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INTERNATIONAL DIVERSIFICATION FOR LONG-TERM INVESTORS

DISCUSSION NOTE

In this note, we explore the benefits of international diversification from the perspective of a long-term, multi-asset investor.

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SUMMARY

INTERNATIONAL DIVERSIFICATION FOR LONG-TERM INVESTORS

- There is a high degree of cross-country co-movement in equity and fixed income returns, and correlations have been increasing over time. This implies a reduction in international diversification benefits, at least in the short term.

- The extent to which diversification benefits deteriorate for long-term investors, however, depends on the extent to which short-term correlations persist over longer horizons. We illustrate a distinction between correlations driven by cash flow and discount rate co-movement. When co-movement in discount rate shocks underlies return correlations, this is less detrimental to the longer-term risk of a globally diversified portfolio.

- Using a data set of developed and emerging market equity and fixed income returns, we empirically assess the case for international diversification, comparing narrowly and globally diversified portfolios over multi-period horizons. We find that, for both equity and fixed income portfolios, diversification is beneficial, and that the relative performance diverges as the return horizon is extended. This divergence appears more prominently in equity than in fixed income returns and is consistent with a larger role for discount rate co-movement in international equity return correlations.

- In a multi-asset portfolio context, there are gains from diversification of the equity allocation. There is less of a gain from diversification of the fixed income allocation in the presence of a large diversified equity component, due to correlated currency movements across currency-unhedged equity and fixed income returns. We document positive co-movement between emerging market fixed income and equity returns in the more recent past, which also lessens the diversification benefits from fixed income.

- We estimate cash flow and discount rate news components of international equity and fixed income returns. We find average cross-country correlations in equity returns are primarily attributed to co-movement in discount rates, while cash flow news co-movement plays a larger role in fixed income correlations.

- These findings suggest that high equity market correlations may be considered more benign for a longer-term investor and less of an issue for portfolio risk over longer horizons. For fixed income returns, however, our findings suggest that cross-country correlations are more persistent and that there is therefore an implied reduction in diversification benefits from a longer-term perspective.

1. Introduction

It is widely understood that the risk-adjusted performance of a portfolio can be improved through diversification across imperfectly correlated assets. One dimension along which to diversify a portfolio is across countries, and a significant body of research assesses the benefits from international diversification, generally documenting significant positive effects. These findings underlie a large literature on the "home bias puzzle", which is the tendency of investors to hold primarily local assets and forgo the apparent benefits that international diversification offers. For the most part, however, the case for diversifying across countries has been considered from a shorter-term perspective, and studies usually focus on international equity markets. In this note, we examine the case for international diversification in equity and fixed income markets, placing emphasis on the potential benefits from the perspective of a long-term investor, and considering the case within a multi-asset context.

Using a data set of equity and fixed income total returns for 42 countries, we compare narrowly focused country portfolios to broader, globally diversified portfolios, following Asness, Israelov and Liew (2011). We consider the relative performance of narrow and broad portfolios from the point of view of a range of developed markets, and take the average perspective as representative. In any analysis using international returns, an important consideration is the currency in which returns are measured and the appropriate currency basket for the fund. Throughout our analysis, we attempt to remain agnostic over the exact composition of the currency basket, and consider a general question of whether investing in a wider set of countries, relative to a narrower currency basket, is beneficial.

We first show that there are short-term benefits to international diversification, then proceed to explore benefits over the longer term, where we estimate the expected shortfall of the portfolios over multi-period horizons. For both equity and fixed income portfolios, there is an improvement in performance of broad relative to narrowly diversified portfolios, which diverges as the return horizon is extended. This divergence appears more prominently in the equity portfolios than in the fixed income portfolios. When applying the same methodology to assess the role of diversification in a multi-asset portfolio, we find greater gains from diversification of the equity component. In this context, there is less of a case for expanding the range of fixed income countries when there is already a large, globally diversified equity allocation. This finding partly arises from correlated currency components across currency-unhedged equity and fixed income returns, increasing overall portfolio risk. There is also evidence to suggest that positive correlations between emerging market fixed income and equity returns, in the more recent past when data are available, contribute to increased risk in a multi-asset context.

While we estimate strong short-term co-movement in international returns, this observation cannot necessarily be utilised directly in a longer-term setting. An important consideration for long-term investors is whether high return correlations should be viewed as persistent or transitory

co-movement. Following Viceira, Wang and Zhou (2017), we provide a framework for understanding long-term diversification effects. High short-term correlations across international returns imply lower diversification benefits, but the deterioration of these benefits over the longer term depends on the extent to which correlations persist. This, in turn, depends on whether short-term correlations are driven by persistent or transitory components of returns. We show that the distinction between correlations in cash flows and discount rate components of returns is relevant for the risks faced by a long-term investor. We use a stylised framework to simulate international returns, and show that if co-movement in discount rates underlies high return correlations, this is less detrimental for a long-term investor than if co-movement in cash flows underlies the high return correlations.

We proceed to empirically identify the cash flow and discount rate news components of international equity and fixed income returns, following Viceira, Wang and Zhou (2017). We use a VAR model return decomposition to explore the relative role of cash flow and discount rate co-movement within global equity and fixed income portfolios.

Our analysis suggests that the high cross-country co-movement in equity returns is primarily attributable to co-movement in discount rates. In a globally diversified fixed income portfolio, on the other hand, cross-country co-movement in cash flow news plays a larger role.[1] These findings suggest that, from the point of view of a long-term investor, high equity market correlations may be considered more transitory in nature, and over the longer term less of an issue for portfolio risk. For fixed income returns, however, the larger role of cash flow news implies that the cross-country correlations are more persistent. This suggests that the reduction in diversification benefits from high return correlations is more pronounced for fixed income returns.

The note proceeds as follows. The next section describes previous research relevant to international diversification, in particular the "home bias puzzle" literature. Section 3 outlines the data set and methodology underlying the portfolio comparisons, and compares equity, fixed income and multi-asset portfolios on the basis of short- and long-term metrics. Section 4 outlines a theoretical framework and uses simulations to illustrate the different implications of cash flow and discount rate news in international return correlations. In Section 5, we estimate the cash flow and discount rate news components of returns directly and use these series to decompose the variance of global equity and fixed income portfolios. Section 6 concludes.

1 For nominal bonds, cash flow news is variation in expected future inflation affecting the real value of future coupons.

2. International Diversification and the Home Bias Puzzle

There is a large body of academic work that relates to the benefits of international diversification. In general, early studies concluded that diversification across countries is beneficial in both equity and fixed income markets.[2] Indeed, the documented benefits underlie a large literature concerned with the "home bias puzzle", which documents and attempts to explain the tendency of investors to concentrate their portfolios in local assets. These high proportions of local assets within investor portfolios tend to be far higher than would be predicted based on theory, where there are apparent gains to holding a more globally diversified portfolio.

In an influential paper, French and Poterba (1991) showed that investors tend to have high portfolio weights assigned to local-market equities, appearing to forgo diversification opportunities provided by imperfectly correlated international returns. This puzzle has been shown to exist across many countries and markets, and has persisted over time. Coeurdacier and Rey (2013) provide comprehensive empirical evidence of the home bias puzzle and a detailed discussion of work in this area. In general, early studies documenting the benefits of international diversification and the subsequent home bias puzzle rely in part on a number of assumptions. These include assuming homogenous investors and the absence of significant frictions in financial markets. Possible explanations for the home bias puzzle have therefore often arisen from challenges to these assumptions.

An intuitive possible explanation for investor home bias is that there are significant costs to investing abroad, perhaps through fixed or proportional transaction costs or due to differential tax treatments of domestic and foreign portfolio incomes. In general, however, studies have not been able to rationalise the extent of the home bias on the basis of these costs, where they tend to find that the implied costs required to justify the bias would need to be very large (French and Poterba, 1991; Jeske, 2001). These cost estimates are very uncertain, however, and there is little research examining the relative costs of investing at home and abroad directly. A related explanation for the puzzle is that investors have less information or familiarity regarding investments abroad, where this information is costly to acquire, and as a result investors view foreign investments as riskier. There is evidence to suggest that this explanation is relevant. Portes and Rey (2005) show that the degree of cross-country transactions in financial assets is heavily related to the distance between countries. Grinblatt and Keloharju (2001) also find evidence that distance, language and cultural similarities are influential factors in portfolio decisions.

Another possible explanation for the puzzle arises from the heterogeneity of investors, where portfolio holdings are biased to home countries due to the different hedging demands of investors. Two sources of risk to investors,

2 For equities, examples include Grubel (1968), Levy and Sarnat (1970), French and Poterba (1991) and Harvey (1995). For bonds, see Levy and Lerman (1988) and Campbell, Medeiros and Viceira (2010). While studies are mostly from a US perspective, there is also evidence that there are benefits from multiple local perspectives: see Driessen and Laeven (2007) and Asness, Israelov and Liew (2011).

and the potential to hedge these risks, have received particular attention in the home bias literature. The first is the risk of relative price movements, referred to as real exchange rate risk, reducing the purchasing power of investors' income. In this context, investors may place higher weight on local equities if they perform well when their consumption basket becomes more expensive. This explanation has appeared insufficient to explain the home bias puzzle empirically, given low correlations between equity returns and relative inflation levels (Cooper and Kaplanis, 1994), and between equity returns and the real exchange rate (Van Wincoop and Warnock, 2010). The second hedging explanation is the presence of non-tradeable income risk, where investors may choose to hold more local equities as a hedge against a deterioration in their labour income. This idea was challenged in Baxter and Jermann (1997), who showed that high positive correlations between domestic labour and capital should actually imply a negative position in local equities. A key development, however, has been the incorporation of additional asset classes, in particular bonds, alongside equities in international macroeconomic models. Coeurdacier and Gourinchas (2016) show that, both theoretically and empirically, relative bond returns are strongly correlated with real exchange rates and can be used to hedge real exchange rate risk. In this context, once returns on bonds are accounted for, the authors find a negative relationship between domestic equity returns and non-tradeable income, generating a home bias in equities in line with the level observed in the data.

