)	Sharpe ratio	Mean (%)	Standard Deviation (%)	Sharpe ratio	Amount of EU listed shares held (M€)
AT	1.2	8.2	31.4	0.26	10	26.1	0.38	74,386
BE	4.5	11.5	23.6	0.49	10.6	21.7	0.49	168,15
BG	0.2	1.5	25.2	0.06	4.2	23	0.18	4618
CZ	0.3	10.5	24.4	0.43	10.3	20.5	0.5	13,611
DK	3.3	22.4	22.7	0.99	20.9	20.5	1.02	172,755
EE	0	13.2	25.5	0.52	10.4	19.5	0.54	1665
FI	2.4	9.7	25.8	0.38	13.2	22	0.6	109,923
FR	24.9	13.4	24.1	0.56	14.7	22	0.67	1,288,499
DE	20.7	11.2	24.4	0.46	11.9	22.3	0.53	828,909
HU	0.2	10.2	36.1	0.28	10.9	25.2	0.43	9988
IE	1.7	11.5	29.5	0.39	12.9	23.1	0.56	166,117
IT	7	7.9	29.4	0.27	11.3	26.9	0.42	262,231
LT	0	15.7	18.2	0.86	10.9	14.7	0.74	2853
NL	9.4	17.1	23.4	0.73	15.6	21.3	0.73	205,822
PL	2	4.5	31.5	0.14	3.1	27.7	0.11	77,564
PT	0.7	5.1	24.6	0.21	6.9	22.5	0.31	14,758
RO	0.3	17.3	29.3	0.59	20.9	21.9	0.96	8758
SI	0.1	11	19.9	0.55	14.2	18.5	0.77	4363
ES	11.8	6.4	27.7	0.23	7.7	25	0.31	392,628
SE	8.4	16.4	28.4	0.58	12.2	24.2	0.51	423,217

Note. Cap_i is the share of each country's capitalisation among all European countries in 2014 as a %. Values for the mean, the standard deviation and the Sharpe ratio are also annualised. The amount of EU listed shares includes both foreign and domestic shares.

used as the proxy for the risk-free interest rate. Logarithmic returns r_t are obtained from MSCI indices I_t as $r_t = log(I_t) - log(I_{t-1})$. For most of the series, we accept the hypothesis of stationary returns,[11] but reject the hypothesis of normal ones (using the Augmented Dickey-Fuller and Jarque-Bera tests). We find no clear difference between the raw performances in old and new EU Member States.

Market capitalisations in 2014 are obtained from the World Federation of Exchanges. A national breakdown for the Euronext market is no longer available after 2014. For Baltic and Nordic financial markets (Finland, Sweden, Lithuania and Estonia) belonging to the NASDAQ Nordic, no breakdown is available. We therefore use the 2012 World Bank survey on financial markets to extrapolate national market capitalisations in 2014. The GDP series are obtained from World Bank national accounts and OECD National Accounts data.

As regards indicators relating to the quality of institutions, we use the Worldwide Governance Indicators (WGI) of the World Bank (Kaufmann et al., 2013) which are available up to 2021.[12] More specifically, we consider three dimensions of institutional quality and governance: i) *Voice and Accountability*, ii) *Political Stability,* and iii) *Rule of Law*. As in Zhang and Kim (2022), we use the first two indicators to reflect country-specific risks related to a low quality of democracy implying potentially more corruption or less stable government and the last indicator to measure the abuse of public officials for private gains since these three dimensions can directly affect investment decisions.

2.2. The realistic reference portfolios

For the study of diversification gains, we consider the portfolio of a representative investor in 2014 as a reference for each country: a so-called realistic reference portfolio (RRP). It corresponds to the 2014 geographical breakdown of its investments in listed shares. Previous studies, as in Bekaert and Urias (1996), generally used fully domestic portfolios as references. Our choice enables us to include already existing foreign investments and to be closer to existing portfolios. We consider a fixed portfolio over the period (and using 2014 as reference) because taking into account the portfolios' temporal evolution may confound results regarding diversification gains. We use the Coordinated Portfolio Investment Survey (CPIS) to obtain the geographical breakdown of foreign equity and seek to correct the impact of cross-border positions of mutual funds.[13] We use a three-step method similar to the one used by Monti and Felettigh (2008). The main idea is to redistribute investments made in mutual funds according to the global CPIS geographical distribution of foreign assets of the two main financial centres for the EU (Ireland and Luxembourg[14]).

The asset of a country in another country (except those held in Ireland and Luxembourg) are in fact calculated as the sum of the amount directly invested (1), the amount invested through Luxembourg or Irish mutual funds (2) and the amount invested through both an Irish and a Luxembourg fund (3).

1. The amount directly invested is obtained directly from the CPIS data.
2. The amount invested through mutual funds is calculated using ECB data on the share of portfolio investments made in mutual funds.[15] We then use the average year-end asset allocation by mutual fund instrument: equity or debt securities.[16] For each country, we can therefore estimate the amount invested in Luxembourg or Irish funds, which is then reinvested in equities. These amounts reinvested

[11] Harvey and Liu (2021) show that in-sample performances tend to persist out-of-sample when data are stationary. However, we chose to focus on out-of-sample performances to analyse maximisation in realistic conditions.

[12] For data availability reasons, we assume that values for 2022 and 2023 remain equal to those of 2021.

[13] For instance, according to the 2017 CPIS data, 35% of French foreign investments are made in Luxembourg and 10% in Ireland. Cross-border positions in mutual funds are indistinctly classified as equity assets in the CPIS data.

[14] In addition to the approximations described above and due to the lack of precise data, we consider that none of the investments are made in financial centres outside the EU (Jersey, Bermuda, etc.). Moreover, we abstract for the existence of a mutual fund industry in European countries other than Luxembourg and Ireland. However, some countries such as France or the Netherlands may also play a (marginal) role in the intermediation of European foreign portfolio investments. For example, according to Coletta and Santioni (2019), 9% of Italian investments in foreign fund shares are made in France (also 9% in Ireland but 72% in Luxembourg).

[15] The share cannot be obtained country by country, but only the aggregated proportion.

[16] We abstract for other assets, such as participation in other fund shares.

Table 2
List of portfolio models.

No.	Model	Abbreviation
Heuristic portfolio models		
1	Equal weights (1/N)	Eq-w
2	GDP weighted	GDP-w
3	Market capitalisation weighted	MC-w
Maximum Sharpe ratio approach		
4	With short sale	MSR-short
5	With no short sale	MSR-noshort
6	Market capitalisation constraint on maximum weights	MSR-mc-max
7	Market capitalisation constraint on minimum and maximum weights	MSR-mc-min&max
8	GDP constraint on maximum weights	MSR-GDP-max
9	GDP constraint on minimum and maximum weights	MSR-GDP-min&max
Minimum Variance approach		
10	With short sale	MV-short
11	With no short sale	MV-noshort
12	Market capitalisation constraint on maximum weights	MV-MC-max
13	Market capitalisation constraint on minimum and maximum weights	MV-MC-min&max
14	GDP constraint on maximum weights	MV-GDP-max
15	GDP constraint on minimum and maximum weights	MV-GDP-min&max
16	Lassance et al. (2022)	ICMV

in equities are distributed across all countries using the CPIS data for Luxembourg and Ireland on the geographical distribution of foreign equity assets.[17]

3. A part of the amount reinvested from the Luxembourg mutual funds goes to Ireland (and vice-versa). We finally distribute it using the CPIS data for Ireland (Luxembourg respectively). We choose to correct and redistribute these amounts to account for possible investments in funds of funds.[18]

We obtain the size of domestic and foreign listed shares held by investors in each country using euro area securities issues statistics (including for non-euro EU members). The final breakdown of listed shares is obtained by splitting the amount of foreign listed shares with the corrected weights calculated using CPIS data.[19] Finally, we calculate the returns of each country's realistic reference portfolio. Table 1 summarises the average annual returns of the stock market indices observed for the period 2009-23, as well as the performance of the realistic reference portfolios for investors of each country over the same period and the amount of listed shares held by each country.

3. Methods and optimal portfolios

3.1. Methodology

We study the optimal distribution of investments and diversification gains using the mean-variance optimisation framework. We assume that investment opportunities can be characterised by a vector of multivariate Gaussian returns *(R)* of N risky assets *(r_i)*:

$$R = [r_1, r_2, \dots, r_N] \tag{1}$$

The performance of each portfolio is measured using the classical Sharpe ratio, i.e. the ratio of average excess returns over the variance of the portfolio.

$$SR = \frac{w^T(\mu - r_f)}{(w^T V w)^{1/2}} \tag{2}$$

Where w is the vector of shares in each asset; r_f the mean risk-free interest rate; μ is the vector of expected returns and V the matrix of variance and covariance.

The change in performance between our benchmark (RRP) and any optimised portfolio considered is measured as ΔSR, the difference between the Sharpe ratios (SR) of the RRP and the optimal portfolio: $\Delta SR = SR_{\text{optimal}} - SR_{\text{RRP}}$.

We only consider a redistribution of intra-EU investments (including domestic ones) and we assume throughout this study that the distribution of investments outside the EU is left untouched. This choice is motivated by two factors. First, as shown by Jobson and Korkie (1980), the precision of estimates decreases rapidly with the number of assets held in the portfolio when using the mean-variance optimisation[20] the estimated parameters can therefore be sub-optimal and often lead to extreme portfolios (with highly concentrated investments). Second, the study aims to determine the potential impact of removing intra-EU barriers to cross-border investments. In particular, the development of the Capital Markets Union in the EU should help reduce these obstacles and could result, in the middle term, in a redistribution of investments within the EU and improve the performances of financial portfolios.

We assess the out-of-sample performance of each portfolio using rolling-window estimations, as in DeMiguel et al. (2009). We first estimate the optimal portfolio weights using the first three years of our sample (2009–2011). These weights are then used to invest over the next six months. After six months, we roll forward the estimation window by six months and repeat this procedure until the end of the dataset is reached. We finally obtain 12.5 years of daily portfolio returns (3000 observations, from January 2012 to June 2023). Using these out-of-sample returns, we obtain a credible estimate of the Sharpe ratio that can actually be achieved with each portfolio over the period 2012-23.

We finally test whether diversification gains are significant by comparing the Sharpe ratios of the optimal and reference portfolios ($H_0 : SR_{\text{optimal}} = SR_{\text{RRP}}$). We use the Ledoit and Wolf (2008) test based on the inversion of the Studentised time series bootstrap confidence interval, since it accounts for the possible non-normality of returns and for possible serial correlation.[21] To test for the equality of the log-variance of two portfolios ($H_0 : \log(\sigma_1) = \log(\sigma_2)$), we similarly use the time series bootstrap based test of Ledoit and Wolf (2011).

We consider 16 optimal portfolios, which are briefly summarised in Table 2, along with their abbreviations used as a reference in other tables.

[17] We first suppose that Irish or Luxembourg mutual funds invest all their resources abroad. We differ here from Monti and Felettigh (2008), who consider that none of the re-investments occur in either Luxembourg or Ireland. Moreover, we use the global CPIS data as we do not have the geographical allocation of resources by the mutual fund industry but, given the size of this sector in Ireland or Luxembourg, our approximation seems to be valid and close to reality.

[18] For instance, a French corporation invests in a Luxembourg mutual fund, which itself invests in an Irish fund, which itself finally invests in equities or debt securities abroad.

[19] See appendix B for the geographical breakdown of listed shares for the 20 countries studied (21 countries mentioned before except Croatia). Indeed, Croatia is included in the portfolio optimisation process among listed shares, but not on the investor side, since the geographical breakdown of its foreign investments is not available.

[20] This is partly explained by the fact that the number of elements in the covariance matrix is quadratic with respect to the number of assets.

[21] The Jobson and Korkie (1981) test (later corrected by Memmel (2003)) is often used to test the difference in Sharpe ratios between two investment strategies. Unfortunately, this test is not valid if the returns are non-normal (presence of thick tails) or if they are time series. The Ledoit and Wolf (2008) test uses a HAC inference to account for serial correlation and bootstrap is used to obtain the real sampling distribution of the t-statistic. More details in Appendix C.

3.2. Heuristic portfolios

We first consider three simple heuristic portfolios: a naive equally weighted portfolio involves holding a 1/N share of each of the N assets (Eq-w), a market capitalisation weighted portfolio (2014 market capitalisation weights) derived from the optimal strategy in the CAPM (MC-w) and a GDP weighted portfolio (GDP-w).

Such investment strategies are easy to implement because they do not rely on the estimation of the moments of asset returns. Moreover, DeMiguel et al. (2009) show that classical optimisation models often poorly perform against the naive equally weighted portfolio in terms of Sharpe ratio.

