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International equity portfolio diversification: a sectoral and security-by-security analysis

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Abstract

International portfolio diversification has been shown to be subject to several puzzles, notably the home bias in equity investment, and the correlation bias. Taken together, those facts suggest that not only do investors tend to prefer domestic equity to foreign equity, but that, when they venture into cross-border investments, they do so in countries where stock prices are most correlated with home markets - contradicting the intuition that international investments are used to diversify portfolios more optimally. Our paper deals mainly with the correlation bias. It uses a dataset on French external financial portfolio positions produced by the Banque de France that allows a security-by-security analysis of international positions. We show that although insurance companies and investment funds are indeed more exposed to highly correlated markets, the way they arrange their portfolios at the security-level is consistent with the existence of a diversification motive.

Keywords: gross international investment positions, home bias, correlation puzzle, financial structure, macro-prudential regulation

JEL codes: G11; G15

Introduction

Amidst the unprecedented increase in cross-border financial transactions that took place over the past couple of decades, two key features emerge. First, portfolio investments - in particular in equity - are heavily allocated in domestic assets. This is the well-known equity home bias (EHB) - first documented in French and Poterba (1991), Lewis (1999), and more recently by Coeurdacier and Rey (2013) for equity as well as debt instruments. Even though it has steadily reduced in the developed world (and especially for euro area countries as shown for instance by Coeurdacier and Martin, 2009) over the last two decades, the share of foreign equities is still on average one third of the share implied by the basic Capital Asset Pricing Model (see Coeurdacier and Rey, 2013). Following Coeurdacier and Rey (2013), three classes of theoretical explanations have been proposed: (i) hedging motives in frictionless markets from non-tradable income risk or real exchange rate risk, (ii) trade costs in international financial markets and (iii) informational frictions and behavioral assets.

Second, given home bias, one expects a rational investor to compensate for its over-exposure to domestic risk by privileging investments in destinations whose equity markets are weakly correlated to the domestic market. The opposite of this is actually observed. Higher correlations between domestic and foreign stock returns are associated with higher equity investments, a situation to which we refer to as correlation bias.

Several explanations have been proposed to explain this result. Portes and Rey (2005) have found weak support for the diversification motive by controlling for informational frictions. Aviat and Coeurdacier (2007) have conjectured that the correlation bias is driven by endogeneity of stock return correlations to financial integration. In particular, highly financially integrated economies are more likely to exhibit both stronger correlations of stock returns and high levels of cross-border asset holdings, given that it comes with a decrease in transactions costs, regulatory barriers, and other financial frictions. Following this line of reasoning, Coeurdacier and Guibaud (2011) instrument current stock return correlations by correlations prior to the stock market liberalization of the 1980s, arguing to thereby capture variations in current correlations that are unrelated to financial integration. They find that investors are driven by the diversification motive and, *ceteris paribus*, tilt their portfolio towards countries that provide better hedge against domestic risk. Building on Coeurdacier and

Guibaud (2011), Balli, Balli and Basher (2013) replicate the econometric analysis at the sectoral level using CPIS ¹ data from the IMF on portfolio holdings by financial institutions, insurance companies, corporations, households, and the government. They can solve the correlation puzzle for most of the sectors, while financial institutions and corporations are found to exhibit a stronger diversification motive than households and the government. Pericoli, Pierucci and Ventura (2013) also find diversification motive using fractional regression techniques and controlling for trade relationships.

On the whole, the existing literature is characterized by two main features. *First*, the correlation bias questions the optimality of investors' choices, and so far this question has been dealt with by trying to identify the potential omitted financial frictions responsible for this result. *Second*, the majority of research on the correlation bias (with the exception of Balli et al., 2013) investigates diversification of the aggregated country portfolio and does not take into account differential investment behaviours across investor types (with possibly different degrees of risk aversion or institutional constraints). While this approach is interesting per se, we argue that empirical results on international portfolio diversification based on aggregate country portfolios might be biased and not allow conclusions on diversification of more disaggregated, i.e. sectoral portfolios (see, e.g. Galstyan et al., 2016).

Falling into the strand of this literature, our paper aims at analysing the correlation bias for French investors. We go further than the previous studies thanks to the use of a unique database on French holdings of securities provided by the Banque de France, that allows us to analyse equity portfolio choice for each investor type at the security level. With this level of detail, we are able to show that although French investors are positively biased toward highly correlated equity markets at the country level, the magnitude of this bias differs a lot across investor categories. As far as the financial sector is concerned for example, it is very strong for insurance companies, intermediate for investment funds, and non-existent for banks. This result is different from Galstyan et al. (2016) who found that banks are more sensitive to gravity-like determinants (that are closely related to markets correlation) than other financial corporations.²

¹Coordinated Portfolio Investment Survey.