While the home bias puzzle has persisted over time, the case for international diversification may have nonetheless weakened. A related literature documents an increase in global market integration and a corresponding increase in international return co-movement over the recent past, in both equity and fixed income markets.[3] To illustrate this, Figure 1 shows the average cross-country rolling correlation of international equity and fixed income returns since 1960. Despite variability in the estimate over time, there is a broad upward trend in international correlations, implying that, all else equal, there has been a reduction in international diversification benefits over time. As noted in the introduction, however, the extent of the reduction in diversification benefits is less clear for a long-term investor. As outlined in Viceira, Wang and Zhou (2017), high short-term correlations may be less detrimental for a long-term investor if they are driven by co-movement in transitory components of returns rather than permanent components.

3 For equity markets, see Longin and Solnik (1995), Goetzmann, Li and Rouwenhorst (2005), Quinn and Voth (2008), Bekaert, Hodrick and Zhang (2009), Christoffersen, Errunza, Jacobs and Langlois (2012) and Dahlquist and Hasseltoft (2013) for co-movement in bond risk premiums.

Figure 1: Average 5-year Rolling Correlation (USD returns)

In addition, the benefits of international diversification may have been overstated. Studies such as Erb, Harvey, and Viskanta (1994), Longin and Solnik (1995) and Solnik and Watewai (2016) identify time variation in international correlations, in particular noting higher correlations during "down" markets or periods of heightened volatility. International diversification benefits are somewhat lower as a result of these increases in correlations, which are particularly painful since diversification benefits are not experienced at times when protection would be particularly valuable. This issue is outlined in Asness, Israelov and Liew (2011), who assess the protection international diversification provides in market downturns over multi-period horizons, and we use a similar methodology in the next section.

3. International Diversification: Narrow vs Broad Portfolios

In this section, we briefly describe the data set of international equity and fixed income returns and describe the methodology used to assess diversification benefits. Our analysis follows a similar approach to that used in Asness, Israelov and Liew (2011), who compare "local" and "global" portfolios on a range of metrics. We refer to single-country portfolios as "narrow" portfolios, and globally diversified portfolios as "broad" portfolios. Following the description of data and methodology, we compare the short-term and multi-period performance of these narrow and broad portfolios.

When comparing narrow and broad multi-asset portfolios, an important consideration is the currency in which returns are measured. In Asness, Israelov and Liew (2011), both the "local" and "global" portfolios are measured from a single real return perspective, i.e. for each country within their data set, which is then averaged across perspectives. For the Government Pension Fund Global (GPFG), the consideration of local vs global should not be taken literally, since the fund is restricted from investing in Norway, and more importantly its objective is to maximise its *international*

purchasing power. It follows from this that it is more appropriate to consider returns measured in currencies relevant to the international purchasing power of the fund. The Asness, Israelov and Liew (2011) approach can be seen as a special case where purchasing power is considered in the context of a single country. As a robustness check, we repeat our analysis using randomly drawn groups of currencies in which to measure narrow and broad portfolio returns, and show that our findings do not change materially as a result. Our analysis could hence be interpreted as assessing whether there are benefits to investing in a broader set of currencies relative to a given currency measurement basket.

i. Narrow vs Broad Portfolios: Data and Methodology

Our analysis is based on country-level equity and 10-year benchmark government bond total return indices, compiled from multiple sources. There are a total of 42 countries in the data set, which covers developed and emerging markets over samples of varying lengths, during the period from 1950 to 2016. The list of countries and additional details are provided in Appendix A. Total returns from a given country perspective are unhedged against currency movements and are deflated using the country's local consumer price index.

Narrow portfolios are defined in terms of local-market returns for a given country, such that there is a narrow portfolio for each country in the data set. For example, the narrow equity portfolio for the UK is set equal to the UK stock market index returns, and the narrow fixed income portfolio is set equal to the 10-year UK government bond returns. Broad portfolios are also constructed for each country perspective, defined as value-weighted returns across all markets in the data set (including the local-market returns). For global equity portfolios, country returns are weighted by USD market capitalisation; for global fixed income portfolios, returns are weighted by USD nominal GDP.[4]

The available history for equity and fixed income returns varies across countries, with start dates provided in Appendix A. To ensure that differences in samples do not affect our portfolio comparisons both within and across asset classes, we align the samples of equity and fixed income returns by country in line with the shortest available series. While the country composition of broad portfolios is the same across countries, there are differences in broad portfolio real returns by country due to differing unhedged currency movements and inflation rates.

The above definitions imply that there are 42 possible narrow and 42 possible broad portfolios, defined from the perspective of each country within the data set. Similarly to Asness, Israelov and Liew (2011), we do not choose a specific country from which to draw comparisons between the narrow and broad portfolios. We assess the benefit from international diversification, i.e. the formation of a broad as opposed to a narrow portfolio,

4 Using nominal GDP as opposed to market capitalisation for fixed income allows for a longer sample history. Global portfolio returns weighted using nominal GDP are highly correlated with market-capitalisation-weighted returns over the period when both series are available.

from the real return perspective of each developed market country, and form a representative comparison by averaging over these perspectives.[5] The differences in performance across the narrow and broad portfolios reflect how, on average, an investor in each developed market perspective would fare when invested in either their local market or a global portfolio (including their local market). A list of developed market perspectives and average equity and fixed income portfolio weights is provided in Appendix A.

ii. Narrow vs Broad Portfolios: Short-term Diversification

The analysis of diversification benefits is typically based on the implications of including additional assets for portfolio risk, measured by return variance. In this context, the determinants of the possible benefits associated with international diversification can be easily shown using a stylised example. Consider a portfolio comprising two country-level indices, for country A and country B. The return on the portfolio, $\mathrm{r_p}$, is given by:

$$\mathrm{r_p} = \mathrm{w_A r_A} + \mathrm{w_B r_B}$$

where w is the weight of the country within the portfolio, and r is its return. The variance of portfolio returns, σ_p^2, is given by:

$$\sigma_p^2 = w_A^2\sigma_A^2 + w_B^2\sigma_B^2 + 2w_A w_B \sigma_A \sigma_B \rho_{A,B}$$

where σ is the standard deviation of country returns and $\rho_{A,B}$ is the cross-country correlation of returns. The degree to which an additional country reduces portfolio risk depends on its weight within the portfolio, the relative variance of its return, and its correlation with other countries within the portfolio. As an initial assessment of diversification effects, we calculate this portfolio risk measure for the narrow and broad portfolios defined above. In Table 1, we show the average excess return over the local Treasury bill rate, volatility and Sharpe ratio for the narrow and broad portfolios constructed for equity, fixed income and 60-40 multi-asset portfolios. There are four alternatives in the multi-asset context: holding broad portfolios for both asset classes, holding narrow portfolios for both asset classes, and a mix of broad and narrow portfolios in equity or fixed income.

For the equity portfolios, there is a sizeable reduction in volatility in the broad equity returns relative to narrow portfolios, with only a small difference in average excess return. Combining risk and return, we observe a higher Sharpe ratio for the internationally diversified equity portfolio compared to the narrow portfolio. For the fixed income portfolios, there is a much smaller reduction in volatility when moving from the narrow to the broad portfolio. Combined with a lower average excess return, there is a decrease in the Sharpe ratio, and it appears that international diversification is less effective within fixed income relative to equity portfolios. A key factor in the variability of global fixed income portfolios is currency movements, an issue

5 We consider developed market perspectives to be more relevant, and restricting perspectives to these markets also reduces the influence of shorter samples available in emerging market broad vs narrow comparisons.

we return to later.[6] Combining equity and fixed income returns in a multi-asset portfolio with weights of 60 and 40 percent respectively, we observe a reduction in volatility and a higher Sharpe ratio in the broad-broad portfolio relative to the narrow-narrow portfolio.[7] In line with the results within the asset classes individually, a larger gain is observed from diversification of the equity allocation in the multi-asset context. The broad-narrow portfolio produces the lowest volatility of all the combinations, while there is not a large reduction in the volatility of the narrow-broad combination, suggesting a weaker case for diversification of fixed income in the multi-asset cases. We return to these observations later in this section.