3.3. Maximum sharpe ratio approach

The second type of portfolios that we consider attempts to directly maximise the Sharpe ratio of the portfolio. Our optimal portfolio $w = (w_1, w_2, \dots, w_N)$ is then defined as[22]

$$w^{MSR} = \underset{w \in A}{\text{argmax}} \quad SR(w) = \underset{w \in A}{\text{argmax}} \quad \frac{w^T(\mu - r_f)}{(w^T V w)^{1/2}} \tag{3}$$

Where argmax (argument of the maximum) is the point at which the function value is maximised.

The expected returns and variance matrix can be estimated using their simple empirical counterparts (MSR-short). However, such estimates have proved to be prone to estimation errors and may lead to overconcentrated portfolios. Several methods have been developed to improve the reliability of the optimisation.[23] In particular, imposing constraints on the portfolios weights have proved to be efficient and we therefore consider five different constraints.

First, we exclude short selling to restrict the subset A of possible portfolios as follows:

Constraint (1): $A = \{w = (w_1, w_2, \dots, w_N) \in \mathbb{R}^N \mid w_i \geq 0\}$.

Second, following Chiou et al. (2009), we impose a maximum limit to each weight, which is proportional to the market capitalisation of the destination country.[24] Large investments in small stock markets (in terms of capitalisation) may indeed lead to illiquid portfolios. We choose to set the upper bound to 5[25]

Constraint (2): $A = \{w = (w_1, w_2, \dots, w_N) \in \mathbb{R}^N \mid 0 \leq w_i \leq 5 \ \text{x} \ Cap_i\}$.

Where Cap is the share of each country's market capitalisation among countries included in the sample.

Third, we consider the case with both a lower bound (up to 1/5 times the share of each country in market capitalisation) and an upper bound (up to 5 times the share of each country in market capitalisation) on the portfolio weights.

Constraint (3): $A = \{w = (w_1, w_2, \dots, w_N) \in \mathbb{R}^N \mid 0.2 \ \text{x} \ Cap_i \leq w_i \leq 5 \ \text{x} \ Cap_i\}$.

We then define similar constraints on the portfolio weights using the relative GDP. Indeed, the GDP can be used to proxy the relative sizes of potential investment opportunities in each country. This defines two new constraints:

Constraint (4): $A = \{w = (w_1, w_2, \dots, w_N) \in \mathbb{R}^N \mid 0 \leq w_i \leq 5 \ x \ GDP_i\}$.

Constraint (5): $A = \{w = (w_1, w_2, \dots, w_N) \in \mathbb{R}^N \mid 0.2 \ \text{x} \ GDP_i \leq w_i \leq 5 \ \text{x} \ GDP_i\}$.

[22] With w_i the share of the portfolio invested in country i and A the subset of possible portfolio.

[23] For a review of the estimation problems and the main correction methods, see Brandt (2010).

[24] The market capitalisation can be seen as an indicator of investments opportunities.

[25] The value is fixed arbitrarily, following Chiou et al. (2009). However, more restrictive limits are then used to check for the sensitivity of our results.

3.4. Minimum variance approach

In addition to models that seek to directly maximise the Sharpe ratio, we also consider the strategy of minimising the variance:

$$w^{MVP} = \underset{w \in A}{\text{argmin}} \quad V(w) = \underset{w \in A}{\text{argmin}} \quad w^T V w \tag{4}$$

Although it does not directly target the Sharpe ratio, this method has been widely shown to display good out-of-sample performances (e.g. DeMiguel and Nogales, 2009). Indeed, it does not require any estimation of expected returns, thus reducing estimation errors. We also consider the same set of five constraints (no short sales, maximum and minimum weights on market capitalisation or on GDP) presented above to further improve the reliability of the estimation.

3.5. Independent component analysis approach

Finally, we consider the optimisation strategy recently developed by Lassance et al. (2022). Their optimal portfolio is a shrinkage combining the minimum variance portfolio w^{MVP} and a risk-parity portfolio w^{IC}, i.e. a portfolio whose risk is spread equally among a set of uncorrelated factors extracted via independent component analysis (see Appendix D for more details).

$$w^{ICMV} = (1 - \delta) w^{MVP} + \delta w^{IC} \tag{5}$$

Where δ is the shrinkage intensity which is computed via a 10-fold cross-validation.

Using three different datasets, they find that an Independent Component and Minimum Variance (ICMV) portfolio significantly outperforms, in terms of Sharpe ratio, a shrinkage of the equally weighted and minimum variance portfolios.

4. Empirical results

Following the different optimisation methods described above, we calculate the optimal portfolios for intra-EU investments and compare them with the RRP ones.

4.1. Baseline results

Table 3 presents the results obtained for the European Union. The first column shows the Sharpe ratio of the Realistic Reference Portfolios (RRPs). The following columns show the improvement, in terms of Sharpe ratio, obtained with a redistribution of intra-EU investments. It appears that the heuristic portfolios do not improve portfolios' performances as compared to the RRPs in most cases, with two exceptions (Spain and Poland). We also find that the unconstrained models (MSR and MV with or without short sales) do not perform very well in out-of-sample estimations since they tend to concentrate the portfolios in a smaller number of assets, which raises the associated risk. With the exception of Denmark and Romania, the Sharpe ratios of the other optimal portfolios based on market capitalisation and GDP constraints are always higher than the reference realistic ones. Even under restrictive constraints, for a majority of countries, it is possible to achieve better performances than the RRPs with a different distribution of investments.

When redistributing intra-EU investments under market capitalisation constraints, improvements in performance are found to be significant (at the 10% level) for Austria, Belgium, Germany, Italy, Poland, Portugal, Spain and Sweden, representing more than 53% of investments in listed shares within the EU. The Sharpe ratios obtained with GDP constraints, on the maximum weights only, are significantly higher than the RRP Sharpe ratios for 11 countries (the eight mentioned above plus Bulgaria, Hungary and Ireland), accounting for 57% of total stock market investments in the EU. This result is not confirmed for the

Table 3
RRPs and optimal portfolios: Delta Sharpe ratios.

	RRP	Heuristic models			Maximum Sharpe Ratio approach						Minimum Variance approach						
		Eq-w	MC-w	GDP-w	MSR-short	MSR-noshort	MSR-MC-max	MSR-MC-min&max	MSR-GDP-max	MSR-GDP-min&max	MV-short	MV-noshort	MV-MC-max	MV-MC-min&max	MV-GDP-max	MV-GDP-min&max	ICMV
AT	0.384	0.184	0.21	0.325**	−0.082	0.462	0.416*	0.4*	0.429**	0.389*	0.585	0.484	0.399*	0.371*	0.44**	0.411**	0.512
BE	0.489	0.079	0.105	0.22	−0.187	0.356	0.311*	0.294*	0.324**	0.284*	0.48	0.379	0.293*	0.266*	0.334**	0.306*	0.407
BG	0.183	0.385	0.41	0.526	0.118	0.662	0.617	0.6	0.629	0.59	0.785**	0.685*	0.599	0.572	0.64	0.612	0.713**
CZ	0.501	0.067	0.092	0.208	−0.199	0.344	0.299	0.282	0.311	0.272	0.468	0.367	0.281	0.254	0.322	0.294	0.395
DK	1.021	−0.453*	−0.428	−0.313	−0.72*	−0.176	−0.221	−0.238	−0.209	−0.248	−0.053	−0.154	−0.239	−0.266	−0.198	−0.226	−0.125
EE	0.535	0.033	0.058	0.174	−0.233	0.31	0.265	0.248	0.278	0.238	0.434	0.333	0.247	0.22	0.288	0.26	0.361
FI	0.603	−0.034	−0.009	0.106	−0.301	0.243	0.198	0.181	0.21	0.171	0.366	0.265	0.18	0.152	0.221	0.193	0.294
FR	0.667	−0.099	−0.074	0.042	−0.365	0.178	0.133	0.116	0.146	0.106	0.302	0.201	0.115	0.088	0.156	0.128	0.229
DE	0.533	0.035	0.061	0.176	−0.231	0.313	0.267*	0.251*	0.28**	0.24*	0.436	0.335	0.25*	0.222*	0.291*	0.262*	0.364
HU	0.435	0.133	0.159	0.274	−0.133	0.411	0.365	0.348	0.378	0.338	0.534	0.433	0.348	0.32	0.388	0.36	0.461
IE	0.559	0.009	0.035	0.15	−0.257	0.287	0.241	0.224	0.254	0.214	0.41	0.309	0.223	0.196	0.264	0.236	0.337
IT	0.422	0.147	0.172	0.287*	−0.12	0.424	0.379*	0.362*	0.391*	0.352*	0.547	0.446	0.361*	0.333*	0.402**	0.374**	0.475
LT	0.742	−0.174	−0.148	−0.033	−0.44	0.104	0.058	0.042	0.071	0.031	0.227	0.126	0.041	0.013	0.081	0.053	0.154
NL	0.734	−0.166	−0.141	−0.025	−0.432	0.111	0.066	0.049	0.079	0.039	0.235	0.134	0.048	0.021	0.089	0.061	0.162
PL	0.113	0.455*	0.481*	0.596**	0.189	0.733**	0.687**	0.671**	0.7**	0.66**	0.856**	0.755**	0.67**	0.642**	0.711***	0.682***	0.783**
PT	0.309	0.259	0.285	0.4*	−0.007	0.536	0.491*	0.474*	0.504**	0.464*	0.66*	0.559	0.473*	0.446*	0.514**	0.486**	0.587*
RO	0.957	−0.389	−0.363	−0.248	−0.655	−0.111	−0.157	−0.174	−0.144	−0.184	0.012	−0.089	−0.174	−0.202	−0.134	−0.162	−0.061
SI	0.766	−0.197	−0.172	−0.057	−0.464	0.08	0.035	0.018	0.047	0.007	0.203	0.102	0.017	−0.011	0.058	0.03	0.131
ES	0.307	0.261*	0.286*	0.401**	−0.006	0.538	0.493**	0.476**	0.505**	0.466**	0.661*	0.561	0.475**	0.448**	0.516**	0.488**	0.589
SE	0.506	0.062	0.088	0.203	−0.204	0.34	0.294*	0.278*	0.307**	0.267*	0.463	0.362	0.277*	0.249	0.318*	0.289	0.391

Note: The first column shows the Sharpe ratio of the realistic reference portfolio and the other columns the delta Sharpe ratio for each portfolio (compared to the Sharpe ratio of the RRP). Sharpe ratio values are annualised. For t-statistics from the Ledoit and Wolf (2008) test, * (**/***) indicates significance at the 10% level (5%level/1%level). Appendix E presents the mean out-of-sample perfomances of the different maximised portfolios. Abbreviations of models are summarised in Table 2.

three latter countries for the model minimising variance with a constraint on maximum weights based on GDP but the Sharpe ratios are significantly improved for the eight countries identified above. The ICMV model does not perform very well and only improves significantly the Sharpe ratio for three countries (Poland, Portugal and Bulgaria).

Table 4 shows the reduction in the log-variance for each portfolio as compared to the RRP. In almost all cases, we find that optimal models significantly reduce the portfolios' variance. However, equal weights and market capitalisation weights do not reduce the variance in a quarter of the countries. The variance is significantly increased for all countries with the MSR-short model. The optimal models rarely reduce the variance in Slovenia and the volatility of Lithuanian RRP is significantly lower than in most models. Finally, seven of the models that aim at minimising the variance (MSR-GDP-max, MSR-GDP-min&max, MV-short, MV-noshort, MV-GDP-max, MV-GDP-min&max and ICMV) significantly reduce the volatility of the portfolio for all of the 20 countries of the sample.

Using market capitalisation to constrain weights tends to limit investments in CEECs, which only represent 3% of the EU total but 9% of the EU GDP (Table 5). Optimal portfolios imply a geographical redistribution of investments. For example, in the RRPs, French and German listed shares account for around half of total intra-EU investments although their share in optimal portfolios is much lower. In the optimal portfolios, the main countries that receive more investments are Belgium, the Netherlands, and the Scandinavian and Baltic countries. This can be explained by the strong performances of their equity markets over the observation period and the size of their market capitalisation. The optimal portfolio based on the GDP constraint leads to more investments in CEECs. Most of these countries strongly benefit from the redistribution. As illustrated by Table 5, the share of CEECs ranges from 20% to 34% for GDP constrained portfolios, compared to 5%–13% for market capitalisation constrained portfolios.

Since this time span includes high volatility periods (European sovereign debt crisis, Covid crisis and global energy crisis), we use the Volatility Index (VSTOXX) based on the real-time options prices of the EURO STOXX 50 in order to distinguish five quintiles of volatility. Fig. 1 shows the variation in the Sharpe ratios depending on the level of volatility observed on the European equity markets for Poland, Germany, Italy and Spain. The optimal models perform much better during periods of lower volatility in the four major countries for which we found significant gains in all cases in the four models under review. Conversely, gains are very limited or almost nil during periods of high volatility. Thus, investors gain in the 60% less volatile periods, but do not lose in the 40% more volatile periods (results would be more similar to RRP Sharpe ratios). Differences between quintiles are particularly pronounced for Poland.