²This difference can partly be explained by the fact that we included investment firms in the banking sector, whereas the "other financial corporation" sector in Galstyan et al. (2016) includes not only insurances and investment firms, but also pension funds and investment funds.

Furthermore, the security-by-security dimension of our database allows us to go beyond the endogeneity concerns put forward by the literature. Whereas previous studies used gravity-like and instrumental variables in order to control for endogeneity in country-to-country positions, we are able to consider the determinants of portfolio composition *within* a destination country. This approach enables us to show that the observed correlation bias does not exclude the existence of a significant diversification motive in portfolio choices, as even "biased" financial sectors are composing their portfolio in each destination country so as to reduce its correlation with their oversized domestic portfolio.³

The rest of the paper is organized as follows. Section 1 provides a description of the dataset and gives an insight on the profiles of the different investor types. Section 2 assesses the strength of the home and correlation biases of international portfolio choices of French investors. Section 3 moves to the security-by-security analysis of portfolio choice. Section 4 concludes.

1 Data and descriptive statistics

Our analysis mainly relies on the database PROTIDE provided by the Banque de France that contains French international portfolio investment positions by investor type at the security-level.⁴ It provides information on security characteristics on the integrality of equity holdings by French residents at quarterly frequency from March 2008 to March 2014. Data on outstandings, valuation (both due to market price and exchange rate changes) as well as flows are included. We use the detailed information on security characteristics and on the type of investor to construct sectoral domestic and foreign portfolios in stocks (in particular excluding investment fund shares). We also use security valuation rates to construct sectoral portfolio return indices and security return correlations for our security-level empirical analysis.

This dataset allows us to consider international portfolio diversification for seven investor types, both financial and non-financial, the aggregate of which corresponds to the total country-level stock portfolio of French residents. We distinguish four financial sectors, i.e. investment funds, banks,⁵ insurance companies and other financial institutions, and three non-financial investors, households, corporations, and the public sector. Throughout this paper, we are particularly

³We obtain no such result for non-financial ones.

⁴Excluding direct investment positions.

⁵Including investment firms, as the bulk of them are in practice subsidiaries of banks.

interested in the portfolio choices of investment funds and banks as they are by far the largest investors in non-French equities (with a portfolio amounting to respectively 205 Bn Euro and 128 Bn Euro in 2014Q1) but also in the choices of insurances and households, who are second-orderly important (25 Bn Euro and 16 Bn Euro respectively).

To shed light on sectoral investment strategies, we look at the characteristics of the average foreign stock investment and overall portfolio performance by investor type as shown in Table 1. Insurance companies and investment funds tend to hold large positions on a small number of securities, with an average position by security at 25.0 Mil. Euro and 32.6 Mil. Euro respectively. Insurance companies also tend to invest in highly capitalized stocks (16 Bil Euro on average). This suggests a preference for more liquid and less volatile stocks. On the other hand, banks invest on average smaller amounts in less capitalized stocks. The low median investment position across all investor types suggests that the vast majority of investments are small and that the high average is due to a few very large foreign stock investments, i.e. a fat-tailed distribution of stock investments.

Stock portfolio returns and volatilities suggest that insurance companies have the highest risk aversion accepting a relatively low average portfolio return of 2.6% for the lowest volatility of 11.38% in the group of financial investors. Investment funds' and banks' foreign stock portfolios both exhibit higher average returns, and higher volatilities. Within the group of non-financial investors, corporations seem to be most risk-taking investors, with average stock portfolio return and volatility standing at 3.9% and 12.99% respectively, followed by the public sector and households.

Finally looking at the correlation of the foreign stock portfolio with the domestic one, we observe that banks achieve the least correlated foreign stock portfolio (0.45) among the financial investors followed by other financial institutions, investment funds and insurance companies. Again, this could reflect the level of sophistication of portfolio management of the different investor types. Within the non-financial investor group, corporations realize the lowest correlation (0.37) with their domestic stock portfolio, followed by the public sector and households.