Table 1: Average Excess Return, Volatility and Sharpe Ratio of Narrow and Broad Portfolios

	Portfolio	Excess Return (%)	Volatility (%)	Sharpe Ratio
Equity	Narrow	5.7	19.6	0.30
	Broad	5.9	14.9	0.40
Fixed Income	Narrow	2.9	7.8	0.39
	Broad	2.6	7.5	0.36
Multi-Asset (EQ-FI)	Narrow-Narrow	4.6	12.7	0.37
	Broad-Narrow	4.7	9.7	0.49
	Narrow-Broad	4.5	12.2	0.37
	Broad-Broad	4.6	10.5	0.45

iii. Narrow vs Broad Portfolios: Expected Shortfall and Longer-term Diversification

While we find some short-term equity diversification benefits on the basis of volatility and Sharpe ratio estimates, studies suggest, as noted earlier, that such benefits risk being overstated due to the tendency of correlations to increase in market downturns. Such behaviour may be less apparent when comparing volatility estimates, and this motivates the use of expected shortfall as an appropriate measure for assessing international diversification effects, as argued in Asness, Israelov and Liew (2011).[8] For the narrow and broad portfolios, we estimate the expected shortfall defined as the average of the 5 percent worst monthly returns in our sample. Table 2 compares the average expected shortfall of equity, fixed income and multi-asset portfolios. In all three cases, there is a lower expected shortfall in the broad-broad diversified portfolio relative to the narrow-narrow portfolio. On the basis of comparable results, Asness, Israelov and Liew (2011) suggest that the protection provided by global diversification is not especially large in the short term. Similarly to Table 1, the broad-narrow combination produces the most favourable outcome, while the improvement with the narrow-broad

6 If we were to currency-hedge the broad fixed income portfolios, the volatility reduction when moving from narrow to broad would be much larger, and the Sharpe ratios would increase on average. This is consistent with Campbell, Medeiros and Viceira (2010), who find that currency returns tend to be uncorrelated with bond returns in a group of seven developed market currencies, suggesting that foreign exchange risk can only increase the volatility of a bond portfolio. Glen and Jorion (1993) also find that the benefits of currency hedging are more prominent in bond portfolios than in equity portfolios.

7 The increase in the Sharpe ratio in the multi-asset case will partly reflect the negative correlation between aggregate country-level equity and fixed income returns in the period since the late-1990s.

8 We focus on short- and long-term expected shortfalls for the remainder of the section. Our findings are similar, and messages the same, when comparing narrow and broad portfolios in terms of return volatility.

combination is small, pointing to a lesser gain from diversifying the fixed income component of a multi-asset portfolio.

Table 2: Average 5 Percent Expected Shortfall of Narrow and Broad Portfolios

	Portfolio	Expected Shortfall (%)
Equity	Narrow	12.5
	Broad	9.4
Fixed Income	Narrow	5.0
	Broad	4.0
Multi-Asset (EQ-FI)	Narrow-Narrow	7.9
	Broad-Narrow	6.1
	Narrow-Broad	7.6
	Broad-Broad	6.2

An important limitation of the preceding analysis in this section is that the narrow vs broad comparisons have been made on the basis of short-term measures. Asness, Israelov and Liew (2011) note that the high co-movement that has been documented over shorter periods is only relevant for a long-horizon investor to the extent that this co-movement persists. In their paper, they show that drawdowns in broad developed market equity portfolios are less pronounced compared to narrow portfolios, in particular when the horizon over which they are compared is extended. Following a similar methodology, we estimate expected shortfall curves defined as the average of the 5 percent worst returns for each horizon from 1 to 60 months, for the narrow and broad equity, fixed income and multi-asset portfolios defined earlier.

Figure 2: 5 Percent Expected Shortfall for Narrow vs Broad Portfolios over 1- to 60-month Horizons – Equities

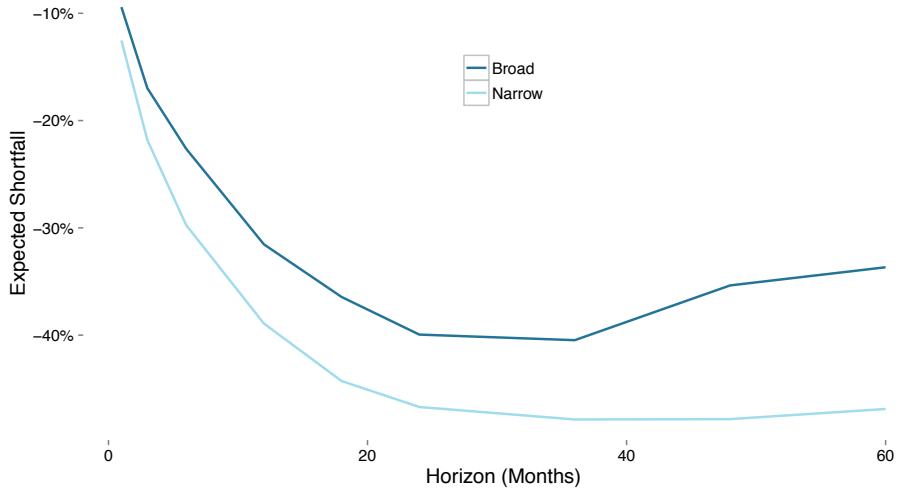
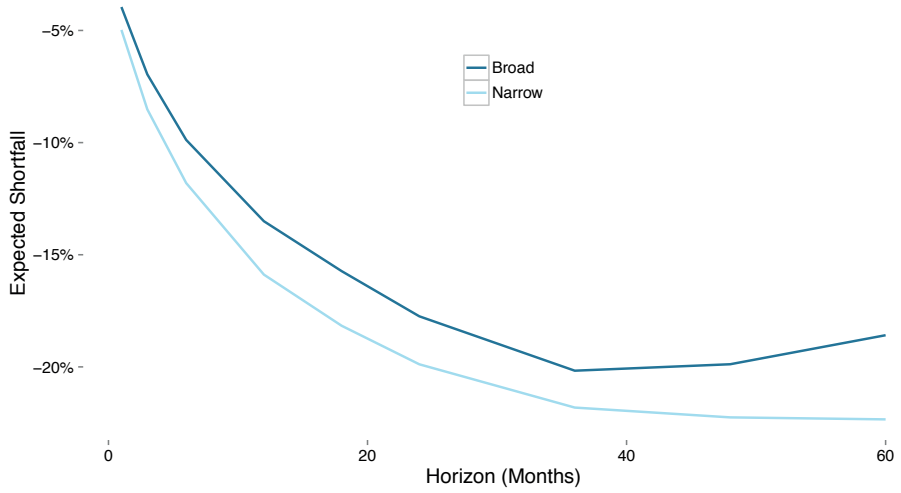


Figure 2 shows the expected shortfall curves for narrow and broad equity portfolios. While the gap between the narrow and broad curves is not large at shorter horizons, it becomes wider as we extend to longer horizons, and the broad portfolio appears to be increasingly attractive relative to the narrow portfolio. For narrow equity portfolios at the 60-month horizon, the expected

shortfall reaches on average around -50 percent, while the global diversified portfolios average around a 20 percentage point improvement at around -30 percent.[9]

Figure 3 shows the same expected shortfall curves as in Figure 2, this time for fixed income returns. Again, the relatively small difference between the narrow and broad portfolios expands as the horizon extends, although the gap does not appear to grow to the same extent as in the equity case. The expected shortfall decreases from 22 to 17 percentage points at the 60-month horizon, reflecting a significant gain from diversification, albeit a more modest improvement relative to the equities case.

Figure 3: 5 Percent Expected Shortfall for Narrow vs Broad Portfolios over 1- to 60-month Horizons – Fixed Income

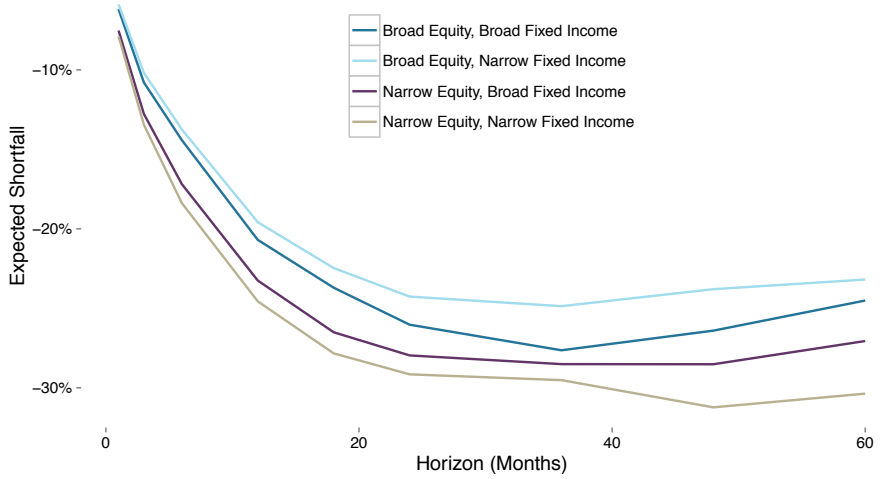


Next, we consider the impact of international diversification within the context of a multi-asset portfolio. Using the same methodology, we estimate expected shortfall curves by horizon for a portfolio containing 60 percent equities and 40 percent fixed income. Figure 4 shows the expected shortfall curves for each multi-asset alternative. Given the improvement in expected shortfall seen earlier for broad relative to narrow portfolios in equity and fixed income markets, we might expect an improvement within the multi-asset context as well. Indeed, compared to the narrow-only case, diversification of either the equity or the fixed income component improves the expected shortfall for all horizons. However, we observe a deterioration in expected shortfall when comparing the broad equity and broad fixed income portfolio with the broad equity, narrow fixed income case.[10]

9 These findings are similar to Asness, Israelov and Liew (2011). Our results are quite comparable to their findings based on equally-weighted global portfolios, whereas in our analysis we use value-weighted returns. They show in their paper that the value-weighted portfolio produces weaker results, primarily due to the large weight of the US in their data set. Indeed, in our analysis, the difference between narrow and broad portfolios is larger when using equally-weighted portfolios, but the reasonably strong performance of the value-weighted portfolio is likely to reflect the broader range of countries included in our analysis.