When analysing the delta Sharpe ratios during recent crises, we find similar results as for the 20% most volatile periods with some exceptions (Fig. 2). In Spain, the Sharpe ratios are much higher during the Covid crisis (similar levels as for the 40% less volatile periods in Fig. 1) and much lower during the energy crisis. In Poland, the Sharpe ratios tends to be higher during the energy crisis compared to those observed for high volatility periods over the whole sample.

4.2. Incorporating institutional indicators on political risk, democracy and the rule of law

In this section, we investigate whether the higher Sharpe ratios implied by optimal portfolios result from higher levels of political risk that can be related to larger investment shares in CEECs. To do so we introduce an additional constraint on the mean level of institutional indicators of the optimised portfolio that should not exceed the mean of

Table 4
RRPs and optimal portfolios: reduction in the log-variance.

	RRP	Heuristic models			Maximum Sharpe Ratio approach						Minimum Variance approach						
		Eq-w	MC-w	GDP-w	MSR-short	MSR-noshort	MSR-MC-max	MSR-MC-min&max	MSR-GDP-max	MSR-GDP-min&max	MV-short	MV-noshort	MV-MC-max	MV-GDP-max	MV-MC-min&max	MV-GDP-min&max	ICMV
AT	−2.69	−0.43***	−0.42***	−0.97***	0.88***	−1.19***	−0.56***	−0.57***	−0.75***	−0.73***	−1.77***	−1.79***	−0.68***	−0.67***	−0.89***	−0.87***	−1.71***
BE	−3.06	−0.06**	−0.05	−0.6***	1.25***	−0.82***	−0.19***	−0.2***	−0.38***	−0.36***	−1.4***	−1.42***	−0.31***	−0.3***	−0.52***	−0.5***	−1.34***
BG	−2.94	−0.18**	−0.17**	−0.72***	1.13***	−0.94***	−0.31***	−0.32***	−0.5***	−0.48***	−1.52***	−1.54***	−0.43***	−0.42***	−0.64***	−0.62***	−1.46***
CZ	−3.17	0.06	0.07	−0.48***	1.37***	−0.7***	−0.07	−0.08	−0.26***	−0.25***	−1.28***	−1.3***	−0.2***	−0.18***	−0.4***	−0.38***	−1.22***
DK	−3.17	0.05	0.07	−0.49***	1.37***	−0.71***	−0.08*	−0.09**	−0.26***	−0.25***	−1.28***	−1.3***	−0.2***	−0.19***	−0.41***	−0.38***	−1.22***
EE	−3.27	0.15*	0.16*	−0.39***	1.47***	−0.61***	0.02	0.01	−0.17**	−0.15*	−1.19***	−1.21***	−0.1	−0.09	−0.31***	−0.29***	−1.12***
FI	−3.03	−0.09*	−0.07*	−0.62***	1.23***	−0.84***	−0.22***	−0.23***	−0.4***	−0.39***	−1.42***	−1.44***	−0.34***	−0.33***	−0.55***	−0.52***	−1.36***
FR	−3.03	−0.09***	−0.08***	−0.63***	1.23***	−0.85***	−0.22***	−0.23***	−0.41***	−0.39***	−1.43***	−1.45***	−0.34***	−0.33***	−0.55***	−0.53***	−1.37***
DE	−3	−0.11***	−0.1***	−0.65***	1.2***	−0.87***	−0.24***	−0.25***	−0.43***	−0.42***	−1.45***	−1.47***	−0.37***	−0.35***	−0.57***	−0.55***	−1.39***
HU	−2.76	−0.36***	−0.35***	−0.9***	0.96***	−1.12***	−0.49***	−0.5***	−0.68***	−0.66***	−1.7***	−1.72***	−0.61***	−0.6***	−0.82***	−0.8***	−1.63***
IE	−2.93	−0.18***	−0.17***	−0.72***	1.13***	−0.94***	−0.31***	−0.32***	−0.5***	−0.49***	−1.52***	−1.54***	−0.44***	−0.42***	−0.64***	−0.62***	−1.46***
IT	−2.63	−0.49***	−0.47***	−1.03***	0.83***	−1.25***	−0.62***	−0.63***	−0.81***	−0.79***	−1.83***	−1.85***	−0.74***	−0.73***	−0.95***	−0.92***	−1.76***
LT	−3.84	0.72***	0.74***	0.18**	2.04***	−0.04	0.59***	0.58***	0.4***	0.42***	−0.62***	−0.64***	0.47***	0.48***	0.26	0.29***	−0.55***
NL	−3.1	−0.02	−0.01	−0.56***	1.3***	−0.78***	−0.15***	−0.16***	−0.34***	−0.32***	−1.36***	−1.38***	−0.27***	−0.26***	−0.48***	−0.46***	−1.3***
PL	−2.57	−0.55***	−0.54***	−1.09***	0.76***	−1.31***	−0.68***	−0.69***	−0.87***	−0.85***	−1.89***	−1.91***	−0.8***	−0.79***	−1.01***	−0.99***	−1.83***
PT	−2.99	−0.13***	−0.12***	−0.67***	1.18***	−0.89***	−0.26***	−0.27***	−0.45***	−0.44***	−1.47***	−1.49***	−0.38***	−0.37***	−0.59***	−0.57***	−1.41***
RO	−3.04	−0.08	−0.07	−0.62***	1.24***	−0.84***	−0.21*	−0.22*	−0.4***	−0.38***	−1.42***	−1.44***	−0.33**	−0.32***	−0.54***	−0.51***	−1.35***
SI	−3.37	0.25***	0.27***	−0.28***	1.57***	−0.5***	0.13*	0.12*	−0.06	−0.05	−1.08***	−1.1***	0	0.02	−0.2***	−0.18***	−1.02***
ES	−2.78	−0.34***	−0.33***	−0.88***	0.97***	−1.1***	−0.47***	−0.48***	−0.66***	−0.65***	−1.68***	−1.7***	−0.59***	−0.58***	−0.8***	−0.78***	−1.62***
SE	−2.84	−0.28***	−0.27***	−0.82***	1.04***	−1.04***	−0.41***	−0.42***	−0.6***	−0.58***	−1.62***	−1.64***	−0.53***	−0.52***	−0.74***	−0.71***	−1.55***

Note: The first column shows the annualised log-variance of the realistic reference portfolio and the other columns the reduction in the log-variance for each portfolio (compared to the log-variance of the RRP). For t-statistics from the Ledoit and Wolf (2011) test, * (**/***) indicates significance at the 10% level (5%level/1%level). Abbreviations of models are summarised in Table 2.

Table 5
CEECs' share in the different optimal portfolios (%).

	Eq-w	MC-w	GDP-w	MSR-MC-max	MSR-GDP-max	MV-MC-max	MV-GDP-max
Mean CEECs share over the period	42.9	3.4	9.4	5.4	20.9	13.0	34.0

Note: Shares are expressed as a % of the total investments made in EU stock markets by European investors. Abbreviations of models are summarised in Table 2.

the RRP.[26] Contrary to previous analysis, the optimal portfolio is different for each country as it depends on the mean value of institutional indicators of each RRP. The rationale behind this new constraint is to obtain an optimised portfolio that is equivalent in terms of institutional quality to the existing ones. We check whether it is possible to combine diversification gains with reduced exposure to more risky portfolios. We impose similar constraints on the three institutional indicators selected:

Constraint (6): $A^* = \{w = (w_1, w_2, \ldots, w_N) \in \mathbb{R}^N \mid w^T I_{RL} \leq w_{RRP}^T I_{RL}\}$.

Constraint (7): $A^* = \{w = (w_1, w_2, \ldots, w_N) \in \mathbb{R}^N \mid w^T I_{VA} \leq w_{RRP}^T I_{VA}\}$.

Constraint (8): $A^* = \{w = (w_1, w_2, \ldots, w_N) \in \mathbb{R}^N \mid w^T I_{PS} \leq w_{RRP}^T I_{PS}\}$.

Where I_{RL}, I_{VA} and I_{PS} are the indicators for the rule of law, voice and accountability and political stability.

This enables us to take into account the fact that some CEECs dropped significantly in the rankings of governance indicators such as the rule of law, voice and accountability and political stability, which might have diverted investors from Western Europe.

Table 6 presents the results when applying constraints on institutional indicators. Significant diversification gains found in section 4.1 are confirmed for all countries except Sweden and Portugal (for the political stability index only for the latter).[27] For these two countries, it was not possible to compute optimal portfolios when adding these constraints because of the very high levels of the average institutional indicators in their RRP. The share of CEECs is sometimes lower than those found in section 4.1 for the same model (Table 5), especially when constraints based on GDP are applied, but always remains at much higher levels than in RRPs for Western and Southern European countries (Table 7). Investors therefore still benefit from significant diversification gains when investing more significantly in CEECs for an equivalent or higher average level of institutional indicators of their portfolios.

5. Discussion and robustness checks

5.1. Robustness of baseline optimal portfolios' performance

When redistributing intra-euro area investments, gains appear to be less robust in one case for four countries out of the six euro area countries identified above (Austria, Belgium, Germany and Italy),[28] and are still significant in all cases for Portugal and Spain (Table 8). Investment

[26] In our setting, we impose this constraint when estimating the optimal portfolio weights using the three-year training period. This does not guarantee that during the test period (when our optimal weights are used as an investment strategy) the constraint holds (the constraint is imposed on the training period only). Our empirical results, however, show that the mean level of indicators of institutional quality of our optimal portfolio is indeed higher (or at least equivalent) to the RRP.

[27] Results for the three remaining Worldwide Governance Indicators are shown in Appendix F. They confirm the significance of gains for the seven countries exhibiting significant gains in 4.2.

[28] In this section, we decide to focus our analysis on models maximising the Sharpe ratio and minimising the variance with constraints on the maximum weights only using both market capitalisation and GDP.

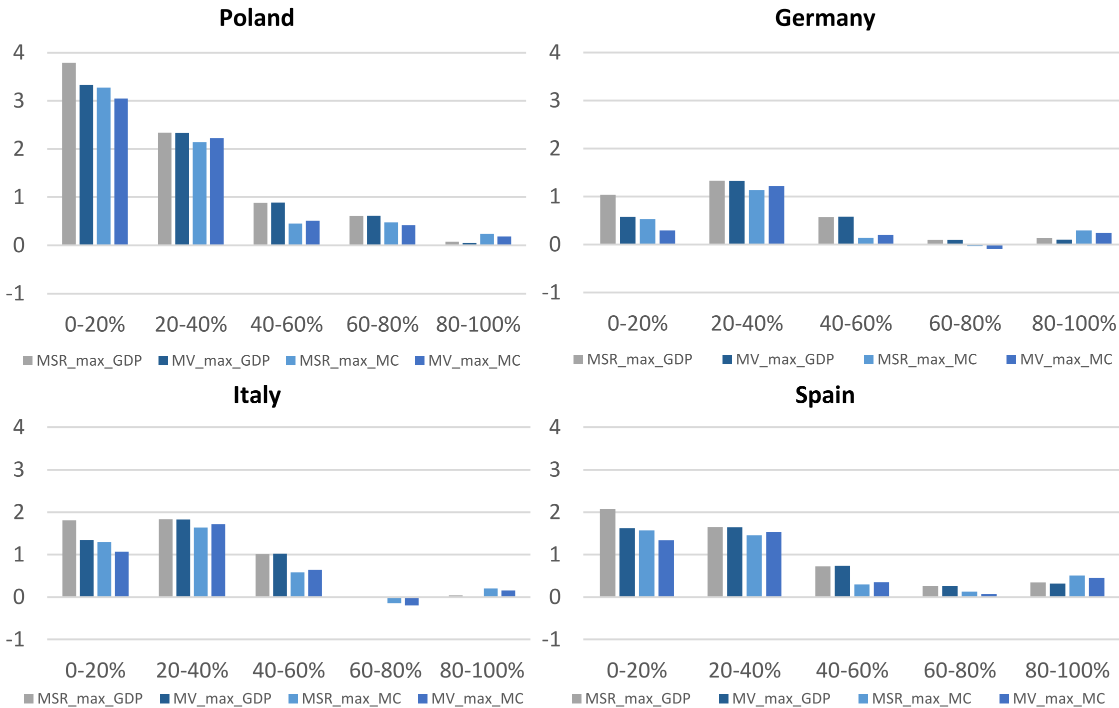

Fig. 1. Delta Sharpe ratios for the four largest countries exhibiting significant gains depending on the level of volatility Note: The figures show the delta Sharpe ratio for the different quantiles of market volatility (mesured with the VSTOXX).