		IC	Banks	Inv Funds	OFI	HH	CORP	GG	RES
Investment Position	Mean	25.0Mil.	9.2Mil.	32.6Mil.	1.4Mil.	2.2Mil.	3.3Mil.	3.9Mil.	28.4Mil.
	Med	0.7Mil.	0.2Mil.	2.2Mil.	0.0Mil.	0.0Mil.	0.0Mil.	1.0Mil.	0.5Mil.
	Tot*	24.7 Bil	127.7 Bil	205.3 Bil	8.6 Bil	15.7 Bil	9.9 Bil	7.7 Bil	407.6 Bil
Return	Mean	2.1%	2.2%	2.5%	2.1%	1.8%	1.7%	3.0%	1.8%
	Med	2.3%	1.8%	2.3%	2.0%	1.7%	1.8%	2.7%	1.6%
	Pf	2.6%	3.1%	3.3%	2.6%	3.3%	3.9%	3.7%	3.2%
Volatility	Mean	14.74%	14.85%	14.54%	14.34%	16.04%	15.06%	14.12%	15.26%
	Med	12.08%	12.49%	12.41%	12.38%	13.46%	12.61%	11.71%	12.81%
	Pf	11.38%	12.39%	12.12%	12.26%	10.71%	12.99%	12.72%	12.12%
Correlation	Mean	0.47	0.39	0.42	0.37	0.44	0.45	0.34	0.46
	Med	0.65	0.54	0.59	0.53	0.61	0.62	0.51	0.62
	Pf	0.54	0.45	0.50	0.46	0.48	0.37	0.43	0.66
Market Capitalisation	Mean	16.31Bil.	4.02Bil.	5.42Bil.	13.38Bil.	4.92Bil.	10.91Bil.	9.17Bil.	3.39Bil.
	Med	5.59Bil.	0.85Bil.	1.60Bil.	3.79Bil.	0.70Bil.	2.50Bil.	3.31Bil.	0.56Bil.
	Pf	241.0Bil.	542.6Bil.	533.2Bil.	259.2Bil.	484.8Bil.	324.2Bil.	376.7Bil.	635.3Bil.
N of Obs		14 774	134 957	98 425	19 366	98 543	29 730	41 082	187 607

Note 1: IC=insurance companies, Inv Funds = investment funds, OFI = other financial institutions, HH = households,

CORP = non-financial corporation, GG = general government, RES = All resident investors, Pf = portfolio.

Note 2: * Total volume of the international equity portfolio in 2014Q1.

Table 1: Descriptive statistics - based on the total sample

Furthermore, investor-type specific investment strategies are also suggested by the portfolio turnover, that we define here as the ratio of the absolute value of flows (investments and desinvestments) into securities over the amount outstanding (see Table 2):

$$\tau_d = \frac{\sum_{i \in PF_d} |F_{di}|}{S_{PF_d}} \quad (1)$$

where PF_d is the portfolio of securities held by sector d , F_{di} is the net investment of sector d in security i over one quarter and S_{PF_d} is the volume of the portfolio (where the max is taken over the ex ante and the ex post volume). We interpret this measure as a proxy for dynamism and sophistication of portfolio management. Across all investor types, the turnover of the foreign stock portfolio is higher than the turnover of the domestic stock portfolio. As Tesar and Werner (1995) have pointed out, this suggests that variable transaction costs are an unlikely explanation to the home bias. We also find that portfolio management tends to be more dynamic in markets that have a low correlation with the domestic market, so transaction costs are probably not an explanation for the correlation bias either (except for banks, but it will turn out that banks are not as biased toward correlated markets as other categories of investors). Last but not least, there exist important differences in portfolio turnover across investor types. Banks manage their stock portfolios, both domestic and foreign, most actively with a turnover of 3.39 and 4.16, respectively, while the turnover of stock portfolios managed by insurance companies is 2.51 domestically and 2.89 for the foreign portfolio. If we interpret these differences as the result of unequal financial expertise, they may be indicative of different propensities to be subject to informational disadvantage or familiarity effect that may contribute to explaining correlation bias. They may also be explained by the differences in regulatory rules applicable to each investor type.

2 Stylized facts: Home and correlation biases

Let us now investigate the two perennial puzzles of international portfolio choice at the sectoral level for our seven investor types, i.e. the home bias and the correlation bias.