10 For the fixed income narrow and broad comparisons, and in the multi-asset context, the inclusion of Greece within the developed market perspectives somewhat improves the case for the broad fixed income portfolio. This is due to very large negative returns on Greek government bonds during the euro sovereign debt crisis, while the global fixed income portfolio experiences relatively mild losses during the Greece sample period. The exclusion of Greece worsens the case for a broad fixed income portfolio and remains consistent with a weaker case for fixed income.

Figure 4: 5 Percent Expected Shortfall for Narrow vs Broad Portfolios over 1- to 60-month Horizons – 60 Percent Equity, 40 Percent Fixed Income



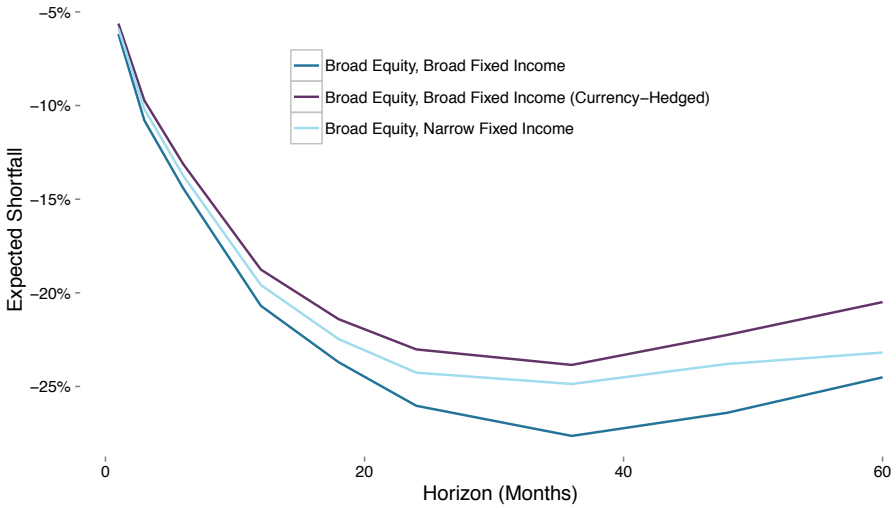
There are a several explanations for why the inclusion of a globally diversified fixed income portfolio alongside a diversified equity portfolio does not lead to an improvement in expected shortfalls across horizons in our sample. First, the deterioration partly results from currency volatility that is common to both the global equity and global fixed income portfolios, which are both unhedged against currency movements. When one asset class within the portfolio is already diversified, the international diversification of the other asset class introduces correlated currency movements across the asset classes, which acts to increase the total variability of the portfolio and worsen expected shortfalls.[11] Figure 5 demonstrates this effect, by showing the expected shortfall curves of the fully global multi-asset portfolio when removing currency risk from the fixed income portfolio. When removing currency risk from fixed income returns, the expected shortfall profile improves and moves above the case with a more narrowly defined fixed income component. It is worth noting that the underperformance of the broad-broad portfolio is robust to the relative allocations to equity and fixed income. However, when the fixed income allocation is greater than the equity allocation, the portfolio with narrow equity and broad fixed income produces the most favourable expected shortfall. This suggests that, given an already diversified component that comprises the majority of the portfolio, diversification of the smaller component leads to a worsening of expected shortfall due to unhedged currency effects. The deterioration in shortfall from fixed income diversification is therefore partly a consequence of the 60-40 equity and fixed income portfolio composition.

As noted earlier, following the Asness, Israelov and Liew (2011) methodology implicitly assumes that the relevant measurement currency for the fund is a single currency. Given the importance of currency measurement in the multi-asset comparisons, Appendix B provides a robustness check of our findings when using an alternative, wider currency measurement of portfolio returns. We estimate the equivalent 60-40 multi-asset expected shortfall where the narrow and broad portfolio returns are measured in a small basket of currencies, based on the randomly drawn country groups. Under this more

11 Co-movement between currency movements and equity and fixed income returns may also act to increase risk, although the overall effect may vary quite substantially based on which country perspective is used.

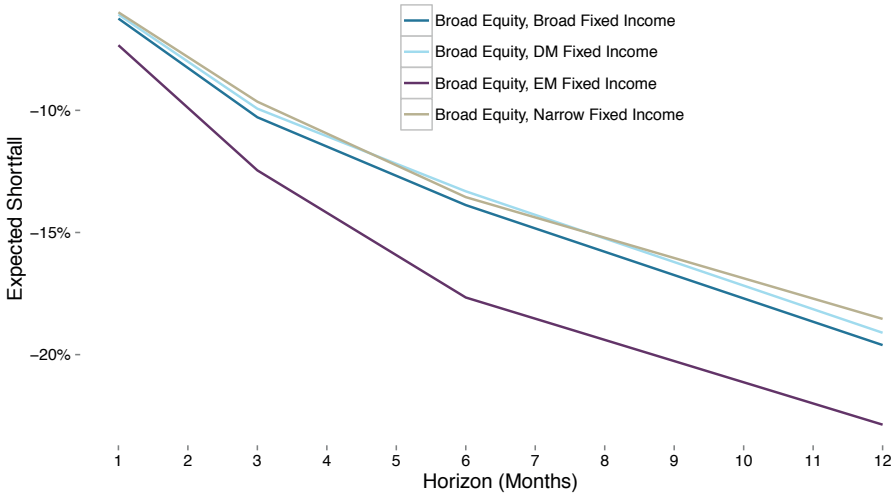
general approach, there remains a case for diversification of the equity and fixed income components relative to the narrow-only case, and diversifying the fixed income component in the presence of a diversified equity component still leads to a deterioration in expected shortfall.

Figure 5: 5 Percent Expected Shortfall for Narrow vs Broad Portfolios over 1- to 60-month Horizons – 60 Percent Equity, 40 Percent Currency-Hedged Fixed Income



In addition to correlated currency returns across asset classes, some components of an internationally diversified fixed income portfolio may lead to increases in multi-asset portfolio risk, through positive co-movement with international equity returns. For example, it is well documented that fixed income returns for emerging market countries tend to be positively correlated with global equity markets (see, for example, Du, Pflueger and Schreger (2016)).[12] To explore this effect, Figure 6 shows multi-asset expected shortfall curves when including a diversified fixed income component that is either global, as before, or restricted to developed markets (DM) or emerging markets (EM).

Figure 6: 5 Percent Expected Shortfall for Narrow vs Broad Portfolios over 1- to 12-month Horizons – 60 Percent Equity, 40 Percent DM or EM Fixed Income



12 The distinction between "developed" and "emerging" is one simple way of distinguishing between fixed income portfolio components. Additional classifications, for example based on debt- or current account-to-GDP ratios, could similarly be used to group countries and identify differences in co-movement.

The DM and EM cases represent multi-asset portfolios where the fixed income component comprises a GDP-weighted portfolio of developed and emerging market countries, respectively. Analysis of longer-term expected shortfalls is difficult in this context, due to data limitations in emerging market returns. It is important that we align the sample periods across the global, developed and emerging market curves, to ensure that differences in sample periods do not drive differences across the various portfolios. This means that we must restrict the sample to the period post-1997, where return series are available for the majority of emerging markets across equity and fixed income markets. Given the shorter sample period, we also restrict the shortfall curves to a 12-month horizon.

The chart shows that the addition of emerging market fixed income to a globally diversified equity portfolio leads to a deterioration in the multi-asset expected shortfall over horizons up to 12 months, consistent with positive equity exposure of EM fixed income.[13] This is also consistent with Lettau, Maggiori and Weber (2014), who explore the exposure of various portfolios to large declines in the market. They show that their "downside beta" measure – the market beta of portfolio returns conditional on market returns being below a certain threshold – is able to account for differences in expected returns across portfolios, in particular for currency portfolios sorted on interest rates.