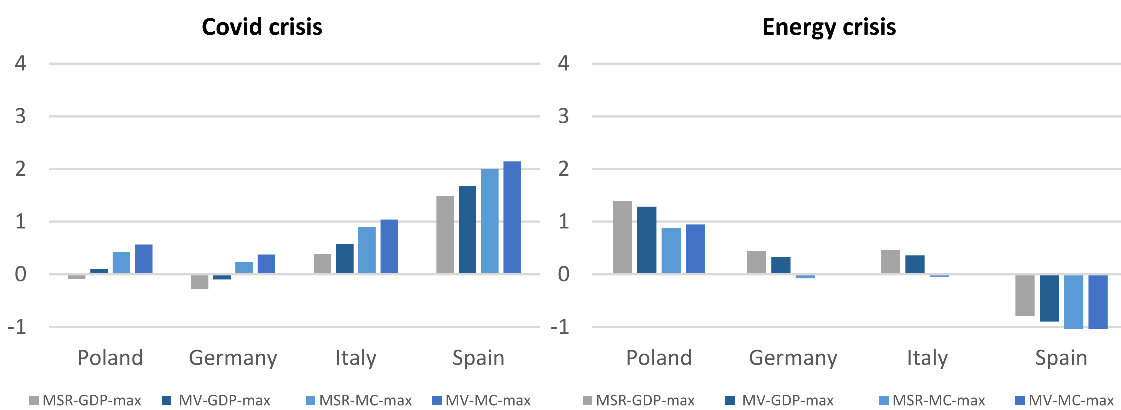

Fig. 2. Delta Sharpe ratios for the four largest countries during Covid and energy crises Note: The figures show the delta Sharpe ratio for the quantiles of market volatility (mesured with the VSTOXX) for the periods of high volatility (using the same 80% threshold as in Fig. 1) following the Covid (March to July 2021) and Energy crises (March to June 2022).

opportunities in EU countries – including outside the euro area – lead to more robust diversification gains for these countries and can also benefit more than half of EU countries in the maximum Sharpe ratio model constraining maximum weights using GDP (Table 3).

We check the sensitivity of our results regarding the limits imposed on the portfolio weights used to obtain the optimal portfolios. The upper and lower bounds for each country's weights were previously 5 and 1/5 times its financial weight - measured by the market capitalisation. As this parameter was chosen arbitrarily, we test different limits for the upper and lower bounds and check for their impact on diversification gains. Fig. 3 shows the deformation of the maximum Sharpe ratio depending on the tightness of the constraints. It appears that the upper bound is the most binding constraint. We consider a more restrictive constraint when the upper and lower bounds are set to 3 and 1/3 – i.e. the deviation from the market weighted portfolio is smaller – and test whether it significantly improves the Sharpe ratio (Table 8). As expected, the Sharpe ratios are smaller with tighter constraints but remain significantly higher than the RRPs in most cases for the eight countries identified above except Sweden. Further analyses show the validity of our results when using tighter MC-based constraints on maximum weights.

As in Driessen and Laeven (2007), we control for currency effects by replacing returns in euros[29] with local currency returns. Results over the period are similar to those obtained when using euro-denominated assets for EU countries outside the euro area (Table 8). The Sharpe ratios of optimal portfolios are still significantly higher than the RRPs in most cases for the eight countries identified above except Sweden. Finally, the literature often compares 100% domestic portfolios (i.e. German

[29] This is commonly the case in the literature: all assets are denominated in a unique currency, most commonly the US dollar.

Table 6
RRPs and optimal portfolios: Delta Sharpe ratios with constraints on institutional indicators.

	MSR-MC-max			MSR-GDP-max			MV-MC-max			MV-GDP-max		
	RL	VA	PS	RL	VA	PS	RL	VA	PS	RL	VA	PS
AT	0.417*	0.417*	0.361	0.349*	0.362*	0.393*	0.483**	0.425*	0.481**	0.389**	0.408*	0.475**
BE	0.311*	0.311*	0.307*	0.347**	0.306*	0.313*	0.293*	0.311**	0.293*	0.35**	0.317**	0.332**
BG	0.617	0.617	0.617	0.629	0.629	0.629	0.599	0.599	0.599	0.64	0.64	0.64
CZ	0.299	0.299	0.297	0.309	0.311	0.328	0.281	0.281	0.35	0.323	0.322	0.355
DK	–	–	−0.205	–	–	−0.195	–	–	−0.158	–	–	−0.129
EE	0.265	0.267	0.265	0.283	0.294	0.278	0.244	0.247	0.248	0.303	0.29	0.288
FI	–	–	0.198	–	–	0.21	–	–	0.18	–	–	0.221
FR	0.133	0.133	0.023	0.173	0.161	0.072	0.115	0.115	0.142	0.163	0.153	0.127
DE	0.27*	0.268*	0.267*	0.264**	0.206*	0.281**	0.273*	0.28**	0.255*	0.324**	0.255**	0.295*
HU	0.365	0.365	0.365	0.378	0.378	0.378	0.348	0.348	0.36	0.388	0.388	0.393
IE	0.241	0.241	0.249	0.262	0.251	0.274*	0.223	0.215	0.3*	0.296*	0.25	0.335**
IT	0.379*	0.379*	0.379*	0.391*	0.391*	0.391*	0.361*	0.361*	0.361*	0.402**	0.402**	0.402**
LT	0.058	0.058	0.058	0.071	0.071	0.073	0.041	0.041	0.065	0.081	0.081	0.108
NL	0.076	0.061	0.052	0.019	0.003	0.052	0.112	0.076	0.107	0.112	0.06	0.135
PL	0.687**	0.687**	0.675**	0.7**	0.7**	0.664**	0.67**	0.67**	0.668**	0.711***	0.711***	0.695***
PT	0.491*	0.491*	–	0.5**	0.526**	–	0.473**	0.473*	–	0.514**	0.521**	–
RO	−0.157	−0.157	−0.157	−0.144	−0.144	−0.144	−0.174	−0.174	−0.174	−0.134	−0.134	−0.134
SI	0.035	0.035	0.051	0.047	0.047	0.073	0.017	0.017	0.097	0.058	0.058	0.123
ES	0.493**	0.493**	0.493**	0.505**	0.505**	0.505**	0.475**	0.475**	0.475**	0.516**	0.516**	0.516**
SE	–	–	–	–	–	–	–	–	–	–	–	–

Note: RL stands for *Rule of law* (VA and PS for *Voice and accountability* and *Political stability* respectively) and indicates that constraint (6) is used as an additional constraint. When optimal portfolios cannot improve the mean institutional indicator in the training periods, no values are reported. This is the case for Denmark, Finland, Portugal and Sweden. Values for the Sharpe ratio are annualised. Abbreviations of models are summarised in Table 2.

Table 7
RRPs and optimal portfolios: CEEC mean share with constraints on institutional indicators.

	MSR-MC-max			MSR-GDP-max			MV-MC-max			MV-GDP-max		
	RL	VA	PS	RL	VA	PS	RL	VA	PS	RL	VA	PS
AT	2.2	4.3	3.7	3.3	8.4	13.4	5.3	9.1	9.5	8.4	11.6	21.9
BE	5.4	4.6	5.4	19.5	13.7	20.7	13	12.4	13	25.0	17.5	34
BG	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34.0	34.0	34
CZ	5.4	5.4	4.1	20.9	20.9	16	13	13	10.1	33.7	34.0	24.5
DK	–	–	4.8	–	–	17.4	–	–	10.9	–	–	28.6
EE	5.4	5.3	5.4	20.1	18.6	20.9	13	13	13	29.9	29.5	34
FI	–	–	5.4	–	–	20.9	–	–	13	–	–	34
FR	5.4	5.4	2.7	19.5	20	9.1	13	13	6.7	26	28.9	17.2
DE	5	4.2	5.4	14.7	9.5	20.9	12.4	9.3	13	18.8	12.9	34
HU	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34.0	34	33.9
IE	5.4	5.1	5.2	18.6	16.1	19.4	13	12.7	11.4	24.3	19.9	30.9
IT	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34.0	34.0	34
LT	5.4	5.4	5.4	20.9	20.9	20.9	13	13	12.7	34.0	34.0	33.7
NL	4.2	4.2	4.7	8.8	7.5	18.1	9.2	7.8	12	14.4	10.8	28.4
PL	5.4	5.4	5.1	20.9	20.9	20	13	13	13	34.0	34.0	32.2
PT	5.4	5.4	–	20.9	19.8	–	13	13	–	33.9	32.5	–
RO	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34.0	34.0	34
SI	5.4	5.4	5.1	20.9	20.9	18.6	13	13	12.1	34.0	34.0	30.1
ES	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34.0	34.0	34
SE	–	–	–	–	–	–	–	–	–	–	–	–

Note: RL stands for *Rule of law* (VA and PS for *Voice and accountability* and *Political stability* respectively) and indicates that constraint (6) is used as an additonal constraint. When optimal portfolios cannot improve the mean institutional indicator in the training periods, no values are reported. Results are expressed as a percentage of the optimal portfolio. Abbreviations of models are summarised in Table 2.

investors only invest in the German listed market for example) with optimal ones (see Li et al. (2003) for example). As a robustness check, we use the same approach and consider 100% domestic portfolios as a reference (Table 8). Using a domestic portfolio instead of a realistic reference one does not change our main conclusions on the existence of diversification gains within the EU for five countries and on the need to invest more in Central and Eastern European Countries.

5.2. Asymmetric characteristics of risk

The increase in the frequency of price crashes in financial markets over the past decades and investors' concerns about downside risks invite us to test for the sensitivity of our results when considering the asymmetric characteristics of risk. Since Sharpe ratio treats downside and upside risks symmetrically, we consider two alternative measures of diversification gains: the Sortino ratio and the modified Sharpe ratio. The Sortino ratio *(Sor),* first introduced by Sortino and Hopelain (1980), is the ratio of the average excess return of the portfolio and the target downside deviation (TDD).

$$Sor = \frac{w^T\left(\mu - r_f\right)}{TDD} = \frac{w^T\left(\mu - r_f\right)}{\left(w^T V^{+} w\right)^{1/2}}$$

Where V^{+} is the downside variance-covariance matrix (when considering that all returns below the mean target return are set to 0).

The modified Sharpe ratio *(modSR)* proposed by Favre and Galeano (2002) and Gregoriou and Gueyie (2003) is defined as the ratio of the

Table 8
Optimal portfolios: Sharpe ratios (robustness analysis).

	Investing in the euro area				Alternative restrictions on the portfolios' weights				Returns expressed in domestic currency				Domestic portfolio			
	MSR-MC-max	MSR-GDP-max	MV-MC-max	MV-GDP-max	MSR-MC-max	MSR-GDP-max	MV-MC-max	MV-GDP-max	MSR-MC-max	MSR-GDP-max	MV-MC-max	MV-GDP-max	MSR-MC-max	MSR-GDP-max	MV-MC-max	MV-GDP-max
AT	0.389*	0.384*	0.347*	0.326	0.372*	0.395**	0.332*	0.327*	0.426*	0.449**	0.386*	0.424**	0.485*	0.498**	0.468*	0.509**
BE	0.283*	0.278	0.242*	0.221*	0.267*	0.289**	0.226*	0.222	0.32*	0.343**	0.28*	0.318*	0.389*	0.401**	0.371*	0.412**
BG	–	–	–	–	0.573	0.595	0.532	0.527	0.627	0.65	0.587	0.625	0.645	0.657	0.627	0.668
CZ	–	–	–	–	0.255	0.277	0.214	0.209	0.317	0.34	0.277	0.315	0.354	0.367	0.337	0.378
DK	–	–	–	–	−0.265	−0.243	−0.306	−0.311	−0.221	−0.198	−0.261	−0.223	−0.239	−0.226	−0.257	−0.216
EE	0.249	0.244	0.207	0.186	0.221	0.243	0.18	0.176	0.27	0.293	0.23	0.268	0.328	0.34	0.31	0.351
FI	0.176	0.172	0.135	0.114	0.153	0.176	0.113	0.108	0.197	0.219	0.156	0.195	0.22	0.232	0.202	0.243
FR	0.103	0.098	0.061	0.041	0.089	0.111	0.048	0.043	0.142	0.165	0.102	0.14	0.121	0.133	0.103	0.144
DE	0.239*	0.234**	0.197	0.176	0.223**	0.246**	0.183*	0.178	0.277*	0.299**	0.236	0.275*	0.284*	0.296**	0.266*	0.307*
HU	–	–	–	–	0.321	0.344	0.281	0.276	0.279	0.302	0.239	0.277	0.443	0.456	0.426	0.466
IE	0.217	0.212	0.176	0.155	0.197	0.22	0.157	0.152	0.247	0.269	0.207	0.245	0.294	0.307	0.277	0.318
IT	0.349	0.344*	0.307*	0.287*	0.335*	0.357*	0.294*	0.289	0.389*	0.411**	0.348*	0.387*	0.404*	0.416*	0.386*	0.427**
LT	0.029	0.024	−0.013	−0.033	0.014	0.037	−0.026	−0.031	0.068	0.091	0.028	0.066	0.068	0.08	0.05	0.091
NL	0.039	0.034	−0.003	−0.024	0.022	0.044	−0.019	−0.024	0.069	0.091	0.028	0.067	0.007	0.02	−0.01	0.03
PL	–	–	–	–	0.643**	0.666**	0.603**	0.598**	0.691**	0.713**	0.651***	0.689***	0.695**	0.707**	0.677**	0.718***
PT	0.463*	0.458*	0.421*	0.401*	0.447*	0.469*	0.406*	0.402*	0.501*	0.523**	0.461*	0.499**	0.566*	0.579**	0.548*	0.589**
RO	–	–	–	–	−0.201	−0.178	−0.241	−0.246	−0.239	−0.216	−0.279	−0.241	−0.157	−0.144	−0.174	−0.134
SI	0.008	0.003	−0.034	−0.054	−0.01	0.013	−0.05	−0.055	0.044	0.067	0.004	0.042	0.077	0.09	0.059	0.1
ES	0.463**	0.458**	0.422**	0.401**	0.449**	0.471**	0.408**	0.403**	0.503**	0.525**	0.463**	0.501**	0.525**	0.538**	0.507**	0.548**
SE	–	–	–	–	0.25*	0.273*	0.21	0.205	0.134	0.157	0.094	0.132	0.318*	0.33*	0.3*	0.341*

Note: The different columns show the delta Sharpe ratio for each portfolio compared to the Sharpe ratio of the RRP. Sharpe ratio values are annualised. For t-statistics from the Ledoit and Wolf (2008) test, * (**/***) indicates significance at the 10% level (5%level/1%level). Abbreviations of models are summarised in Table 2.

average excess return of the portfolio over the modified Value-at-Risk (modVaR)[30] of level α.[31]

$$modSR = \frac{w^T(\mu - r_f)}{\mathrm{mVaR}(\alpha, w)}$$

To test for the equality of two modified Sharpe ratios ($H_0 : modSR_1 = modSR_2$), we use the Ardia and Boudt (2015) test. This test uses a similar approach than that of Ledoit and Wolf (2008), using an inversion of the Studentised time series bootstrap to compute the confidence interval (see Appendix C).

