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ABSTRACT

Investor confidence and risk tolerance are important concepts that investors are constantly trying to gauge. Yet these concepts are notoriously hard to measure in practice. Most attempts rely on price or return data, but these run into trouble when trying to disentangle whether an observed price change is attributable to a shift in investor confidence or a change in fundamental value. In this paper, we take an alternative approach by looking at the world-wide holdings and trading of risky assets. We model global capital markets as the interaction between large global institutional investors and smaller domestic investors from each country. This permits separation of global price changes into two components, one that reflects changes in demand and fundamentals perceived by all investors, and a second that reflects changes in the relative risk tolerance of institutional investors over and above that of domestics. The latter component, changes in relative risk tolerance of global institutions, is driven by the willingness of these investors to acquire additional assets in each country in proportion to their current holdings. Using our model, we show how data on asset holdings and flows across countries can be used to identify changes in risk tolerance. We then apply this identification scheme to recent data on the global portfolio holdings of institutional investors. The resulting measure of risk tolerance impressionistically accords well with periods of market turbulence and quiescence. It also accounts for a considerable portion of the variation in portfolio holdings and is informative about future returns.

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1 Introduction

Each time there is a major change in global equity prices, investors naturally wonder how to interpret it. Was it attributable to a change in investor confidence (i.e., risk tolerance or sentiment)? If investors have less tolerance for risk, then presumably equity prices fall. However, this is not the only conclusion one can draw from a price decline. One sensible alternative is that a fall in asset fundamentals may have been responsible. That is, expected future cashflows may have declined, or the systematic risk of future cashflows may have increased. Another alternative is that the price change was attributable to a change in investor wealth. For example, a decline in future wage income reduces wealth and may undermine investors' willingness to hold stocks.[1]

With the supply of shares constant in the short run, one or more of the elements of investor demand—risk tolerance, wealth, and expectations of future fundamentals— must change if prices are to fall. To successfully extract a measure of risk tolerance from the data, it is necessary to distinguish among these competing factors. This is particularly difficult because both investor confidence and asset fundamentals cannot be directly observed. As a result, large and widespread price changes generate considerable disagreement as to their source. Good examples would include the 'bubble' in technology stock prices at the end of the last decade, or the Asian crisis of the mid-to-late-1990s.[2]

Our approach to identifying investor confidence focuses on the behavior of market participants, rather than on price changes. We do this by allowing for heterogeneity between global institutions and domestic retail investors, so that they trade with one another. Specifically, we model the global capital-market equilibrium as having different types of investors: domestic investors from individual countries who hold only local risky assets and a global risk-free asset (e.g., US Treasury bills), and a single type of global investor who can trade any and all assets. In this setup, when global institutional investors are buying assets from a given country, smaller domestic investors from that country are selling. In equilibrium, these investors trade with each other because of changes

[1] Our focus in this paper is on investor confidence—defined as risk tolerance—and not necessarily on notions of investor sentiment discussed by many economists. Most approaches to modeling sentiment take investor risk tolerance as fixed, assuming instead that investor expectations depart from those of a rational investor. These approaches are equivalent if there is only one risky asset. For example, in DeLong, Summers, Shleifer, and Waldmann (1990), sentiment shocks affect the expectations of one group of investors, pushing prices away from a rational level. Shocks to this group's expectations under constant risk preferences are isomorphic to shocks to the group's risk tolerance under rational expectations.

[2] Corsetti, Pesanti and Roubini (1998), Kaminsky and Schmukler (1999) argue that the price changes in multiple countries represented shifts in underlying fundamentals. Kyle and Xiong (2002) argue that wealth effects were an important propagation mechanism. Forbes and Rigobon (1999) and Rigobon (2001) hold that the covariance matrix of shocks fundamentally changed.

in their views about asset fundamentals (expected returns and risk at current prices), changes in their relative wealth, or changes in their relative risk tolerance.