In frictionless financial markets, the most basic CAPM model suggests that the representative investor should hold the market portfolio, i.e. the share of

	Domestic PF	Foreign PF	Total PF	$cov(\tau, \rho)$
IC	2.51	2.89	2.63	-0.33
Banks	3.39	4.16	3.91	0.23
Inv Funds	1.93	3.00	2.63	-0.48
OFI	3.08	3.47	3.21	0.099
HH	2.10	2.63	2.16	-0.27
CORP	2.02	3.44	2.13	-0.03
GG	1.59	3.24	1.88	-0.28

Note 1: IC=insurance companies, Inv Funds = investment funds, OFI = other financial institutions, HH = households, CORP = non-financial corporation, GG = general government, PF = portfolio.
Note 2: $cov(\tau, \rho)$ refers to the covariance between the correlation of foreign markets to French market and the turnover on the portfolio to foreign markets.

Table 2: Descriptive statistics - Investor profiles

her financial wealth invested into domestic stocks should be equal to the share of domestic stocks in the world market portfolio. The divergence of the actual holdings of domestic stocks from the market portfolio is the most commonly used measure of the home bias (see for instance Coeurdacier and Rey, 2013).⁶ Since we are predominantly interested in differences across sectors, it suffices here to proxy the degree of sectoral home bias by the share of domestic stocks in the sectoral stock portfolio (since the share of French stocks in the world market stock portfolio is the same for all investors).

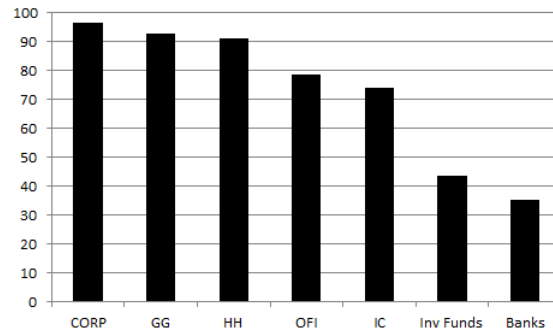


Figure 1: Sectoral home bias - Share of domestic stocks in total stock portfolio in 2014Q1

Figure 1 shows that the degree to which investors venture abroad is very het-

⁶In particular the home bias of the country i equity portfolio is measured as $EHB_i = 1 - \frac{\text{Share of foreign equity in country } i \text{ equity holdings}}{\text{Share of foreign equity in the world market portfolio}}$

erogeneous over investor type. Banks clearly have the most internationalized portfolios with a relatively low share of 35.2% of domestic stocks in their portfolios. On the opposite, insurances and other financial institutions hold the large majority of their stock portfolio invested in domestic stocks, while investment funds are in between (43.4%). Non-financial investors hold a very low share of foreign securities, but this may be due to the fact that direct investments are excluded from the database, whereas there are no equivalent limitations concerning holdings in French equities.⁷

Moving to correlation bias, we measure its magnitude for each investor as the difference between the average correlation of foreign position and the average correlation of a "representative" investor composed of all countries that participate to the CPIS (Figure 2a) :

$$CB_d = \sum_{k=1}^K \omega_{d,k} \rho_{FR,k} - \sum_{k=1}^K \omega_{CPIS,k} \rho_{FR,k} \quad (2)$$

where CB_d denotes the correlation bias, $\omega_{d,k}$ is the share of country k in the international equity portfolio of the resident investor d , $\omega_{CPIS,k}$ is the share of country k in the international equity portfolio of countries that participate to the CPIS,⁸ and $\rho_{FR,k}$ is the correlation between French and country k stock market returns.⁹

The comparison with the CPIS allows us to neutralize all country-specific factors that impact the country's attractiveness for international capital, such as market size, financial openness, information availability or country risk. A positive value of CB_d indicates that the average portfolio of international investors is less correlated to French stock market than the portfolio of investor d .

However, a part of the correlation bias may be explained by the fact that the average CPIS investor is less integrated in the Eurozone than France.¹⁰ We therefore also compute an alternative measure of the correlation bias. Figure 2b shows our measure of the correlation bias net of the effect of Eurozone inte-

⁷Meaning that participating interests in domestic entities are not excluded.

⁸The CPIS data aggregates stocks and investment fund shares into equity in the broad sense. In order to obtain a proxy of stock liabilities outstanding for a given country, we multiply the broad-sense-equity from CPIS with the proportion of stocks in French holdings of broad-sense-equity for this country. This assumes that the composition of broad-sense-equity liabilities of a country is homogeneous across creditors.

⁹Empirical correlations on yearly returns are measured over the past ten years.