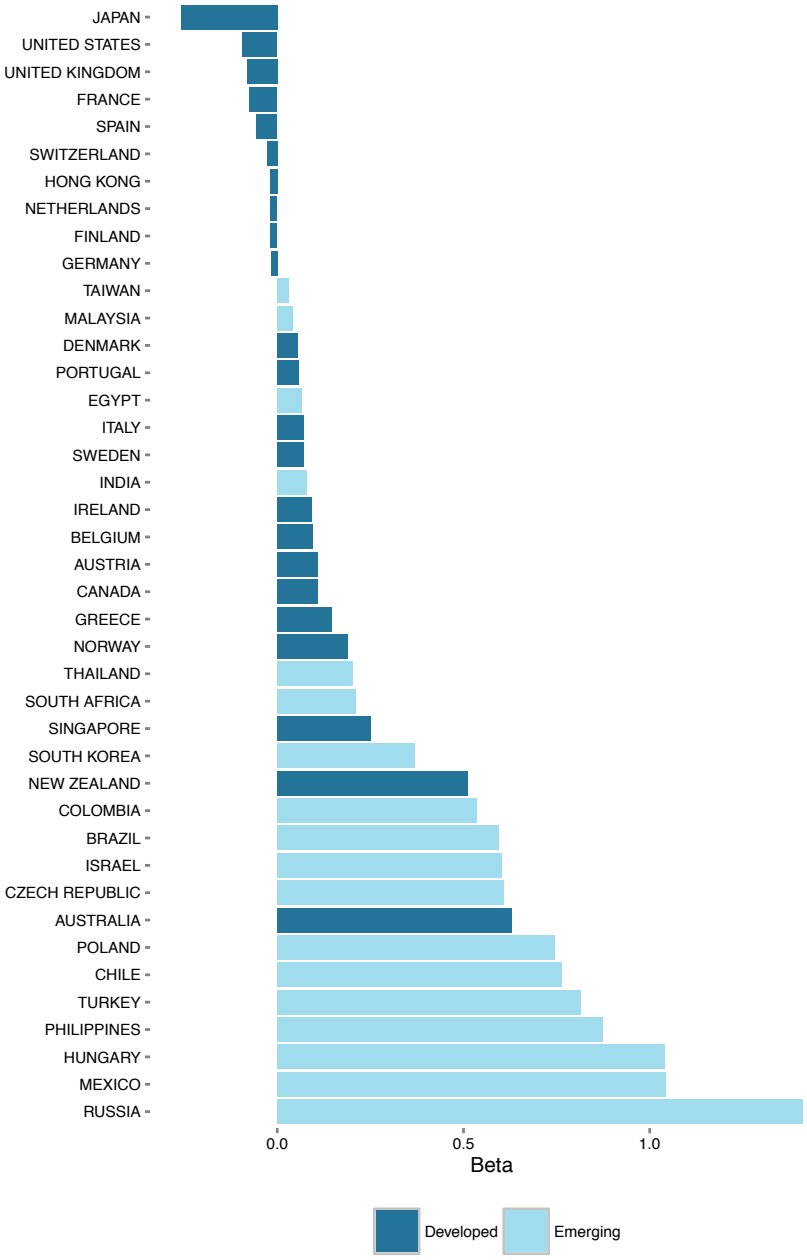
Figure 7 shows the downside beta of fixed income returns by country in our data set. Following Lettau, Maggiori and Weber (2014), we estimate the US equity market downside beta of currency-unhedged fixed income returns.[14] We find higher downside betas for emerging markets on average, consistent with the preceding analysis showing that an emerging market fixed income basket worsens the expected shortfall of a multi-asset portfolio. It is worth noting that, while the expected shortfall of the multi-asset portfolio appears to worsen with emerging market fixed income over the 12-month horizon, it may be the case that higher expected returns justify the inclusion of these assets in portfolio construction. While higher expected returns may indeed be reflected in the shortfall curves, their influence may be more prominent over longer horizons. For our relatively short sample, however, estimation of longer-horizon expected returns is more challenging.[15]

13 It is also well known that the equity beta of US fixed income returns has varied over time, and may have been positive for much of our sample, turning negative in the period since the late-1990s (Campbell, Plueger and Viceira, 2015, NBIM, 2016). It is plausibly the case, abstracting from currency risk in unhedged fixed income returns, that developed market fixed income returns could have added risk to a multi-asset portfolio over the sample period since 1950.

14 Conditional on returns 1 standard deviation below the sample average. Fixed income returns are in excess of the US Treasury bill rate, implying that returns include variation in foreign exchange rates. Indonesia is excluded due to a low number of available observations.

15 For more on the risk and return profile of the carry trade, see NBIM (2014).

Figure 7: Downside Beta of Country Fixed Income Returns



Overall, the analysis in this section suggests that there are benefits to international diversification over longer horizons in both equity and fixed income markets. There appear to be nuances across asset classes, however, in particular in our findings for multi-asset portfolios. Our results suggest that there is little gain from diversification of the fixed income allocation in the presence of a large diversified equity component. In the next section, we provide a framework for considering how correlations may change over longer horizons, and then proceed to empirically identify longer-term diversification effects.

4. Long-term Diversification: A Framework

As shown in the previous section, the benefits of diversification, at least in the short term, depend on the correlation across asset returns. While correlation estimates across international equity and fixed income markets have increased over time, these estimates are based on short-term market co-movement. When considering a longer-term perspective, analysis of short-term diversification benefits might be misleading.[16]

For a long-term investor, the extent to which cross-country returns are correlated remains relevant, although when considering portfolio risk over longer horizons, there are conditions under which high short-term correlations may be less detrimental to the benefits of diversification. Intuitively, the extent to which correlations persist over longer horizons depends on whether co-movement is driven by persistent or transitory components of returns. In this section, we follow Viceira, Wang and Zhou (2017) in providing a framework for understanding diversification effects over longer horizons. For simplicity, we outline and calibrate an illustrative exercise using decompositions of country-level *equity* returns, although the underlying intuition can equally be applied to fixed income markets. In the next section, we expand the return decomposition framework to fixed income.

In a present-value setting, equity prices can be expressed as a function of the expected future cash flows that accrue to the equity holder, for example expected future dividend payments, and the discount rate applied to these cash flows. In this framework, it follows that changes to equity prices result from either changes in expected future cash flows or changes in discount rates. A commonly used formalisation of this intuition is provided in Campbell (1991), where unexpected equity returns, $h_{t+1} - E_t[h_{t+1}]$, can be decomposed into revisions to expected future cash flows and discount rates:

$$h_{t+1} - E_t[h_{t+1}] = (E_{t+1} - E_t)\left\{\sum_{j=0}^{\infty} \beta^j \Delta d_{t+1+j} - \sum_{j=1}^{\infty} \beta^j h_{t+1+j}\right\}$$

Unexpected returns arise from changing expectations of future dividends, d_t, commonly referred to as "cash flow news", or from changing expected returns, h_t, commonly referred to as "discount rate news". We label the news components as follows:

$$N_{CF,t+1} = (E_{t+1} - E_t)\sum_{j=0}^{\infty} \beta^j \Delta d_{t+1+j}$$

$$N_{DR,t+1} = (E_{t+1} - E_t)\sum_{j=1}^{\infty} \beta^j h_{t+1+j}$$

$$h_{t+1} - E_t[h_{t+1}] = N_{CF,t+1} - N_{DR,t+1}$$

16 The short-term analysis applies equally to longer horizons if discount rates are constant over time, although there is a significant body of research suggesting that this is not the case.

Using this decomposition, we can consider international return correlations in terms of the correlated components of returns. In this framework, it follows that correlations across countries arise from correlated cash flow news, correlated discount rate news, or the cross-correlations of the two components. The motivation for considering cross-country correlations in terms of news components is that, over long horizons, correlated cash flow components can have different implications for portfolio risk, compared to correlated discount rate components. We use simulations to illustrate this cash flow and discount rate news distinction. We generate returns from the following system for a set of five hypothetical countries:

$$h_{t+1}^{i} = X_{t}^{i} + \varepsilon_{t+1}^{i}$$

$$X_{t+1}^{i} = \varphi_{0} + \varphi_{1} X_{t}^{i} + u_{t+1}^{i}$$

These equations describe the dynamics of returns for a given country *i*, where the parameters are fixed across each country, such that any differences across simulations are driven by cross-country correlations only. Country returns, h_{t+1}^{i}, are a function of their expected return, X_{t}^{i}, a mean-reverting state variable, and their unexpected return, ε_{t+1}^{i}.[17]

Using these dynamics, cash flow and discount rate news by country *i* can be derived as follows:

$$N_{CF,t+1}^{i} = \varepsilon_{t+1}^{i} + \left(\frac{\rho}{1-\varphi_{1}}\right) u_{t+1}^{i}$$

$$N_{DR,t+1}^{i} = \left(\frac{\rho}{1-\varphi_{1}}\right) u_{t+1}^{i}$$

where ρ is a number a little less than 1. The degree to which the return shock, ε_{t+1}^{i}, has a permanent or transitory effect on the value of the asset depends on the contemporaneous realisation of u_{t+1}^{i}. If u_{t+1}^{i} is equal to zero, the return shock is entirely attributed to cash flow news, which does not revert in the future (i.e. it is a permanent shock). On the other hand, if there is a large corresponding (negative) u_{t}^{i} shock, the return shock is primarily driven by discount rate news, the effect of which dissipates over time (i.e. it is a transitory shock).

Given the dynamics for returns within each simulated country, we can control the nature of cross-country correlations, i.e. whether correlations result from correlated cash flow or discount rate news. As shown in the above expressions, cross-country cash flow news correlations are determined by co-movement in return shocks, ε_{t+1}^{i}, and state variable shocks, u_{t+1}^{i}, whereas discount rate correlations are determined by co-movement in state variable shocks only. We set up the overall shock co-variance matrix in such a way that the co-variance matrix for *within*-country returns and state variables

17 The state variable can be thought of as a predictor of equity returns such as the price-earnings ratio. We calibrate the parameter values in line with the US CAPE, setting $\varphi_{1} = 0.8$, and hold these values fixed across each country i. We set return volatility equal to 16 percent and calculate the variance of return shocks, ε_{t+1}^{i}, and state variable shocks, u_{t+1}^{i}, based on an annual predictive regression, R^{2} of 10 percent, also fixed across countries.