Results over the period are similar to those obtained when using the classical Sharpe ratio (Table 9). With the exception of Denmark and Romania, optimal portfolio ratios are always higher than the realistic reference ones and the modified Sharpe ratios of optimal portfolios are significantly higher than the RRPs for six countries (Austria, Belgium, Italy, Poland, Portugal and Spain) and in at least half cases for Germany and Sweden. Taking into account investors' risk aversion does not change our main conclusions on the existence of diversification gains within the EU.

5.3. Results for alternative constraints on institutional indicators

For robustness checks, we use the polyarchy index – to measure the state of democratisation as in Lewkowicz et al. (2022) – and the rule of law index from Coppedge et al. (2023) as alternative indicators to those used in section 4.2.[32] We find similar results, except for Germany as regards the rule of law, and for Belgium and Portugal as regards the state of democratisation (Table 10). CEEC mean shares are very consistent with those of Table 7 except for Austria, where the constraint is less binding for investments in CEECs, and Portugal and Spain where it is sometimes much more binding (Table 11). Overall, the alternative indicators on institutional quality do not fundamentally call into question our previous conclusions.

5.4. Discussion

Our results in sections 4 and 5 strongly confirm the existence of diversification gains in the EU when using a realistic benchmark (Fig. 4). The various versions of the optimisation models that we implemented confirm significant gains for six countries: Austria, Belgium, Italy, Spain, Poland and Portugal. Thus, using only available information at the time of decision, investors from these countries can improve their gains by a greater diversification of their stock portfolios in the EU. As regards Germany and Sweden, results seem less robust, especially when applying weight constraints based on market capitalisation. Whatever the specification used, we find that a reduction in investment barriers contribute to a better allocation of equity investments by reducing the home bias for these countries. This benefit the CEECs whose share in portfolios strongly increases as compared to the current allocations observed. Moreover, the gains appear to be less attractive when limiting

[30] Introduced to account for asymmetry and fat tails by Zangari (1996), the modified VaR approximates the 1−α quantile of the portfolio return distribution by a fourth order Cornish–Fisher expansion of the 1−α quantile of the standard normal distribution.

[31] We follow Gregoriou and Gueyie (2003) and set α at 5%.

[32] The polyarchy index is a weighted average of indexes measuring freedom of association (thick), clean elections, freedom of expression, elected officials and suffrage. The rule of law index is based on compliance with high court, compliance with judiciary, high court independence, lower court independence, executive respects constitution, rigorous and impartial public administration, transparent laws with predictable enforcement, access to justice for men, access to justice for women, judicial accountability, judicial corruption decision, public sector corrupt exchanges, public sector theft, executive bribery and corrupt exchanges, executive embezzlement and theft.

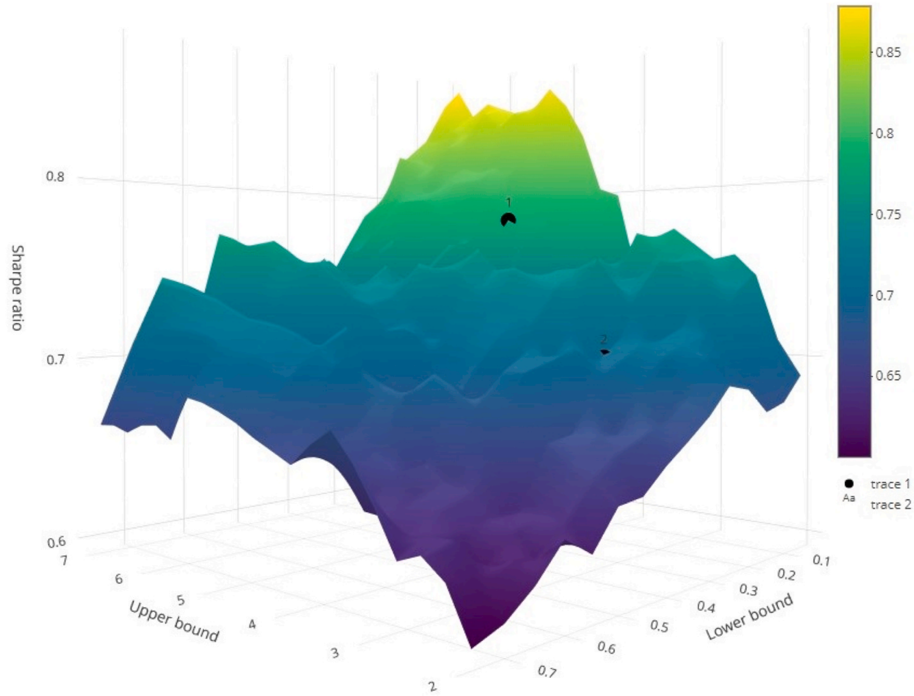

Fig. 3. Constraints and maximum Sharpe ratio Note: Portfolios are restricted as such: $A = \{w = (w_1, w_2, \dots, w_N) \in \mathbf{R}^N \mid Lower\ bound \times GDP_i \leq w_i \leq Upper\ bound \times GDP_i\}$.

Table 9
Optimal portfolios: Sortino and modified Sharpe ratios (robustness analysis).

	Sor	Sortino ratio				MSR	modified Sharpe ratio			
		Delta Sortino ratio					Delta modified Sharpe ratio			
		MSR-MC-max	MSR-GDP-max	MV-MC-max	MV-GDP-max		MSR-MC-max	MSR-GDP-max	MV-MC-max	MV-GDP-max
AT	0.48	0.53 (+110%)	0.57 (+119%)	0.49 (+102%)	0.5 (+104%)	0.012	0.013*	0.014**	0.013*	0.014**
BE	0.6	0.4 (+67%)	0.45 (+75%)	0.37 (+62%)	0.37 (+62%)	0.016	0.01	0.01*	0.009*	0.01*
BG	0.23	0.77 (+335%)	0.82 (+357%)	0.73 (+317%)	0.74 (+322%)	0.006	0.019	0.02	0.019	0.02
CZ	0.6	0.41 (+68%)	0.45 (+75%)	0.37 (+62%)	0.38 (+63%)	0.016	0.01	0.01	0.009	0.01
DK	1.37	−0.36 (−26%)	−0.32 (−23%)	−0.4 (−29%)	−0.39 (−28%)	0.032	−0.007	−0.007	−0.007	−0.006
EE	0.65	0.36 (+55%)	0.4 (+62%)	0.32 (+49%)	0.33 (+51%)	0.019	0.006	0.007	0.006	0.007
FI	0.8	0.2 (+25%)	0.25 (+31%)	0.17 (+21%)	0.17 (+21%)	0.019	0.006	0.007	0.006	0.007
FR	0.83	0.18 (+22%)	0.22 (+27%)	0.14 (+17%)	0.15 (+18%)	0.022	0.004	0.004	0.003	0.005
DE	0.67	0.34 (+51%)	0.39 (+58%)	0.3 (+45%)	0.31 (+46%)	0.017	0.008	0.008*	0.007	0.009*
HU	0.53	0.48 (+91%)	0.52 (+98%)	0.44 (+83%)	0.45 (+85%)	0.014	0.012	0.012	0.011	0.013
IE	0.72	0.28 (+39%)	0.33 (+46%)	0.25 (+35%)	0.25 (+35%)	0.017	0.008	0.008	0.007	0.009
IT	0.52	0.49 (+94%)	0.53 (+102%)	0.45 (+87%)	0.46 (+88%)	0.013	0.012*	0.012*	0.011*	0.013**
LT	0.86	0.15 (+17%)	0.19 (+22%)	0.11 (+13%)	0.12 (+14%)	0.03	−0.005	−0.005	−0.006	−0.004
NL	0.93	0.07 (+8%)	0.12 (+13%)	0.04 (+4%)	0.04 (+4%)	0.024	0.002	0.002	0.001	0.003
PL	0.15	0.86 (+573%)	0.9 (+600%)	0.82 (+547%)	0.83 (+553%)	0.004	0.022**	0.022**	0.021**	0.023***
PT	0.4	0.6 (+150%)	0.65 (+163%)	0.56 (+140%)	0.57 (+143%)	0.01	0.016*	0.016*	0.015*	0.016**
RO	1.13	−0.12 (−11%)	−0.08 (−7%)	−0.16 (+-14%)	−0.15 (−13%)	0.032	−0.007	−0.006	−0.007	−0.006
SI	0.93	0.08 (+9%)	0.12 (+13%)	0.04 (+4%)	0.05 (+5%)	0.024	0.001	0.002	0.001	0.002
ES	0.39	0.62 (+159%)	0.67 (+172%)	0.58 (+149%)	0.59 (+151%)	0.01	0.016*	0.016**	0.015**	0.016**
SE	0.66	0.34 (+52%)	0.39 (+59%)	0.31 (+47%)	0.31 (+47%)	0.016	0.009*	0.01*	0.009	0.01*

Note: The columns show the Sortino and modified Sharpe ratios for the RRP, as well as the delta ratios for each portfolio compared to the ratios of the RRP. Sortino ratio values are annualised. Rates of change in Sortino ratios are shown in brackets. Modified Sharpe ratio values are daily since modified VaR properties do not allow for annualisation. For t-statistics from the Ardia and Boudt (2015) test, * (**/***) indicates significance at the 10% level (5%level/1%level). Abbreviations of models are summarised in Table 2.

the investment scope to the euro area. A successful implementation of the Capital Markets Union initiative led by the European Commission with two action plans in 2015 and 2020 would thus have the potential to improve the capital allocation in Europe as regards stock portfolios, with initiatives such as the creation of a European single access point for financial market data, the simplification of requirements for accessing public capital market funding or the reinforcement of trust in the market to attract retail investors. Finally, we interpret our results as showing that financial development should be encouraged in CEECs to improve the potential gains of diversification. In particular, if the size of capital markets in terms of GDP were converging in EU countries, this would in most cases increase diversification gains and the share of CEECs would more than double (Table 5). In that case, German investors would also benefit from large diversification gains in most specifications.

Our results partially confirm those of previous empirical studies using different methodologies or samples. Like McDowell (2018), we

Table 10
RRPs and optimal portfolios: Delta Sharpe ratios with alternative constraints on institutional indicators.

	MSR-MC-max		MSR-GDP-max		MV-MC-max		MV-GDP-max	
	RL*	SD	RL*	SD	RL*	SD	RL*	SD
AT	0.417*	0.418*	0.458**	0.446**	0.399*	0.399*	0.464**	0.434**
BE	0.312*	0.29	0.347**	0.28*	0.293*	0.261*	0.358**	0.176
DE	0.268*	0.269*	0.286*	0.234**	0.207	0.27**	0.21	0.222*
IT	0.379*	0.396*	0.39**	0.404**	0.361*	0.382*	0.402**	0.411**
PL	0.631**	0.684**	0.612**	0.681**	0.553**	0.674**	0.568**	0.684***
PT	0.53**	0.492*	0.509**	0.456*	0.51**	0.46*	0.43**	0.363
ES	0.481**	0.493**	0.439**	0.514**	0.434**	0.495**	0.416**	0.507**

Note: RL* stands for *Rule of law* (SD for *State of democratisation*) and indicates that the rule of law index from Coppedge et al. (2023) is used as an additonal constraint (state of democratisation index from Coppedge et al. (2023) respectively). Values for the Sharpe ratio are annualised. Abbreviations of models are summarised in Table 2.