¹⁰Lane (2006) has shown the existence of a "Euro Bias" in the global bond portfolio of euro area member countries.

gration. Two correlations biases are computed separately for inside and outside Eurozone investments, and are then averaged according to the weight of each portfolio in the investors' foreign position:

$$\begin{aligned}
CB_d^{EZ} &= \omega_{d,EZ} \left(\sum_{k \in EZ} \frac{\omega_{d,k}}{\omega_{d,EZ}} \rho_{FR,k} - \sum_{k \in EZ} \frac{\omega_{CPIS,k}}{\omega_{CPIS,EZ}} \rho_{FR,k} \right) \\
&+ \omega_{d,outEZ} \left(\sum_{k \notin EZ} \frac{\omega_{d,k}}{\omega_{d,outEZ}} \rho_{FR,k} - \sum_{k \notin EZ} \frac{\omega_{CPIS,k}}{\omega_{CPIS,outEZ}} \rho_{FR,k} \right) \quad (3)
\end{aligned}$$

where EZ (resp. $outEZ$) is the set of Eurozone countries (resp. the set of non Eurozone countries) and $\omega_{x,EZ}$ (resp. $\omega_{x,outEZ}$) is the weight of the Eurozone (resp. non Eurozone countries) in the international equity portfolio of investor x , x being either the resident investor d or the $CPIS$ investor.

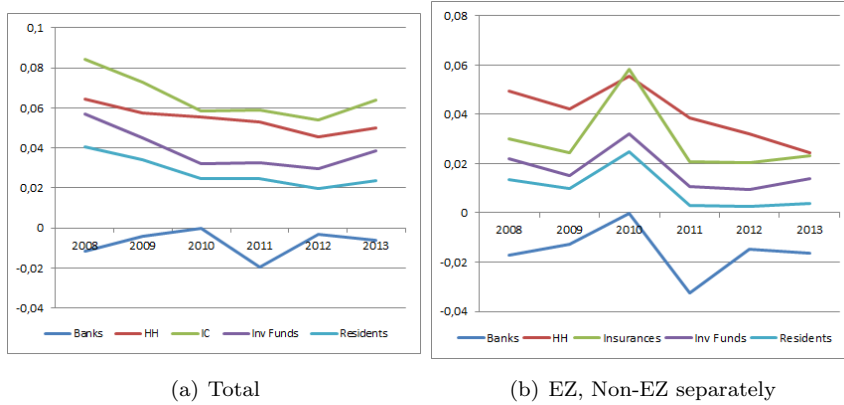


Figure 2: Sectoral correlation bias

Both measures show that French investors tend to be positively biased toward countries with stock markets correlated to the French one. Nonetheless, there exists important differences depending on investor types. Insurance companies appear as "champion correlators", whereas banks seem to diversify their home portfolio by investing in less correlated countries. Investment funds are in an intermediate position, with a positive but less pronounced correlation bias. The correlation bias decreases a lot, for all investors, when we consider separately investments inside and outside the Eurozone and is overall close to 0 in 2013. Still our previous observations remain true: insurance companies stand out as "champion correlators", investment funds have a lower but positive correlation bias, and banks hedge their domestic risk on international markets.

Finally, the joint analysis of these biases shows that investors with a strong correlation bias typically are those with a strong home bias. Thus, both puzzles are linked. This makes them even more puzzling since investors displaying a strong home bias should have more incentives to invest in uncorrelated countries as pointed out by Coeurdacier and Guibaud (2011). This observation also weakens the interpretation of Coeurdacier and Guibaud (2011) holding financial integration responsible for the apparent correlation bias, as we may expect financial integration to affect all investors equally.

3 International diversification at the security level

If resident investors are facing cross-border constraints that prevent them from efficiently hedging against domestic risk when they would actually be willing to, then - everything else being equal - we should observe investors composing their portfolios in each invested country so as to minimize their covariance with the domestic portfolio. We formalize this idea in subsection 3.1, and provide an empirical analysis in subsection 3.2.

3.1 Model

We consider a mean-variance investor who can invest in three countries: the home country (H), the neighbor country (N) and the foreign country (F). Each country has issued n_k securities (with $k \in \{H, N, F\}$). We are interested in the portfolio choice of the home investor. The return of this portfolio is given by:

$$\begin{aligned} \alpha' r &= \alpha_H [\alpha_{H1} r_{H1} + \dots + \alpha_{Hn_H} r_{Hn_H}] \\ &+ \alpha_N [\alpha_{N1} r_{N1} + \dots + \alpha_{Nn_N} r_{Nn_N}] \\ &+ \alpha_F [\alpha_{F1} r_{F1} + \dots + \alpha_{Fn_F} r_{Fn_F}] \end{aligned} \tag{4}$$

where α_k is the share of the investor's portfolio invested in country k and α_{ki} the share of the investor's country k portfolio invested in security i . The return of security i of country k is denoted r_{ki} . For notational clarity, we drop the time index.