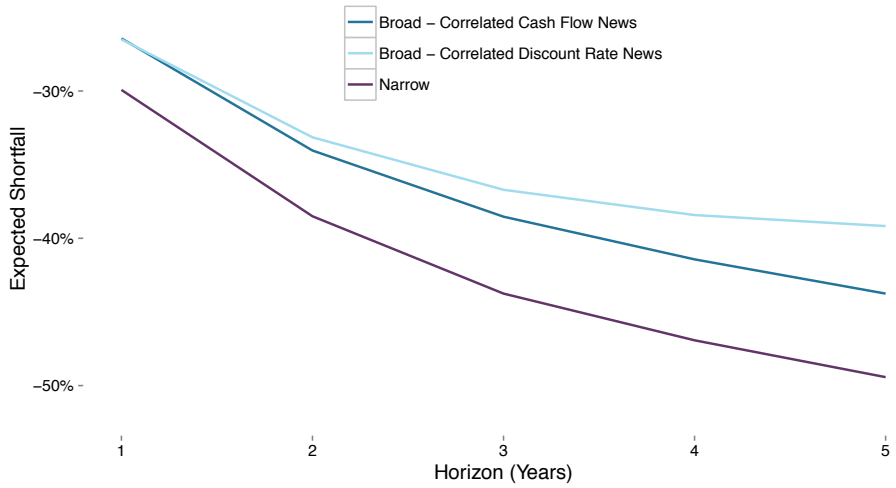
is identical across countries. We then consider two different cases for the cross-country components of the shock co-variance matrix:

Case 1: Returns are correlated across countries primarily due to correlated cash flow news

Case 2: Returns are correlated across countries primarily due to correlated discount rate news

We calibrate the co-variance between either the return or state variable shocks to generate high cross-country return correlations that are the same across each country pair. We simulate 50,000 return series, five years in length, for each of the five markets, under both cases. For each case, we construct an equally-weighted portfolio return series to represent international diversified portfolios. Following the earlier analysis, we draw comparisons between narrow and broad portfolios using simulated returns to aid interpretation of the empirical analysis. We compare the equally-weighted broad portfolios with a narrow portfolio containing a single country. Figure 8 shows the expected shortfall by horizon under the two cases relative to a narrow portfolio case.

Figure 8: Expected Shortfall by Horizon of Simulated Narrow and Broad Portfolios under Alternative Correlation Cases



Given imperfectly correlated cross-country returns, h^i_{t+1}, there is an improvement in expected shortfall when diversifying across the simulated countries. For one-period expected shortfalls, the expected shortfalls across the two cases are the same, by construction.[18] As the horizon is extended to the longer term, however, there are diverging implications of the two cases. When co-movement in discount rate news terms, $N^i_{DR,t+1}$, is the primary driver of high return correlations, the expected shortfall improves relative to the case when cash flow co-movement dominates. This is an implication of the return-generating system over longer horizons, where discount rate shocks do not persist, implying less correlated long-term returns. The more transitory nature of discount rate shocks implies that they play a small role

18 This results from cross-country correlations and the variance of equity returns being fixed at the same values in each of the two cases.

in portfolio variance over longer horizons, and consequently the correlation of transitory components also matters less in longer-term expected shortfall estimates.[19]

This stylised simulation highlights the importance of the distinction between cash flow and discount rate news correlations in driving cross-country return correlations over the longer term. The expected shortfall curves in Section 3 can be viewed as empirical estimates of the simulated shortfall curves, and their profiles potentially offer some tentative guidance on the relative roles of cash flow and discount rate co-movement in return correlations. In the previous section, across the shortfall estimates for equity and fixed income returns, we observed a more pronounced divergence between narrow and broad portfolios in equities compared to fixed income. These profiles are similar to the growing gap between the two cases in the simulation framework. The differing empirical profiles across the equity and fixed income comparisons is therefore consistent with alternative sources of co-movement within the two asset classes, with discount rate co-movement potentially more important in equity return correlations.[20] We return to this hypothesis in the next section, where we try to empirically identify the relative roles of cash flow and discount rate co-movement in equity and fixed income returns directly.

5. Decomposing Correlations: Cash Flow and Discount Rate Co-movement

The previous section used simulations to describe the conditions under which international return correlations may persist over long horizons, distinguishing between co-movement in cash flow and discount rate news. We showed that if discount rate co-movement dominated short-term cross-country return correlations, then high correlations would become less of an issue as the horizon is extended, leading to an improvement in long-term relative to short-term diversification benefits. It is possible to *estimate* the decomposed cash flow and discount rate news components of equity and fixed income returns and to address this question directly.

In this section, we use a model to estimate the relative roles of these components in long-term risks to global equity and fixed income portfolios. We use a VAR model that describes the short-term dynamics of returns, which can then be used to infer longer-horizon return dynamics. The advantage of this approach is that we are able to explore return correlations over very long horizons, which was not possible in the

19 If return correlations were driven entirely by correlated discount rate shocks, the correlated discount rate case would eventually converge on a case where returns are uncorrelated.

20 Clearly, the use of estimated shortfall curves allows for significant nuances and differences relative to the simulation framework. In the empirical analysis, more countries are included in the broad (value-weighted) portfolio. In addition, as mentioned earlier, there is evidence that international correlations are not fixed over time, and the empirical shortfall curves allow for this feature of the data.

analysis in Section 3 due to data limitations. We continue to use the return decomposition framework set out in the previous section, for both equities and fixed income. We proceed to provide a brief overview of the return decompositions, further details of which are included in Appendix C.

iv. Return Decompositions: Equity and Fixed Income

For equity returns, the unexpected excess return, $e_{t+1} - E_t[e_{t+1}]$, can be expressed in terms of cash flow news, $N_{d,t+1}$, and expected return news, $N_{h,t+1}$:

$$e_{t+1} - E_t[e_{t+1}] = N_{d,t+1} - N_{h,t+1}$$

This is the same decomposition as in the previous section, except in terms of excess returns.[21] A similar decomposition can be applied to excess fixed income returns, f_{t+1}.

$$f_{t+1} - E_t[f_{t+1}] = -N_{\pi,t+1} - N_{b,t+1}$$

For nominal bonds, the cash flow news component of returns, $N_{\pi,t+1}$, is in the form of shocks to the expected real value of future payments, through variation in expected future inflation. Unexpected returns are also a function of expected return news, $N_{b,t+1}$. In order to obtain estimates of the news components for equity and fixed income returns, a model is required. We follow a large literature that uses VAR models to decompose returns (see Campbell, 1991; Campbell and Ammer, 1993; Ammer and Mei, 1996; Campbell and Vuolteenaho, 2004; and Viceira, Wang and Zhou, 2017). These studies assume that returns are generated using a first-order VAR:

$$z_{t+1} = a + \Gamma z_t + u_{t+1}$$

z_{t+1} is a state vector including asset returns and variables that help to describe dynamics of returns.

$$z_t = \{e_t, f_t, r_t, \Delta i_t \ ts_t, pe_t, rb_t\}$$

This model is a broader, empirical implementation of the return-generating system described in the previous section. The z_{t+1} vector includes the h^i_{t+1} returns for equity and fixed income markets (although measured in excess of local Treasury bill rates) and a range of variables that proxy the X^i_{t+1} state variable. These include the short-term real interest rate, r_t, the change in the nominal short-term interest rate, Δi_t, the term spread, ts_t, the smoothed price-earnings ratio, pe_t and the relative bill rate, rb_t. Additional details for these variables are provided in Appendix C. The Γ matrix then describes the

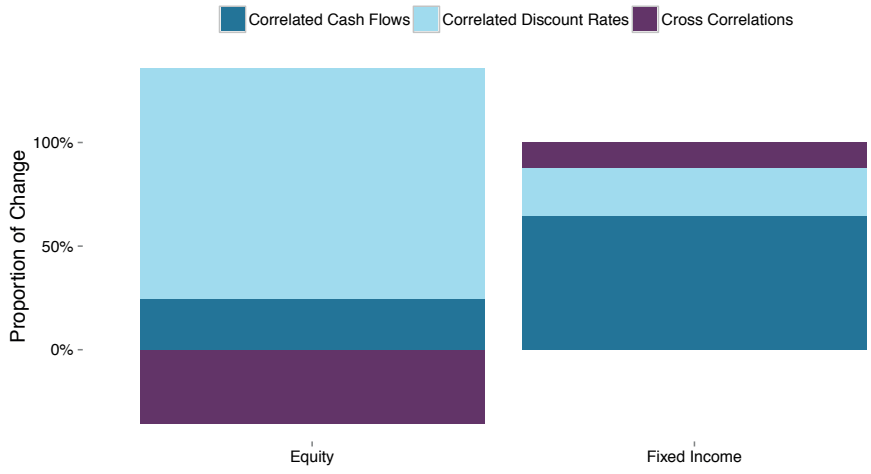
21 We work with excess returns in this section, as opposed to total returns in the simulated return decomposition. As a result, the decomposition is expressed with a separate news terms for risk-free rates, but for our purposes we re-combine excess return and risk-free rate news into a total discount rate news variable. See Appendix C for details.

relationship across returns and state variables analogous to the β, φ_0 and φ_1 parameters in the simulation exercise. In this setting, revisions to expectations implied by the model are used as proxies for the return news components.