Table 11
RRPs and optimal portfolios: CEEC mean share with alternative constraints on institutional indicators.

	MSR-MC-max		MSR-GDP-max		MV-MC-max		MV-GDP-max	
	RL*	SD	RL*	SD	RL*	SD	RL*	SD
AT	5,4	5,4	19,6	17,4	13	13	32	28,9
BE	5,1	1,6	18	4,7	13	8,3	30	15,5
DE	4	3	13,3	9,1	13,2	9,4	24,8	20
IT	5,4	4,6	20,9	16	13	11,8	34	27,2
PL	5,3	5,3	20,1	19,1	13,1	13,3	30,2	31,1
PT	2,7	2	8,6	6,1	9,8	8,7	18,6	17,1
ES	4	5,4	11,9	16,7	10,6	12,3	21,6	27,4

Note: RL* stands for *Rule of law* (SD for *State of democratisation*) and indicates that the rule of law index from Coppedge et al. (2023) is used as an additonal constraint (state of democratisation index from Coppedge et al. (2023) respectively). When optimal portfolios cannot improve the mean institutional indicator in the training periods, no values are reported. Results are expressed as a percentage of the optimal portfolio. Abbreviations of models are summarised in Table 2.

find significant diversification gains for Austria and Italy, as well as for Ireland in some cases (but not for France). Buch et al. (2010) also find potential benefits from more cross-border diversification for Germany when considering banks' portfolios. Our results are more mixed for Germany when considering only equity portfolios and we find no significant gains for France. Contrary to Jacobs et al. (2014), we do find significant improvements when adopting optimal portfolios. However, these results are not really comparable since Jacobs et al. (2014) compare optimal portfolios with naïve strategies and include equity indices of North America, Asia and emerging markets. An explanation for the difference between our results and those of previous studies might lie in the specific gains related to diversification within the EU, which appear to be strong and significant in our analysis based on real time information and that takes into account several constraints and the asymmetry of risk aversion. The methodology developed by Lassance et al. (2022) enables us to improve the out-of-sample results in only three cases, while the methodologies based on standard approaches or on modified Sharpe ratios produce significant gains in more cases. We also conclude that gains are robust when constraining the average level of political stability and institutional quality to remain equivalent or higher. This implies that the current state of the European quality of democracy and political risks is compatible with diversification gains given observed investor preferences.

6. Conclusion

This paper empirically studies potential diversification gains that exist across European Union countries. We first compute a realistic and robust geographical breakdown of investments in listed shares in order to determine realistic reference portfolios. To do so, we apply a correction to the existing CPIS data to account for the role of mutual funds in major financial centres. This enables us to calculate the returns of EU portfolios during the last decade and to compare them with several optimal portfolios in out-of-sample analyses to determine whether investors would improve the performance of their portfolios with available information at the time of the investment decision. We include various investment constraints to exclude extreme investment strategies and to improve our estimations and perform a wide range of robustness checks.

We find very significant diversification gains for seven European countries (Austria, Belgium, Germany, Italy, Poland, Portugal and Spain), which account for 43% of total EU investment in listed shares, and for up to 11 countries, which represent 57% of such investment under less constraining restrictions on weights. It would have been possible for investors in these countries to achieve better performances over the last decade by reducing their home biases, which remain very high, and by further diversifying their portfolios in other EU countries. In the four large countries where benefits are found to be particularly

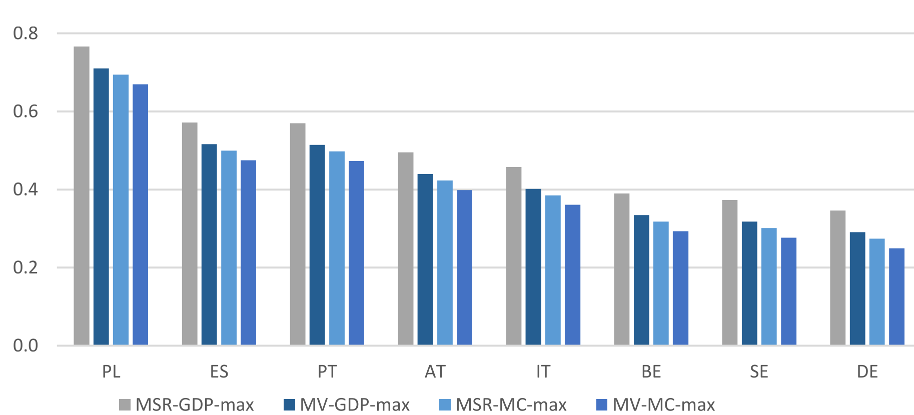

Fig. 4. Delta Sharpe ratios (extract from Table 3): significant gains for eight countries.

robust, we also show that investors gain more in less volatile periods.

When taking into account the aggregated institutional quality and political risk of portfolios, we find that signficant gains are compatible with observed investor preferences. Indeed, portfolio optimisation does not imply a deterioration in average institutional indicators for the investors of six countries (all the seven countries where robust gains have been found except Portugal). We find similar results using Sortino and modified Sharpe ratios to deal with the investors' concerns about downside risks.

Our study therefore show that stock investors in some countries benefit from further diversification within the EU under various specifications. However, in order to avoid an imbalance between the demand for shares in markets that provide potential portfolio efficiencies and the supply of listed shares (McDowell, 2018), it would be necessary to develop financial markets in Central and Eastern European Countries to a level more in line with the size of their economies. This portfolio diversification would thus contribute to easing access to capital for CEEC firms, where the level of investment has decreased since the global financial crisis. When including political risk and institutional quality, the share of CEECs decreases but remains much higher than in the reference portfolios. Our results therefore tend to support, from financial investors' point of view, the benefits of deepening the Capital Markets Union – to further facilitate cross-border investments –, of developing financial markets and of improving the quality of institutions in CEECs.

Future research could be conducted to explore the following topics. First, the use of multivariate GARCH models would provide time-varying variances and covariances and help achieve better performance gains than with constant correlation approaches. Second, to contribute to the achievement of climate goals, future developments could integrate the carbon footprint into diversification strategies by constraining the aggregated level of CO2 emissions of stock holdings.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The Authors do not have the permission to share some of the Data.

Benefits of diversification in EU Capital Markets: Evidence from stock portfolios - Mendeley Data (Original data) (Mendeley Data)

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Appendix

A. Home bias and EU bias

As in Coeurdacier and Rey (2013), we define the home bias HB_i for country *i* as:

$$\mathrm{HB}_i = 1 - \frac{\mathrm{ShareofForeignEquitiesinCountryiEquityHoldings}}{\mathrm{ShareofForeignEquitiesintheWorldMarketPortfolio}}$$

The EU equity bias is defined similarly to the home bias, as:

$$\mathrm{EUB}_i = 1 - \frac{1 - \mathrm{ShareofEUEquitiesinCountryiEquityHoldings(excludingdomesticinvestments)}}{1 - \mathrm{ShareofEUEquitiesintheWorldMarketPortfolio(excludingdomesticcapitalization)}}.$$

A nil bias corresponds to the absence of home/EU bias.

The domestic bias is very strong for equity holdings in all EU countries (Figures A1 and A.2). The portfolios of most European countries continue to be mainly composed of domestic equities. The bias is particularly high in some Eastern European countries but is also very high in the four largest economies of the EU (Germany, France, Italy and Spain). The share of equity holdings in the EU (excluding domestic investments) remains small (between 5% and 20%). Calculating an EU bias, we find a negative bias for 13 countries over 21. Some countries, such as Germany and France are often over-represented, at the expense of CEECs for example: the latter only represent 1.5% of foreign investments but 3% of EU market capitalisation. This large domestic bias and unequal distribution could lead to large diversification gains. The absence of an EU bias can be explained by the method used to correct our data. As explained by Floreani and Habib (2018), we overstate the EU bias when using standard cross-border financial statistics: investments in financial centres tend indeed to be more internationally diversified and less concentrated in the EU.

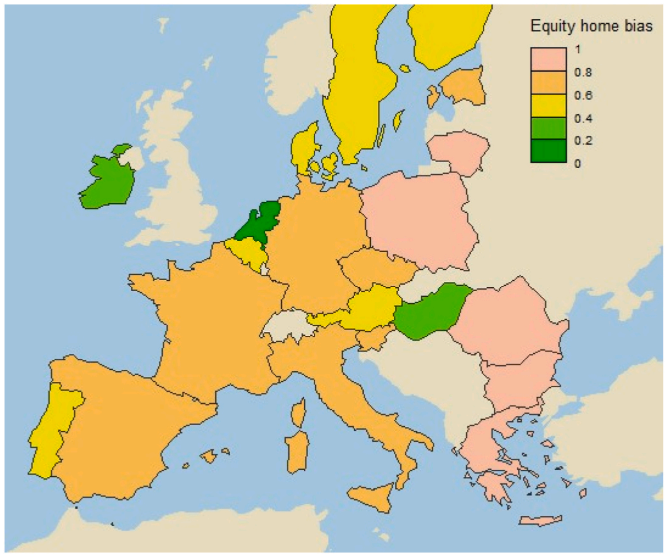

Fig. A.1. Equity home bias (2014) Source: ECB, authors' calculations.

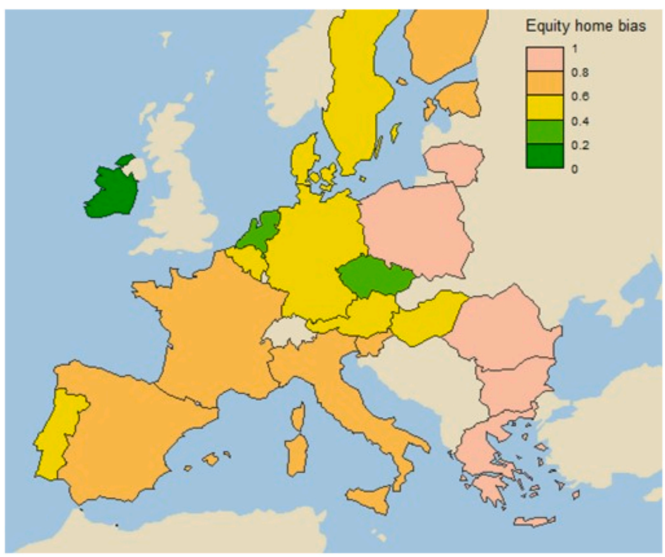

Fig. A.2. Equity EU bias (2020).

B. Geographical breakdown for listed shares in 2014

Table B.1
Geographical breakdown for listed shares in 2014, including the share of the rest of the world

	AT	BE	BG	HR	CZ	DK	EE	FI	FR	DE	HU	IE	IT	LT	NL	PL	PT	RO	SI	ES	SE	RW
AT	53.519	0.339	0.001	0.031	0.025	0.162	0.002	0.157	2.838	11.859	0.024	0.73	0.514	0	1.127	0.137	0.032	0.056	0.017	0.375	0.285	27.77
BE	0.123	45.987	0.001	0.001	0.01	0.183	0	0.235	8.008	5.389	0.008	0.382	0.737	0	2.05	0.042	0.07	0.008	0.001	0.747	0.367	35.65
BG	0.306	0.121	88.045	0.006	0.03	0.01	0	0.007	1.674	1.993	0.035	0.174	0.186	0	0.146	0.052	0.003	0.053	0.005	0.196	0.024	6.93
CZ	5.402	7.942	0	0.001	60.364	0.065	0.001	0.061	1.623	2.189	1.173	0.413	0.159	0	0.42	0.47	0.02	0.183	0.001	0.165	0.097	19.25
DK	0.069	0.198	0	0.001	0.01	50.36	0.001	0.292	1.486	2.347	0.012	0.484	0.383	0.001	0.842	0.097	0.03	0.006	0.001	0.401	2.049	40.93
EE	0.227	0.135	0.025	0.001	0.064	0.16	70.215	2.695	1.116	0.998	0.069	1.559	0.213	0.27	0.22	0.298	0.031	0.244	0.069	0.15	1.812	19.42
FI	0	0.197	0	0	0.008	1.007	0.02	57.751	1.711	1.601	0.005	1.355	0.336	0.004	0.654	0.053	0.039	0.004	0.001	0.329	3.864	31.06
FR	0.08	0.826	0.015	0	0.004	0.204	0.002	0.226	67.329	4.156	0.029	0.412	1.122	0	2.105	0.142	0.079	0.003	0.017	1.286	0.293	21.67
DE	0.336	0.489	0	0.001	0.011	0.247	0.002	0.241	3.525	62.546	0.027	0.492	0.679	0.001	1.284	0.214	0.046	0.005	0.001	0.819	0.374	28.66
HU	6.064	5.687	0.134	0.332	0.42	0.116	0.006	0.076	2.116	4.969	38.272	0.342	0.377	0.011	0.563	1.672	0.027	0.424	0.186	0.26	0.21	37.74
IE	0.088	0.511	0	0.003	0.022	0.338	0.002	0.271	2.792	3.129	0.019	24.348	2.839	0	1.787	0.123	0.11	0.01	0.002	1.067	0.934	61.61