For simplicity, we assume that all securities have the same expected return equal to zero. Therefore, the objective of the risk-averse investor reduces to minimizing the variance of returns subject to her budget constraint. We rule out short-positions.

The optimisation program is written as follows:

$\min_{\{\alpha\}} \frac{1}{2} Var[\alpha' r]$ subject to:

$$\begin{aligned} \sum_{k \in \{H, N, F\}} \alpha_k &= 1 \quad (\mu_0) \\ \forall k, \sum_i \alpha_{ki} &= 1 \quad (\mu_k) \\ \forall k, \alpha_k &\geq 0 \quad (\theta_k) \\ \forall k, n_k, \alpha_{kn_k} &\geq 0 \quad (\theta_{kn_k}) \end{aligned} \quad (5)$$

where μ_0, μ_k, θ_k and θ_{kn_k} are Lagrangian multipliers associated to the constraints. To further simplify, we assume that the "no-short-position constraints" are not binding (implying that all θ_k and θ_{kn_k} equal to zero for all k, n_k). Moreover, we assume that the investor is constrained to invest a minimum share ($\bar{\alpha}_H$) of her portfolio in the home country and a minimum share ($\bar{\alpha}_N$) of her portfolio into the neighbor country N :

$$\begin{aligned} \alpha_H &\geq \bar{\alpha}_H \quad (\lambda_H) \\ \alpha_N &\geq \bar{\alpha}_N \quad (\lambda_N) \end{aligned}$$

These constraints are associated with Lagrangian multipliers λ_H and λ_N that represent respectively home bias and correlation bias.

Before computing the solutions, we introduce some useful notations:

$$\begin{aligned} \Omega_{kl} &= CoVar[(r_{k1} \dots r_{kn_k}), (r_{l1} \dots r_{ln_l})] \quad k, l \in \{H, N, F\} \\ \tilde{\alpha}_l &= (\alpha_{l1} \dots \alpha_{ln_l})' \quad l \in \{H, N, F\} \end{aligned}$$

Then, the investor's objective can be written as

$$Var[\alpha' r] = \sum_{k, l \in \{H, N, F\}} \alpha_k \alpha_l \tilde{\alpha}'_k \Omega_{kl} \tilde{\alpha}_l \quad (6)$$

and the Lagrangian of the investor's problem writes :

$$\begin{aligned} L &= \frac{1}{2} Var[\alpha' r] + \lambda_H (\bar{\alpha}_H - \alpha_H) + \lambda_N (\bar{\alpha}_N - \alpha_N) \\ &+ \mu_0 \left(1 - \sum_{k \in \{H, N, F\}} \alpha_k \right) + \sum_{k \in \{H, N, F\}} \mu_k \left(1 - \sum_i \alpha_{ki} \right) \end{aligned} \quad (7)$$

The first-order conditions of this problem imply for $\tilde{\alpha}_k$:

$$\alpha_k^2 \Omega_{kk} \tilde{\alpha}_k + \sum_{l \neq k} \alpha_k \alpha_l \Omega_{kl} \tilde{\alpha}_l = \mu_k \mathbb{1} \quad k \in \{H, N, F\} \quad (8)$$

Finally, re-arranging the last equation, we find that the security-level portfolio allocation of the resident investor in destination country k ($\tilde{\alpha}_k$) is given by:

$$\tilde{\alpha}_k = \Omega_{kk}^{-1} \left(\frac{\mu_k}{\alpha_k^2} \mathbb{1} - \sum_{l \neq k} \frac{\alpha_l}{\alpha_k} \Omega_{kl} \tilde{\alpha}_l \right), \quad k \in \{H, N, F\} \quad (9)$$

This equation allows us to analyse the implications of portfolio constraints on the investor's optimal security choice. In particular, we can directly assess the sensitivity of security-level portfolio allocation (within-country) to the correlation with the home portfolio of the investor: it increases with the share of the portfolio invested in the home market (α_H) and decreases with the portfolio share invested in another country (α_N and α_F).