We assume that all investors observe a fundamental shock in each country, a component of which is common across investors. This common component may also be correlated across countries or regions. Because these shocks affect all investors symmetrically, they move prices but create no incentives for trade. Such price changes therefore cannot be interpreted as a change in relative risk tolerance. However, these price changes can be arbitrarily correlated across countries and regions.

In addition to the common shock, each type of investor also observes his or her own perceived country-specific fundamentals shock. Unlike the common shock, there are differences in these shocks across global and domestic investors. These shocks therefore generally lead to both trading as well as price changes. From the perspective of a given investor, investor-specific shocks may be correlated across countries in a region, but, critically, not across regions. So, for example, global investors may learn something that causes them to revise upward their expected returns for one country, or all countries in a region, and therefore, all else equal, to purchase assets from that region's domestics. Anything global investors may learn that affects their expected returns simultaneously across all countries is assumed to be common across investors, not investor-specific.

With this setup, purchases by global investors that are common across all countries can come from only two possible sources: changes in wealth or changes in risk tolerance. These two sources are easily separated given the structure of our model. Because each security can be held by only one investor type other than the global investors, it is possible to measure all types of investors' wealth by observing total market capitalization and the holdings of global investors only. Subject then to an assumption about the form of investors' utility functions, we can isolate shocks to wealth. The remaining portion of the common component in purchases by global investors is the change in investor risk tolerance.

The common component across countries of global investor trades we wish to measure is a proportional one. That is, we look for a common component in purchases *as a fraction of global investor holdings in that country.* This is because changes in risk tolerance should affect holdings equiproportionately. To see this, consider what happens if, all else equal, institutional investors' risk tolerance declines. These investors would then sell risky assets in proportion to their initial holdings. This pattern of selling is very different from what would take place if expected fundamentals changed randomly across regions. In such a case, we might at any given time, observe institutional investors are on average selling across countries. However, the selling would be proportional to the declines in expected fundamentals, and not proportional to prior holdings.[3]

Our ability to identify changes in risk preferences relies on the empirical measurement of institutional investors' evolving positions and trades. We observe directly the wealth and positions of a large group of international institutional investors. The data are from State Street Corporation (SSC), and they encompass approximately one eighth of all globally tradable securities. We use these data to measure the demand by institutional investors for equity securities in 29 markets, both developed and emerging, over the period January 1996-July 2003. Using our model and the portfolio flow and holding information of this group of institutional investors, we can identify shifts in relative investor confidence.

Our approach to confidence can be compared to, and contrasted with, a very vast literature on investor sentiment. Sentiment, broadly interpreted usually means that investor expectations depart from full rationality. In other words, most economists modeling sentiment let expectations of at least one group of investors wander, but take risk tolerance as fixed. We do the opposite, in that we let risk tolerance of one group of investors wander, and instead assume that the cross-country components of expectations are common across investors. These two approaches can appear equivalent if there is only one risky asset. For example, in Delong, Summers, Shleifer, and Waldmann (1987), sentiment shocks affect the expectations of one group of investors, pushing prices away from a rational level as these investor buy or sell assets. The same price movement and trading could result if these investors' expectations were to remain constant, and instead their risk tolerance were to change. Thus, for a single risky asset there is no observational distinction between confidence and sentiment.

With multiple risk assets, however, investor confidence and sentiment depart. Confidence—or risk tolerance—is a property of the investor's preferences, and not at all related to the asset. Sentiment, however, is specific to both the investor and the asset, in that an investor may simultaneously have positive sentiment about some assets and negative sentiment about others. Nevertheless, with multiple assets, any common component of an investor's purchases relative to their holdings can be interpreted either as a confidence or sentiment shock, since there is no meaningful distinction between them.