(*continued on next page*)

Table B.1 (*continued*)

	AT	BE	BG	HR	CZ	DK	EE	FI	FR	DE	HU	IE	IT	LT	NL	PL	PT	RO	SI	ES	SE	RW
IT	0.16	0.301	0	0.001	0.005	0.083	0.002	0.09	4.042	1.718	0.005	0.747	67.151	0	0.564	0.026	0.027	0.004	0.001	0.334	0.208	24.53
LT	0.046	0.05	0	0.004	0.008	0.021	0.386	0.195	0.318	0.24	0.001	0.261	0.048	93.744	0.057	0.031	0.01	0.016	0.003	0.032	0.203	4.33
NL	0.124	0.604	0	0.001	0.021	0.529	0.001	0.238	3.312	3.099	0.019	1.262	0.7	−0.001	18.451	0.116	0.075	0.003	0.005	1.062	1.013	69.37
PL	0.383	0.04	0	0	0	0	0	0.008	0.254	0.358	0.155	0.019	0.202	0.02	0.247	93.791	0.03	0.051	0	0	0	4.44
PT	0.031	0.314	0	0	0.004	0.111	0.001	0.075	2.887	3.192	0.017	0.614	0.414	0.001	1.2	0.021	49.247	0.004	0.001	7.047	0.243	34.58
RO	0.72	0	0.025	0	0.035	0	0	0.003	0.171	0.303	0.017	0.004	0.017	0	0.024	0.104	0.002	96.841	0.001	0.015	0.012	1.71
SI	2.404	0.23	0.021	0.324	0.007	0.051	0.003	0.055	1.854	2.39	0.026	0.422	0.207	0.005	0.528	0.049	0.009	0.187	69.551	0.138	0.115	21.42
ES	0	0.444	0	0	0	0.06	0	0.059	3.273	1.985	0	0.539	0.502	0	0.629	0	0.362	0	0	73.065	0.163	18.91
SE	0.037	0.214	0	0	0.007	0.762	0.005	1.244	1.312	1.911	0.006	0.304	0.23	0.001	0.548	0.047	0.017	0.004	0	0.304	57.83	35.22

Note: Results are expressed as a percentage of the global portfolio of listed shares and should be read by line: for example, 0.34% of the Austrian listed shares' portfolio is invested in Belgium. Investments outside the EU are gathered under the column RW.

C. Ledoit and Wolf test[33]

The Ledoit and Wolf (2008) test assumes that a number T of pairs of returns are observed for two investment strategies (i and n): $\begin{pmatrix} r_{1i} \\ r_{1n} \end{pmatrix}, \ldots, \begin{pmatrix} r_{Ti} \\ r_{Tn} \end{pmatrix}$. It is also assumed that the series are stationary. The series have a mean $\mu = \begin{pmatrix} \mu_i \\ \mu_n \end{pmatrix}$ and a covariance matrix $\Sigma = \begin{pmatrix} \sigma_i^2 & \sigma_{in} \\ \sigma_{ni} & \sigma_n^2 \end{pmatrix}$.

The difference between the two Sharpe ratios is given by $\Delta = \frac{\mu_i}{\sigma_i} - \frac{\mu_n}{\sigma_n}$.

We test H_0: $\Delta = 0$ by inverting a confidence interval obtained by bootstrap. The advantage of this "indirect" approach is that it is possible to simply resample the observed data. As the data are time series, it is necessary to use the circular block bootstrap of Politis and Romano (1991), where blocks (i.e. several successive observations) and not individual data are resampled (it partially maintains the temporality of the data).

The size of the blocks can be determined using a calibration method proposed by the authors. But as the results are similar for block size values between 2 and 10, we use a constant block size equal to 5 for all applications, as in DeMiguel et al. (2009). The number of bootstrap replications is set at 5000.

Ledoit and Wolf (2011) test for the equality of the log-variance of portfolios relies on the same method. We test $H_0 : \log(\sigma_n) = \log(\sigma_i)$ by similarly inverting a confidence interval obtained by bootstrap.

The Ardia and Boudt (2015) test for the equality of the modified Sharpe ratio of two portfolios relies on the same method. We test $H_0 : MSR_i = MSR_n$ by similarly inverting a confidence interval obtained by bootstrap.

D. Lassance et al. (2022)'s portfolio

The optimal ICMV portfolio of Lassance et al. (2022) combines the classical minimum variance portfolio w^{MVP} and a risk-parity portfolio obtained using a K-factor independent component analysis w^{IC}:

$$w^{ICMV} = (1-\delta)w^{MVP} + \delta w^{IC}$$

More precisely, w^{IC} is the independent component and minimum variance portfolio defined as:

$$w^{IC} = \frac{V \wedge^{-1/2} R^{*T} 1_K^{MV}}{1_N^T V \wedge^{-1/2} R^{*T} 1_K^{MV}}$$

$$1_K^{MV} = \text{sign}\left(R^* \wedge^{-\frac{1}{2}} V^T 1_N\right)$$

Where $\wedge$ is the diagonal matrix containing the K largest eigenvalues of the covariance matrix and V the corresponding eigenvectors (obtained through a classical principal component analysis).

R^* is the rotation matrix of the principal components Y^* that minimise the mutual information I.

$$R^* \in \left\{ \underset{R \in SO(K)}{\text{argmin}} I(RY^*) \right\}$$

The number of independent components K is chosen using the minimum-average-partial-correlation method of Velicer (1976).

The shrinkage intensity δ between both portfolios is estimated via a 10-fold cross-validation, using the Sharpe ratio as calibration criterion.

E. Out-of-sample performances of maximised portfolios

Table E.1. Shows the mean out-of-sample performances of the different maximised portfolios presented in Table 2.

[33] In order to implement the Ledoit and Wolf (2008) and Ardia and Boudt (2015) tests, we use the *PeerPerformance* R package developed by Ardia and Boudt. For the Ledoit and Wolf (2011) test, we use the code made available by the authors (https://www.econ.uzh.ch/en/people/faculty/wolf/publications.html#Programming_Code).

Table E.1
Out-of-sample performances of maximised portfolios

		Returns (%)	Standard deviation (%)	Sharpe ratio
Heuristic models	Eq-w	11.9	21.0	0.568
	MC-w	12.6	21.2	0.594
	GDP-w	11.4	16.1	0.709
Maximum Sharpe Ratio approach	MSR-short	12.3	40.6	0.302
	MSR-noshort	12.2	14.4	0.846
	MSR-MC-max	**15.8**	19.7	0.800
	MSR-MC-min&max	15.4	19.6	0.783
	MSR-GDP-max	14.6	17.9	0.813
	MSR-GDP-min&max	14.0	18.1	0.773
Minimum Variance approach	MV-short	10.4	10.8	**0.969**
	MV-noshort	9.3	**10.7**	0.868
	MV-MC-max	14.5	18.5	0.782
	MV-MC-min&max	14.1	18.7	0.755
	MV-GDP-max	13.8	16.7	0.823
	MV-GDP-min&max	13.5	16.9	0.795
	ICMV	10.0	11.1	0.896

Note: Values for the mean returns, the variance and the Sharpe ratio values are annualised. Abbreviations of models are summarised in Table 2.

F. Alternative Worldwide Governance Indicators

Table F1 and F.2. presents the results when applying constraints on other Worldwide Governance indicators. Indeed, Section 4.2. only focuses on three Wolrlwide Governance indicators out of six (political stability, voice and accountability and rule of law). We impose similar constraints on the three others institutional indicators available:

Constraint (F1): $A^* = \{w = (w_1, w_2, ..., w_N) \in \mathbb{R}^N \mid w^T I_{CO} \leq w_{RRP}^T I_{CO}\}$.

Constraint (F2): $A^* = \{w = (w_1, w_2, ..., w_N) \in \mathbb{R}^N \mid w^T I_{GE} \leq w_{RRP}^T I_{GE}\}$.

Constraint (F3): $A^* = \{w = (w_1, w_2, ..., w_N) \in \mathbb{R}^N \mid w^T I_{RQ} \leq w_{RRP}^T I_{RQ}\}$.

Where I_{CO}, I_{GE} and I_{RQ} are the Worldwide Governance indicators for corruption, government effectiveness and regulatory quality.

Table F.1
RRPs and optimal portfolios: Delta Sharpe ratios with constraints on alternative Worldwide Governance Indicators

	MSR-MC-max			MSR-GDP-max			MV-MC-max			MV-GDP-max		
	CO	GE	RQ	CO	GE	RQ	CO	GE	RQ	CO	GE	RQ
AT	0.419*	0.42*	0.41*	0.398*	0.414**	0.415**	0.419*	0.418*	0.421*	0.426**	0.423**	0.511**
BE	0.313*	0.31*	0.311*	0.298*	0.327**	0.326**	0.302**	0.29*	0.293*	0.321**	0.349**	0.357**
BG	0.617	0.617	0.617	0.629	0.629	0.629	0.599	0.599	0.599	0.64	0.64	0.64
CZ	0.299	0.299	0.299	0.311	0.311	0.311	0.281	0.281	0.281	0.322	0.322	0.318
DK	–	–	–	–	–	–	–	–	–	–	–	–
EE	0.267	0.265	0.26	0.251	0.264	0.24	0.244	0.248	0.294	0.259	0.299	0.329
FI	–	–	–	–	–	–	–	–	–	–	–	–
FR	0.134	0.133	0.133	0.144	0.169	0.146	0.115	0.115	0.115	0.163	0.163	0.153
DE	0.288**	0.274*	0.262*	0.204*	0.258**	0.218*	0.29**	0.303**	0.33**	0.259**	0.267**	0.306**
HU	0.365	0.365	0.365	0.378	0.378	0.378	0.348	0.348	0.348	0.388	0.388	0.388
IE	0.241	0.241	0.233	0.234	0.264	0.228	0.223	0.224	0.252	0.25	0.288*	0.333**
IT	0.379*	0.379*	0.379*	0.391*	0.391*	0.391*	0.361*	0.361*	0.361*	0.402**	0.402**	0.402**
LT	0.058	0.058	0.058	0.071	0.071	0.071	0.041	0.041	0.041	0.081	0.081	0.081
NL	0.076	0.083	0.06	0.019	0.003	0.023	0.069	0.098	0.147**	0.075	0.053	0.083
PL	0.687**	0.687**	0.687**	0.7**	0.7**	0.7**	0.67**	0.67**	0.67**	0.711***	0.711***	0.711***
PT	0.491*	0.491*	0.491*	0.504*	0.519**	0.504**	0.473*	0.473*	0.473**	0.514**	0.53**	0.514**
RO	−0.157	−0.157	−0.157	−0.144	−0.144	−0.144	−0.174	−0.174	−0.174	−0.134	−0.134	−0.134
SI	0.035	0.035	0.035	0.047	0.043	0.047	0.017	0.017	0.017	0.058	0.059	0.058
ES	0.493*	0.493**	0.493**	0.505**	0.505**	0.505**	0.475**	0.475**	0.475**	0.516**	0.518**	0.516**
SE	–	–	–	–	–	–	–	–	–	–	–	–

Note: CO stands for *Corruption* (GE and RQ for *Government effectiveness* and *Regulatory quality* respectively) and indicates that constraint (F1) is used as an additonal constraint. When optimal portfolios cannot improve the mean institutional indicator in the training periods, no values are reported. This is the case for Denmark, Finland and Sweden. Values for the Sharpe ratio are annualised. Abbreviations of models are summarised in Table 2.