We estimate a pooled VAR model where the Γ matrix is fixed across countries.[22],[23] This VAR specification also implies constraints on the available data for estimation. For the VAR analysis, we restrict the estimation sample to start from 1982, and narrow the range of countries for which we decompose returns. We include Australia, Belgium, Canada, Denmark, France, Germany, Japan, the Netherlands, Sweden, Switzerland, the UK and the US in the VAR model.

As shown in Figure 1, international correlations have been increasing over time in both equity and fixed income markets. With the decomposed return components, we first ask what accounts for the rise in equity and fixed income correlations over time. We divide the sample period into two halves, 1982-1999 and 2000-2016, where the average pairwise country correlation increased from 0.51 to 0.70 in equity markets and from 0.46 to 0.63 in fixed income markets. Following Viceira, Wang and Zhou (2017), we attribute these increases to changes in correlations of the decomposed components, details of which are provided in Appendix C. Figure 9 shows the relative contributions of correlated cash flows and discount rates, and the cross-correlation across the news terms.

Figure 9: Contribution of Correlated Cash Flow and Discount Rate News to Change in Average Equity and Fixed Income Correlation between 1982-1999 and 2000-2016



The decompositions highlight differing roles of cross-country cash flow and discount rate co-movement in the increasing average correlations within

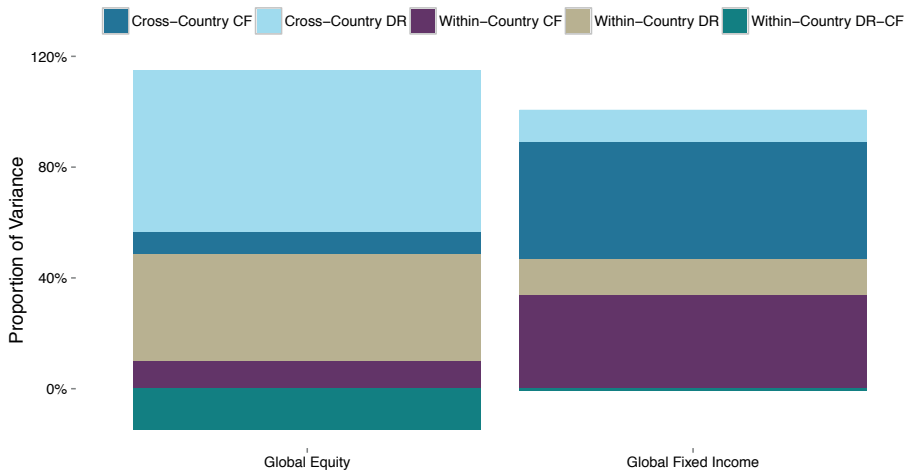
22 Ideally, we would include all country returns across equity and fixed income individually within a VAR model, but such a model would include a large number of parameters and would be difficult to estimate. It should also be noted that the performance of these VAR models can be quite sensitive to the choice of state variables, see the discussion in Chen and Zhao (2009) and Engsted, Pedersen and Tanggaard (2012).

23 As shown in Viceira, Wang and Zhou (2017), returns taken in excess of local Treasury bill rates are hedged against currency movements. We choose to abstract from currency movements in order to avoid having to estimate a very large VAR model including all country unhedged returns, or alternatively needing to average over multiple VAR models. In this context, excess returns also allow us to avoid taking a stance on a single country perspective from which to view the return decomposition.

equity and fixed income returns. For equities, the majority of the increase is attributed to higher co-movement between the discount rate components of returns across countries. For fixed income, on the other hand, the majority of the increase is attributed to increased co-movement between the cash flow news components.[24] Based on the insights from the framework outlined in Section 4, the long-term increase in equity market correlations can be considered less detrimental to international diversification benefits from the point of view of a long-term investor, due to the transitory nature of discount rate news.[25] Since the increase appears to be discount-rate-driven, the higher co-movement is more transitory in nature and, over the longer term, less of an issue for risk. For fixed income returns, however, the larger role of cash flow news implies that the increase in cross-country correlations may be viewed as more persistent, and suggests that longer-term international diversification benefits in fixed income have deteriorated.

While the decompositions suggest different roles of cash flow and discount rate correlations in the increase in cross-country correlations, the simulation framework implies that we should be also be concerned with the *absolute* contribution of each component. It could be the case that the distinction across equity and fixed income we observed for the correlation change does not apply to the level decompositions. To explore this issue, we form value-weighted global equity and fixed income portfolios, and decompose the total variance of these portfolios into within- and cross-country co-variance contributions.[26] Given the observed increase in correlations over time, we focus on the 2000-2016 period. Figure 10 shows the relative contributions.[27]

Figure 10: Contribution of Correlated Cash Flow (CF) and Discount Rate (DR) News to Global Equity and Global Fixed Income Portfolio Variance (2000-2016)



The chart shows a similar picture to the decomposition of the change in correlations. Again, when it comes to cross-country return co-movement,

24 This is consistent with the literature documenting a large global component in inflation rates across countries and its increasing importance over time, see Wen and Wang (2007), Mumtaz, Simonelli and Surico (2011), Neely and Rapach (2011) and Henriksen, Kydland and Sustek (2013).

25 In the VAR system, we estimate an autoregressive coefficient on the CAPE ratio of 0.99 in monthly data. Using shocks to the CAPE ratio as an approximation of discount rate shocks, this implies that transitory discount rate shocks in the estimated model have a half-life of around five years.

26 We fix country weights over time at their average value over the sample.

27 Cross-correlations are omitted, and the remaining values rescaled to sum to 100 percent.

the co-variance terms in global equity portfolio variance are dominated by discount rate co-movement. For the global fixed income portfolio, cash flow news co-movement plays a larger role. These findings are consistent with the suggested explanations for the different shortfall curve profiles across equity and fixed income shown in Section 3. The discount-rate-driven higher co-movement in equity returns is again consistent with a more transitory deterioration in international diversification benefits, leading to less of a longer-term issue with regard to portfolio risk for long-term investors. There is a different picture in fixed income, where, in absolute terms, a larger part of cross-country fixed income co-movement would be expected to persist over the longer term.

6. Summary

The upward trend in co-movement across country equity and fixed income returns suggests that the case for international diversification has weakened. We explore this issue, concentrating on the perspective of a long-term investor. Intuitively, the extent to which diversification benefits deteriorate for long-term investors depends on whether the drivers of short term correlations are persistent or transitory. Using a stylised simulation, we show that there is a distinction between correlations driven by cash flow and discount rate co-movement. International correlations driven by discount rate co-movement are more transitory, while correlations driven by cash flow co-movement are more persistent.

Using a data set of developed and emerging market equity and fixed income total returns, we assess the case for international diversification by comparing narrowly diversified portfolios to globally diversified portfolios over multi-period horizons. For both equity and fixed income portfolios, the relative performance of narrow and globally diversified portfolios diverges as the return horizon is extended, where we find benefits from international diversification within both asset classes. In a multi-asset portfolio context, there is little gain from diversification of the fixed income allocation in the presence of a diversified equity component, when the equity component is the larger component in the portfolio. This results from correlated currency returns in the diversified portfolios, and in part from positive correlations between emerging market fixed income and equity returns in the more recent period.

The divergence between globally diversified and narrow portfolios is less pronounced for fixed income than for equity portfolios, consistent with a larger role for cash flow co-movement in fixed income correlations, and a larger role for discount rate co-movement in equity correlations. We confirm that this is the case by estimating the return components directly and decomposing the variance of global portfolios. As a result, equity market correlations may be considered more transitory and less of an issue for portfolio risk over longer horizons. For fixed income returns, however, these findings suggest cross-country correlations are more persistent, and imply a reduction in diversification benefits also from a longer-term perspective.

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Appendix A: Data Description

Throughout this note, we use a data set compiled from multiple sources that contains country-level equity and benchmark government bond fixed income total return indices. The majority of the data are obtained from Global Financial Data, including equity and fixed income total returns, consumer price indices, nominal GDP series, 3-month Treasury Bill rates and foreign exchange rates.

The sample history covers the period from January 1950 to December 2016, although the start dates vary by series and by which country is under consideration. The table below shows the sample start dates by country. Samples are restricted across equity and fixed income return availability, as well as nominal GDP and equity market capitalisation availability.

Table A1: Sample Start Dates by Country

Country	Start Date	Country	Start Date
Australia	31/01/1970	Japan	31/03/1950
Austria	31/01/1970	Malaysia	31/12/1974
Belgium	31/12/1956	Mexico	31/01/1995
Brazil	31/07/1997	Netherlands	31/01/1970
Canada	31/03/1950	New Zealand	31/07/1986
Chile	28/02/1993	Norway	28/02/1970
Colombia	31/07/1998	Philippines	30/09/1996
Czech Republic	31/03/1997	Poland	31/01/1994
Denmark	31/01/1970	Portugal	29/02/1988
Egypt	31/01/1995	Russia	31/12/1996
Finland	31/12/1975	Singapore	31/12/1987
France	31/12/1950	South Africa	31/12/1960
Germany	31/12/1951	South Korea	31/12/1970
Greece	30/09/1992	Spain	31/12/1950
Hong Kong	31/01/1970	Sweden	31/12/1950
Hungary	28/02/1997	Switzerland	28/02/1966
India	31/01/1988	Taiwan	31/01/1995
Indonesia	31/01/1994	Thailand	31/12/1979
Ireland	29/02/1988	Turkey	31/01/1994
Israel	30/11/1993	United Kingdom	30/04/1950
Italy	31/01/1970	United States	31/03/1950

Unless otherwise stated, equity and fixed income returns are expressed in real terms, adjusted using CPI inflation rates, and returns are not hedged against foreign exchange movements. Fixed income returns refer to 10-year benchmark government bond indices, although the effective maturity will be shorter for a number of emerging markets. Nominal GDP and equity capitalisation data are denominated in US dollars.