Indeed, the sensitivity of within country portfolio allocation to security correlation with the home country is given by the term multiplying the variance-covariance matrix Ω_{kH} : α_H/α_k ($k \in \{N, F\}$). To fix ideas, we analyse the sensitivity to security correlation in three cases in more detail (i) neither home nor correlation bias, (ii) only home bias, (iii) both home and correlation biases. We denote with a * (resp. **, ***) the optimal portfolio shares of the investor problem in case (i) (resp. (ii), (iii)).

- Within country portfolio allocation in both N and F is more sensitive to security correlation with the home portfolio if there is home bias: $\bar{\alpha}_H/\alpha_k^{**} > \alpha_H^*/\alpha_k^*$ ($k \in \{N, F\}$).
- For security-level portfolio allocation in country F , we also have $\bar{\alpha}_H/\alpha_F^{***} > \bar{\alpha}_H/\alpha_F^{**}$. Therefore, the correlation bias further increases this sensitivity.
- For security-level portfolio allocation in country N , however we have $\bar{\alpha}_H/\bar{\alpha}_N < \bar{\alpha}_H/\alpha_N^{**}$. Therefore correlation bias would decrease this sensitivity compared to home bias.

- Nonetheless, the security-level portfolio allocation in country N remains more sensitive to security correlation with home country in case (iii) than in case (i), as long as constraints on home investment are more severe than constraints in neighbor investment : $\bar{\alpha}_H/\alpha_H^* > \bar{\alpha}_N/\alpha_N^*$.

3.2 Estimation results

For each investor we estimate the following equation:

$$Y_{ijt} = \alpha_{jt} + \beta\rho_{it} + \gamma\sigma_{it} + \theta\mu_{it} + \delta\pi_{it} + \epsilon_{it} \quad (10)$$

for $Y_{ijt} > 0$, where Y_{ijt} is the share of the investor's equity portfolio in country j invested in security i at time t , α_{jt} is a country-time fixed effect (j being the country of the issuer of i), ρ_{it} is the correlation between the investor domestic portfolio return and security i , σ_{it} is security i 's volatility, μ_{it} is its return, and π_{ijt} is the share of security i in the market capitalisation of securities from country j held by French investors at time t . ϵ_{it} denotes the error-term.

Considering our model in 3.1, we expect that :

1. Investors with higher home bias and correlation bias will have a significant (negative) value for β . There are two reasons for this. First, as is clear from equation (9), a higher home bias leads to a higher sensitivity of within-country portfolio allocation to correlation with the domestic portfolio. The second reason is more statistical: as ρ_{pit} measures the correlation between security p and the domestic portfolio of investor i , we may also expect that ρ_{pit} is a good proxy for the correlation of the same security p with the portfolio invested in neighbor country securities. Thus, β may capture - in addition to the willingness to hedge against over-exposure to domestic risk - the willingness to hedge against over-exposure to correlated risks.
2. If we estimate the value of the coefficient β for each destination country separately, then β s corresponding to countries that are least invested should be higher.

	IC	Banks	Inv Funds	OFI	HH	CORP	GG	RES
Intercept	3.055* (1.84)	0.852** (0.39)	0.365 (0.38)	7.971*** (2.48)	1.133* (0.58)	2.728* (1.59)	4.614*** (0.70)	0.1 (0.24)
Correlation	-0.268** (0.13)	0.012 (0.02)	-0.055*** (0.02)	-0.301** (0.13)	0.046 (0.03)	0.005 (0.10)	0.091*** (0.03)	0.038*** (0.01)
Volatility	-1.191* (0.64)	0.351*** (0.06)	-0.291*** (0.11)	-0.4 (0.70)	-0.273*** (0.11)	-1.57*** (0.48)	-0.595*** (0.16)	-0.041 (0.04)
Return	-0.503 (0.75)	-0.684*** (0.09)	0.528*** (0.12)	-1.252* (0.75)	0.278** (0.14)	0.82 (0.55)	0.934*** (0.18)	0.04 (0.06)
Market Cap	1.651*** (0.02)	0.96*** (0.00)	0.994*** (0.00)	0.944*** (0.03)	0.66*** (0.01)	0.777*** (0.02)	0.886*** (0.01)	0.909*** (0.00)
Time x Dest FE	yes	yes	yes	yes	yes	yes	yes	yes
R^2	40.8%	41.8%	39.8%	18.8%	20.8%	16.5%	49.4%	42.5%
$Pr > F$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N Obs	14 774	134 957	98 425	19 366	98 543	29 730	41 082	187 607

Note 1: IC=insurance companies, Inv Funds = investment funds, OFI = other financial institutions,

HH = households, CORP = non-financial corporation, GG = general government, RES = all resident investors.