Table F.2
RRPs and optimal portfolios: CEEC mean share with constraints on alternative Worldwide Governance Indicators

	MSR-MC-max			MSR-GDP-max			MV-MC-max			MV-GDP-max		
	CO	GE	RQ	CO	GE	RQ	CO	GE	RQ	CO	GE	RQ
AT	4.5	4.9	5.3	11.7	11.1	16.9	12.4	12.3	12.8	15.4	16.6	21.8
BE	4.9	5.4	5.4	12.7	15.5	20.5	12.8	12.9	13	16.5	21.5	32.4
BG	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34	34	34
CZ	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34	34	34
DK	–	–	–	–	–	–	–	–	–	–	–	–

(*continued on next page*)

Table F.2 (*continued*)

	MSR-MC-max			MSR-GDP-max			MV-MC-max			MV-GDP-max		
	CO	GE	RQ	CO	GE	RQ	CO	GE	RQ	CO	GE	RQ
EE	5.2	5.4	5	14.9	20.8	13.9	12.8	13	12.4	22.6	33.1	19.3
FI	–	–	–	–	–	–	–	–	–	–	–	–
FR	5.4	5.4	5.4	16.6	18	20.9	13	13	13	21	24	34
DE	3.5	4.6	4.6	6.3	12.4	10.3	7.3	12.1	10	8.8	17	16.2
HU	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34	34	34
IE	5.2	5.4	5.4	14.9	18.8	16.1	12.9	13	12.9	18.7	24.1	20.8
IT	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34	34	34
LT	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34	34	33.8
NL	3.9	3.9	4.5	6.5	6.2	8.2	8.9	7.7	9.1	10.3	11.9	15.1
PL	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34	34	34
PT	5.4	5.4	5.4	20.9	19.9	20.9	13	13	13	34	32.6	34
RO	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34	34	34
SI	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34	34	34
ES	5.4	5.4	5.4	20.9	20.9	20.9	13	13	13	34	33.4	34
SE	–	–	–	–	–	–	–	–	–	–	–	–

Note: CO stands for *Corruption* (GE and RQ for *Government effectiveness* and *Regulatory quality* respectively) and indicates that constraint (F1) is used as an additonal constraint. When optimal portfolios cannot improve the mean institutional indicator in the training periods, no values are reported. Results are expressed as a percentage of the optimal portfolio. Abbreviations of models are summarised in Table 2.

References

Aizenman, J., Pinto, B., Radziwill, A., 2007. Sources for financing domestic capital–Is foreign saving a viable option for developing countries? J. Int. Money Finance 26 (5), 682–702.

Alfaro, L., Kalemli-Ozcan, S., Volosovych, V., 2008. Why doesn’t capital flow from rich to poor countries? An empirical investigation. Rev. Econ. Stat. 90 (2), 347–368.

Ardalan, K., 2019. Equity home bias: a review essay. J. Econ. Surv. 33 (3), 949–967.

Ardia, D., Boudt, K., 2015. Testing equality of modified Sharpe ratios. Finance Res. Lett. 13, 97–104.

Attig, N., Guedhami, O., Nazaire, G., Sy, O., 2023. What explains the benefits of international portfolio diversification? J. Int. Financ. Mark. Inst. Money 83, 101729.

Bekaert, G., Urias, M.S., 1996. Diversification, integration and emerging market closed-end funds. J. Finance 51 (3), 835–869.

Brandt, M.W., 2010. Portfolio choice problems. In: Handbook of Financial Econometrics: Tools and Techniques. North-Holland, pp. 269–336.

Brennan, M.J., Cao, H.H., Strong, N., Xu, X., 2005. The dynamics of international equity market expectations. J. Financ. Econ. 77 (2), 257–288.

Britten-Jones, M., 1999. The sampling error in estimates of mean-variance efficient portfolio weights. J. Finance 54 (2), 655–671.

Buch, C.M., Driscoll, J.C., Ostergaard, C., 2010. Cross-border diversification in bank asset portfolios. Int. Finance 13 (1), 79–108.

Buchanan, B.G., Le, Q.V., Rishi, M., 2012. Foreign direct investment and institutional quality: some empirical evidence. Int. Rev. Financ. Anal. 21, 81–89.

Causa, O., Cohen, D., Soto, M., 2006. Lucas and Anti-Lucas Paradoxes. CEPR Discussion Paper No. 6013.

Chiou, W.J.P., 2008. Who benefits more from international diversification? J. Int. Financ. Mark. Inst. Money 18 (5), 466–482.

Chiou, W.J.P., Lee, A.C., Chang, C.C.A., 2009. Do investors still benefit from international diversification with investment constraints? Q. Rev. Econ. Finance 49 (2), 448–483.

Cimadomo, J., Gordo Mora, E., Palazzo, A.A., 2022. Enhancing private and public risk sharing. ECB Occasional Paper 2022–2306.

Coeurdacier, N., Rey, H., 2013. Home bias in open economy financial macroeconomics. J. Econ. Lit. 51 (1), 63–115.

Coletta, M., Santioni, R., 2019. Households’ Investments in Foreign Mutual Funds Made Transparent (No. 533). Economic Research and International Relations Area. Bank of Italy.

Coppedge, M., Gerring, Knutsen C.H., Lindberg, S., Teorell, J., Altman, D., Bernhard, M., Cornell, A., Fish, S., Gastaldi, L., Gjerløw, H., Glynn, A., Good God, A., Grahn, S., Hicken, A., Kinzelbach, K., Krusell, J., Marquardt, K., McMann, K., Mechkova, V., Medzihorsky, J., Natsika, N., Neundorf, A., Paxton, P., Pemstein, D., Pernes, J., Rydén, O., von Römer, J., Seim, B., Sigman, R., Skaaning, S.-E., Staton, J., Sundström, A., Tzelgov, E., Wang, Y., Wig, T., Wilson, S., Ziblatt, D., 2023. V-dem [Country-Year/Country-Date] Dataset V13” Varieties of Democracy (V-Dem) Project.

Daude, C., Stein, E., 2007. The quality of institutions and foreign direct investment. Econ. Polit. 19 (3), 317–344.

De Roon, F.A., Nijman, T.E., Werker, B.J., 2001. Testing for mean-variance spanning with short sales constraints and transaction costs: the case of emerging markets. J. Finance 56 (2), 721–742.

De Santis, R.A., Gérard, B., 2006. Financial Integration, International Portfolio Choice and the European Monetary Union. European Central Bank, Frankfurt. European Central Bank Working Paper 626.

DeMiguel, V., Nogales, F.J., 2009. Portfolio selection with robust estimation. Oper. Res. 57 (3), 560–577.

DeMiguel, V., Garlappi, L., Uppal, R., 2009. Optimal versus naive diversification: how inefficient is the 1/N portfolio strategy? Rev. Financ. Stud. 22 (5), 1915–1953.

Driessen, J., Laeven, L., 2007. International portfolio diversification benefits: cross-country evidence from a local perspective. J. Bank. Finance 31 (6), 1693–1712.

Dufrénot, G., Gossé, J.B., Clerc, C., 2021. Risk sharing in Europe: new empirical evidence on the capital markets channel. Appl. Econ. 53 (2), 262–276.

ECB Committee on Financial Integration, 2022. Financial Integration and Structure in the Euro Area Report.

Eichengreen, B., 2003. Capital Flows and Crisis. The MIT Press, Cambridge.

European Commission, 2015. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Action Plan on Building a Capital Markets Union. Staff Working Document SWD(2015) 183 final.

European Commission, 2021. Commission Staff Working Document on the Movement of Capital and the Freedom of payments.

Favre, L., Galeano, J.A., 2002. Mean-modified value-at-risk optimization with hedge funds. J. Altern. Investments 5 (2), 21–25.

Fletcher, J., 2018. An empirical examination of the diversification benefits of UK international equity closed-end funds. Int. Rev. Financ. Anal. 55, 23–34.

Fletcher, J., Marshall, A., 2005. An empirical examination of the benefits of international diversification. J. Int. Financ. Mark. Inst. Money 15 (5), 455–468.

Floreani, V.A., Habib, M.M., 2018. The euro area bias and the role of financial centres. Int. J. Finance Econ. 23 (3), 233–256.

Gehrig, T., 1993. An information based explanation of the domestic bias in international equity investment. Scand. J. Econ. 97–109.

Geranio, M., Lazzari, V., 2019. Stress testing the equity home bias: a turnover analysis of Eurozone markets. J. Int. Money Finance 97, 70–85.

Gregoriou, G.N., Gueyie, J.P., 2003. Risk-adjusted performance of funds of hedge funds using a modified Sharpe ratio. J. Wealth Manag. 6 (3), 77–83.

Grubel, H.G., 1968. Internationally diversified portfolios: welfare gains and capital flows. Am. Econ. Rev. 58 (5), 1299–1314.

Gucciardi, G., 2022. Measuring the relative development and integration of EU countries’ capital markets using composite indicators and cluster analysis. Rev. World Econ. 1–41.

Guiso, L., Sapienza, P., Zingales, L., 2008. Trusting the stock market. the Journal of Finance 63 (6), 2557–2600.

Harvey, C.R., Liu, Y., 2021. Lucky factors. J. Financ. Econ. 141 (2), 413–435.

Haselmann, R., Herwartz, H., 2010. The introduction of the Euro and its effects on portfolio decisions. J. Int. Money Finance 29 (1), 94–110.

Hodrick, R.J., Zhang, X., 2014. International diversification revisited. In: University of Columbia Working Paper.

Huberman, G., Kandel, S., 1987. Mean-variance spanning. J. Finance 42 (4), 873–888.

Jacobs, H., Müller, S., Weber, M., 2014. How should individual investors diversify? An empirical evaluation of alternative asset allocation policies. J. Financ. Mark. 19, 62–85.

Jagannathan, R., Ma, T., 2003. Risk reduction in large portfolios: why imposing the wrong constraints helps. J. Finance 58 (4), 1651–1683.

Jiang, C., Du, J., An, Y., 2019. Combining the minimum-variance and equally-weighted portfolios: can portfolio performance be improved? Econ. Modell. 80, 260–274.

Jobson, J.D., Korkie, B., 1980. Estimation for Markowitz efficient portfolios. J. Am. Stat. Assoc. 75 (371), 544–554.

Jobson, J.D., Korkie, B.M., 1981. Performance hypothesis testing with the Sharpe and Treynor measures. J. Finance 889–908.

Jorion, P., 1986. Bayes-Stein estimation for portfolio analysis. J. Financ. Quant. Anal. 21 (3), 279–292.

Kalemli-Ozcan, S., Reshef, A., Sørensen, B.E., Yosha, O., 2010. Why does capital flow to rich states? Rev. Econ. Stat. 92 (4), 769–783.

Kaufmann, D., Kraay, A., Mastruzzi, M., 2013. Worldwide Governance Indicators. Dataset.

Lassance, N., DeMiguel, V., Vrins, F., 2022. Optimal portfolio diversification via independent component analysis. Oper. Res. 70 (1), 55–72.

Ledoit, O., Wolf, M., 2008. Robust performance hypothesis testing with the Sharpe ratio. J. Empir. Finance 15 (5), 850–859.

Ledoit, O., Wolf, M., 2011. Robust performances hypothesis testing with the variance. Wilmott 2011 (55), 86–89.

Lehmann, A., 2020. Emerging Europe and the capital markets union (No. 2020/17). Bruegel Policy Contribution.

Levy, H., Sarnat, M., 1970. International diversification of investment portfolios. Am. Econ. Rev. 60 (4), 668–675.

Lewkowicz, Jacek, Woźniak, Michał, Wrzesiński, Michał, 2022. COVID-19 and erosion of democracy. Econ. Modell. 106.

Li, K., Sarkar, A., Wang, Z., 2003. Diversification benefits of emerging markets subject to portfolio constraints. J. Empir. Finance 10 (1–2), 57–80.

Lucas, R.E., 1990. Why doesn't capital flow from rich to poor countries? Am. Econ. Rev. 80 (2), 92–96.

Markowitz, H., 1952. Portfolio selection. J. Finance 7 (1), 77–91.

McDowell, S., 2018. The benefits of international diversification with weight constraints: a cross-country examination. Q. Rev. Econ. Finance 69, 99–109.

Memmel, C., 2003. Performance hypothesis testing with the Sharpe ratio. Finance Letters 1 (2003), 21–23.

Monti, P., Felettigh, A., 2008. How to interpret the cpis data on the distribution of foreign portfolio assets in the presence of sizeable cross-border positions in mutual funds-evidence for Italy and the main euro-area countries. Bank of Italy Occasional Paper 16.

Osina, N., 2021. Global governance and gross capital flows dynamics. Rev. World Econ. 157 (3), 463–493.

Politis, D.N., Romano, J.P., 1991. A circular block-resampling procedure for stationary data. In: LePage, R., Billard, L. (Eds.), Exploring the Limits of Bootstrap. John Wiley, New York, pp. 263–270, 1992.

Raposo, I., Gonc¸alves and A. Lehmann (2019). 'Equity finance and capital market integration in Europe', Bruegel Policy Contribution No. 3/2019. https://academic.oup.com/economicpolicy/article-pdf/doi/10.1093/epolic/eiaa018/38676473/eiaa018.pdf.

Reinhardt, D., Ricci, L.A., Tressel, T., 2013. International capital flows and development: financial openness matters. J. Int. Econ. 91 (2), 235–251.

Smimou, K., 2014. International portfolio choice and political instability risk: a multi-objective approach. Eur. J. Oper. Res. 234 (2), 546–560.

Sortino, F.A., Hopelain, D., 1980. The pension fund: investment, or capital budgeting decision. Financial Executive Magazine 48, 21–23.

Velicer, W.F., 1976. Determining the number of components from the matrix of partial correlations. Psychometrika 41 (3), 321–327.

Zangari, P., 1996. A VaR methodology for portfolios that include options. RiskMetrics Monitor 1, 4–12.

Zhang, H., Kim, H., 2022. Institutional quality and FDI location: a threshold model. Econ. Modell. 114, 105942.