Where equity index histories for a given country are unavailable or have a relatively short history, equity returns from MSCI country indices are used.

This is the case for the Czech Republic, Egypt, Norway and Brazil. Similarly, fixed income returns for Brazil, Colombia, Egypt, Indonesia, Turkey, Poland and Peru are obtained from J.P. Morgan.

Perspectives are based on FTSE country classifications. In order to be included on the list, a country must have been classified as a developed market for more than half of the period for which classifications are available.

Table A2: Developed Market Perspectives

Australia	Japan
Austria	Netherlands
Belgium	New Zealand
Canada	Norway
Denmark	Portugal
Finland	Singapore
France	Spain
Germany	Sweden
Hong Kong	Switzerland
Ireland	United Kingdom
Italy	United States

Table A3: Equity and Fixed Income Weights in Broad Equity and Fixed Income Portfolios (at End of Sample)

	Equity (%)	Fixed Income (%)		Equity (%)	Fixed Income (%)
Australia	1.9	2.2	Japan	10.5	8.5
Austria	0.0	0.7	Malaysia	0.8	0.5
Belgium	0.8	0.8	Mexico	0.7	1.7
Brazil	0.6	3.4	Netherlands	0.8	1.3
Canada	4.1	2.8	New Zealand	0.0	0.3
Chile	0.5	0.4	Norway	0.2	0.7
Colombia	0.2	0.5	Philippines	0.5	0.5
Czech Rep.	0.0	0.3	Poland	0.3	0.8
Denmark	0.4	0.5	Portugal	0.1	0.4
Egypt	0.1	0.3	Russia	1.2	2.3
Finland	0.5	0.4	Singapore	1.4	0.5
France	4.4	4.3	South Africa	2.0	0.6
Germany	3.4	6.0	South Korea	2.7	2.5
Greece	0.1	0.3	Spain	1.4	2.1
Hong Kong	0.9	0.6	Sweden	1.4	0.9
Hungary	0.0	0.2	Switzerland	2.9	1.2
India	3.3	3.8	Taiwan	1.8	1.0
Indonesia	0.9	1.6	Thailand	0.9	0.7
Ireland	0.1	0.5	Turkey	0.4	1.3
Israel	0.4	0.6	United Kingdom	6.9	4.4
Italy	0.5	3.2	United States	40.2	34.3

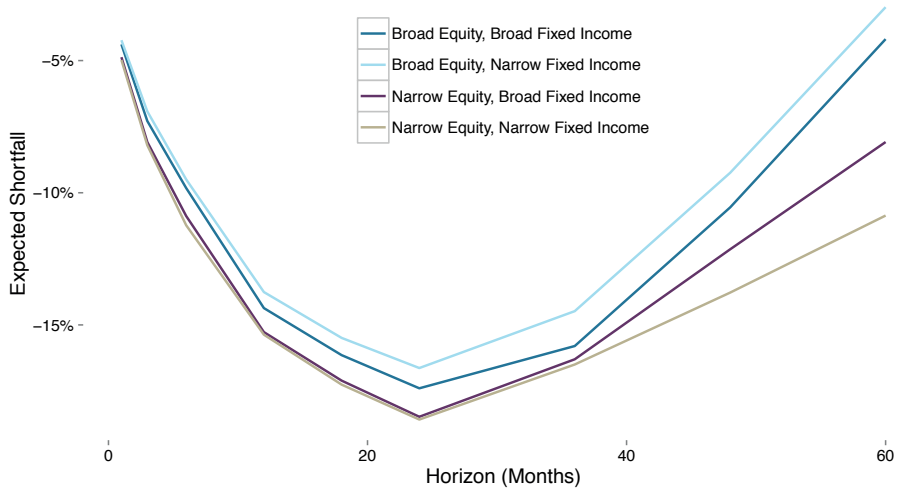
Appendix B: Currency Measurement Robustness

We repeat the analysis in Figure 4, where the narrow portfolio contains three GDP-weighted developed market returns, measured in local currency. The broad portfolio contains the full range of value-weighted countries as before, but measured in the currencies contained in the narrow portfolio.

The selection of multiple countries leads to a reduction in the total number of observations relative to the analysis in the main text, since the return series of the narrow and broad portfolios need to shorten to the shortest of the three series within the narrow portfolio. Given the reduction in sample sizes, we increase the expected shortfall to 10 percent, although the results are qualitatively similar under the 5 percent bound. We limit the basket to three countries, since a greater number leads to a very large number of possible combinations.

This analysis asks whether an investment portfolio with a broader set of currencies provides diversification benefits relative to a narrow portfolio matched to a hypothetical currency basket for the GPFG. We attempt to remain agnostic over the exact composition of the appropriate currency basket. We draw 10,000 randomly picked currency sets and calculate the average shortfall by horizon.

Figure B1: 10 Percent Expected Shortfall for Narrow vs Broad Portfolios over 1- to 60-month Horizons – 60 Percent Equity, 40 Percent Fixed Income



Appendix C: Return Decompositions and VAR Specifications

This section outlines the return identities that underlie the VAR return decompositions. Following Campbell (1991), excess unexpected equity returns can be expressed in terms of revisions to expectations of future dividend growth, Δd_{t+1+j}, excess returns, e_{t+1+j}, and risk-free real interest rates, r_{t+1+j}:

$$e_{t+1} - E_t[e_{t+1}] = (E_{t+1} - E_t)\left\{\sum_{j=0}^{\infty}\beta^j \Delta d_{t+1+j} - \sum_{j=1}^{\infty}\beta^j e_{t+1+j} - \sum_{j=1}^{\infty}\beta^j r_{t+1+j}\right\}$$

$$N_{d,t+1} = (E_{t+1} - E_t)\sum_{j=0}^{\infty}\beta^j \Delta d_{t+1+j}$$

$$N_{e,t+1} = (E_{t+1} - E_t)\sum_{j=1}^{\infty}\beta^j e_{t+1+j}$$

$$N_{r,t+1} = (E_{t+1} - E_t)\sum_{j=1}^{\infty}\beta^j r_{t+1+j}$$

$$e_{t+1} - E_t[e_{t+1}] = N_{d,t+1} - N_{e,t+1} - N_{r,t+1}$$

Following Campbell and Ammer (1993), a similar decomposition can be applied to nominal bonds with a constant maturity of ten years (*n = 120*). Unexpected excess fixed income returns, $f_{t+1} - E_t[f_{t+1}]$, are a function of news on expected future inflation, π_{t+1+j}, excess returns, f_{t+1+j}, and real interest rates, r_{t+1+j} :

$$f_{t+1} - E_t[f_{t+1}] = (E_{t+1} - E_t)\left\{\sum_{j=1}^{n-1}\rho^j \pi_{t+1+j} - \sum_{j=1}^{n-1}\rho^j f_{t+1+j} - \sum_{j=1}^{n-1}\beta^j r_{t+1+j}\right\}$$

$$N_{\pi,t+1} = (E_{t+1} - E_t)\sum_{j=1}^{n-1}\rho^j \pi_{t+1+j}$$

$$N_{f,t+1} = (E_{t+1} - E_t)\sum_{j=1}^{n-1}\rho^j f_{t+1+j}$$

$$N_{rf,t+1} = (E_{t+1} - E_t)\sum_{j=1}^{n-1}\rho^j r_{t+1+j}$$

$$f_{t+1} - E_t[f_{t+1}] = -N_{\pi,t+1} - N_{f,t+1} - N_{rf,t+1}$$

We distinguish between risk-free rate news in equity and fixed income returns due to the finite vs. infinite maturity difference in the two asset classes. In the analysis, we collect the excess return and risk-free rate news terms into discount rate news terms:

$$N_{h,t+1} = N_{e,t+1} + N_{r,t+1}$$

$$N_{b,t+1} = N_{f,t+1} + N_{rf,t+1}$$

We assume return dynamics are described by a first-order VAR:

$$z_{t+1} = a + \Gamma z_t + u_{t+1}$$

The following variables are included in the VAR state vector:

Equity / Fixed Income Excess Returns: Monthly local currency return in excess of the local Treasury bill rate

Real Interest Rate: Monthly Treasury bill rate less realised inflation

Change in Nominal Short Rate: Monthly change in 3-month Treasury bill rate

Term Spread: 10-year benchmark government bond yield less 3-month Treasury bill rate

Smoothed Price-Earnings Ratio: Equity price divided by 10-year average of real earnings

Relative Bill Rate: Monthly Treasury bill rate divided by average over last 12 months of Treasury bill rates

The news terms can be calculated using the VAR estimates, see Appendix B in Campbell and Ammer (1993) for details.