[3]This equiproportionate property is a feature of many standard investor demand specifications, such as constant absolute risk aversion (CARA) and constant relative risk aversion (CRRA). Changes in prices are often associated with, and used to measure, changes in risk tolerance—see for example Eichengreen, Hale and Mody (2000) and Kumar and Persaud (2001). As with our approach, this is motivated by the equilibrium implications of the original Tobin Separation theorem, set out by Sharpe (1964) and Lintner (1965). Brennan (1989) provides a clear exposition. In a one-period setting, equilibrium prices equal $(\bar{P} - \theta\Sigma\mathbf{1})/r$, where $\bar{P}$ represents end-of-period prices, θ is risk-tolerance, Σ is the covariance matrix, and r is the risk-free rate. If θ changes, the vector of equilibrium prices changes by $-\Sigma\mathbf{1}/r$. Only in special cases (e.g., unchanging fundamentals with an identity covariance matrix) will this produce equal returns across assets, and, therefore, cross-sectional price changes that are consistent with a change in risk tolerance.

The paper is organized as follows. Section 2 provides a simple model exploiting our identification scheme and demonstrating how we decompose changes in observed asset allocation for a group of investors. Section 3 describes the data. Section 4 estimates the various components of demand, including investor risk tolerance, by means of the Kalman filter. Specifically, we use the Kalman filter to retrieve a latent common component from the asset allocation data. The technique is similar to that used by the National Bureau of Economic Research in determining concurrent conditions of the U.S. economy. Finally, Section 5 characterizes the various components and their relationship to returns.

2 Asset demand

2.1 The components of equilibrium investor demand

Define investor demand D_j as the desired allocation of wealth W to country j,

$$D_j \equiv \frac{P_j Q_j}{W}, \tag{2.1}$$

where P_j and Q_j are the price and desired quantity of shares held from country j. This implies that percentage changes in demand can be written as

$$\widehat{D}_j = \widehat{Q}_j + \widehat{P}_j - \widehat{W}, \tag{2.2}$$

where the "hat" notation is used to signify log changes.

The task at hand is to decompose the right-hand side of Equation (2.2) into its fundamental components. Note that with a representative agent model (which assumes that all investors have identical holdings), $\widehat{Q}_j = 0$, so that changes in demand are determined by changes in prices and wealth only. Prices and wealth are observable, making representative agent demand easy to estimate. However, it is impossible to determine whether an observed change in price is attributable to a change in the risk appetite of the representative investor or a change in expected risk and return (given initial prices). In the case of heterogeneous agents, however, we can hope to identify changes in the preferences of one group versus another. We do this by making some assumptions about the information each group receives and by observing how ownership of risky assets changes over time.

Equation (2.2) can be decomposed with an asset pricing model that connects demand to risk tolerance, perceived return and risk. In the case of the international CAPM with a single world consumption basket and CRRA utility, demand is proportional to relative risk tolerance and expected returns, and inversely proportional to the covariance matrix of returns:

$$D_j = \theta \boldsymbol{\Sigma}_j^{-1} \boldsymbol{\mu}, \tag{2.3}$$

where θ is risk tolerance, $\boldsymbol{\Sigma}_j^{-1}$ is the jth row of the inverse of the country-return covariance matrix, and $\boldsymbol{\mu}$ is the expected excess return vector. In this model, as in many others, changes to demand emanate from proportionate changes in both risk tolerance and perceived asset-return moments. As an alternative preference specification, we can consider the equilibrium under CARA utility, in which case

$$D_j = (\theta/W) \boldsymbol{\Sigma}_j^{-1} \boldsymbol{\mu}. \tag{2.4}$$

For now, we leave open the importance of wealth effects across markets by specifying demand as

$$D_j = (\theta/W^{\gamma}) \boldsymbol{\Sigma}_j^{-1} \boldsymbol{\mu}, \tag{2.5}$$

where γ can vary from 0 (CRRA) to 1 (CARA). Hence the percentage change in the desired allocation to country j can be written as

$$\widehat{D}_j = \widehat{\theta} - \gamma \widehat{W} + \widehat{\boldsymbol{\Sigma}_j^{-1}} \boldsymbol{\mu}. \tag{2.6}$$

Note that over short horizons, γ is likely to be close to one. We return to this point below.