Note 2: Investments in countries where the portfolio is composed of less than 7 securities are omitted

Note 3: Standard errors are in parenthesis and * (resp. **, ***) denotes significance at the 10% (resp. 5%, 1 %) level

Table 3: Security-level regressions

Table 3 confirms that investors who have a high correlation bias have more incentives to diversify their home equity portfolio at the security-level. Insurance companies are the strongest country-level correlators and the strongest security-level diversifiers. Thus on average, in a given invested country, they hold larger positions in securities that are less correlated with their home portfolio. Investment funds diversify less over securities, but have also less biased aggregate portfolios. As shown in section 2, banks on the contrary are already well diversified across countries (lowest home bias and correlation bias) and seem therefore less concerned about security-level correlation. We consequently speculate that banks' investment choice in foreign securities could be rather driven by motives similar to those that drive domestic investment and therefore other than diversification of their home portfolio.

Moreover, coefficients on volatility suggest that all investors, with the exception of banks, aim to avoid volatility, where insurance companies show the highest concern about reducing volatility. We interpret the positive sign on return volatility for banks as evidence for a "search for yield" motive. Securities with higher past return volatility constitute a riskier investment but might promise higher returns in the future. Banks tend to buy low and sell high.

Moving to the second econometric consideration about the model (that if we estimate equation (9) separately for each destination country, the estimated β s should be more negative in less invested countries), we find no clear-cut confirmation of our prediction.

Table 4 below shows the correlation between the estimated β^k for each destination country k and log of the ratio α_H/α_k (where α_H is the share of the investor equity portfolio invested in France and α_k is the share of the equity portfolio invested in country k) averaged over time. For most investor types, the estimated correlations are not significant, and it is not significant either on the total resident portfolio. But we do find significant negative correlations between β^k and α_H/α_k for insurance companies and general government, whereas we find no investor type for which there exists a significant positive correlation. Hence, these results are overall consistent with our model.

4 Conclusion

This paper uses the dataset PROTIDE on sectoral holdings of securities in order to investigate the correlation bias of French investors based on an analysis of international positions at the sectoral and security levels.

	Estimated correlation	p-value
Banks	0.09	0.566
CORP	0.08	0.660
GG	-0.53	0.004
HH	0.13	0.406
IC	-0.39	0.049
Inv Funds	0.04	0.823
OFI	-0.23	0.217
RES	0.21	0.172

Note 1: IC=insurance companies, Inv Funds = investment funds,

OFI = other financial institutions, HH = households, CORP =

non-financial corporation, GG = general government, RES = all resident investors.

Note 2: All observations ($\beta^k, \log \alpha_H/\alpha_k$) are weighted by $\sqrt{N_k}$

N_k being the number of observations used to estimate β_k .

Table 4: Correlation between α_H/α_k and β^k

We show that the magnitude of the correlation bias strongly differs across investor types. In particular, French banks seem to positively contribute to hedging the French international equity portfolio against domestic risk, and this hedging property seems to have increased over time. The same cannot be said about insurance companies and investment funds: they contribute negatively to this hedging, as we have shown that they would be decreasing the average correlation of their international equity portfolio with the domestic market should they be investing identically to the world-average investor.

Nonetheless, for these investors, we find that the existence of a correlation bias does not rule out a significant diversification motive. Indeed, although they are more exposed to more correlated markets, they seem to compose their portfolio *in each market* so as to lower its correlation with their oversized domestic equity portfolio. This would further confirm that the "correlation puzzle" does not originate from some exotic preferences of investors, but rather from omitted variables in econometric specifications. It also indicates that the correlation puzzle may be overstated.

Taken together, these results suggest that there exists several portfolio management strategies for the financial sectors to satisfy their willingness to diversify their equity portfolios. Insurance companies and to a lesser extent investment funds seem to have adopted a "second-order" diversification strategy, that may be compared to the "home-grown" foreign exposure considered by Cai and

Warnock (2006). Further research may be aiming at making clearer whether this kind of circumvention strategies should be explained by sectoral-specific constraints in international diversification - in particular, prudential constraints - or by familiarity effects. It is worth noticing however that our descriptive statistics would indicate that the latter is at work, in particular concerning insurance companies, as they appear as less "sophisticated" investors.

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