If shocks to *ex ante* country risk or return were uncorrelated with one another, any common component of returns would necessarily be attributable to changes in risk aversion, γ. In that case, Equations (2.2) and (2.6) would be sufficient to identify changes in investor risk tolerance. We could estimate a single factor model of the cross-section of country demands, associate the estimated factor with $(\widehat{\theta} - \gamma \widehat{W})$, and leave the country-specific residuals to account for $\widehat{\boldsymbol{\Sigma}_j^{-1}} \boldsymbol{\mu}$. Essentially, we could measure change in risk aversion from price changes without the ambiguity discussed above.

Of course, the assumption that fundamentals are uncorrelated across countries is not realistic. That is the underlying reason why return data alone are inadequate for measuring investor confidence. Worldwide shocks to expected returns and risk are very important. The presence of this common component in fundamentals confounds the identification of pure risk tolerance changes in the equations above. To see this, consider the sharp drop in prices recorded globally in 2001. Is it right to attribute this to a universal decline in risk-tolerance, or to a systematic reduction in the expected future earnings of assets, especially those in technology-related industries? It is not possible to obtain the answer from the equations above, since we have not introduced any way of separating shocks to investor confidence from systematic shocks to fundamentals.

With a little more structure, however, it is possible to control for common shocks to fundamentals, and, therefore, to be able to identify changes in risk tolerance. To add structure, we allow for two groups of investors in each country —internationals (I) and locals (L). The key assumption is that international investors are free to diversify across countries, but local investors hold only combinations of their own domestic risky assets and the riskless asset. Under this specification, locals' trades with foreigners represent a reallocation of local wealth between the local market and the riskless asset.[4] Thus, we assume Equation (2.6) applies to both internationals and locals, although locals face restrictions on the assets that they can hold.

The supply of country j's risky assets is fixed at $\overline{Q}_j$. This supply is held only by internationals and locals from country j itself:

$$\overline{Q}_j = Q_{I,j} + Q_{L,j}. \tag{2.7}$$

Imposing this equilibrium on the earlier demand equations, we can express equilibrium changes in holdings and prices as:[5]

$$\widehat{Q}^*_{I,j} = \left[(\widehat{D}_{I,j} - \widehat{D}_{L,j}) + (\widehat{W}_I - \widehat{W}_{L,j})\right] \frac{Q_{L,j}}{\overline{Q}_j} \tag{2.8}$$

$$\widehat{P}^*_j = \left[(\widehat{D}_{I,j} - \widehat{D}_{L,j}) + (\widehat{W}_I - \widehat{W}_{L,j})\right] \frac{Q_{I,j}}{\overline{Q}_j} + \widehat{D}_{L,j} + \widehat{W}_{L,j}. \tag{2.9}$$

The first equation says that net purchases by foreigners, $\widehat{Q}^*_{I,j}$, are driven by internationals' excess demand over locals, and by internationals' excess wealth changes, $(\widehat{D}_{I,j} - \widehat{D}_{L,j}) + (\widehat{W}_I - \widehat{W}_{L,j})$, weighted by the holdings share of locals, $\frac{Q_{L,j}}{\overline{Q}_j}$. If locals' holdings are small, they will have already sold out to internationals, so further reallocations are, all else equal, small from internationals' point of view.

The second equation shows that price changes contain these same excess demand and excess wealth terms. However, price changes are not driven so much by excess demand and wealth, as by the level of demand and wealth. As a result, this equation contains an additional component, $\widehat{D}_{L,j} + \widehat{W}_{L,j}$, which is the change in domestics' demand and wealth. The equations say that when there is an improvement in the fundamental outlook, all investors' demands increase (at existing prices). Prices rise, but this does not require an inflow of international ownership into local markets. This happens only when internationals' demands increase by more than locals' demands.

[4] In the simplest international equilibrium, purchasing power parity holds, so that all investors share the same consumption basket. In this case, if there is a riskless asset whose return delivers predictable consumption, it applies to all investors.

[5] From Equation (2.1), the equilibrium price is (dropping j subscripts) $P^* = (D_I W_I + D_L W_L)/\overline{Q}$. Totally differentiating, $\widehat{P}^* = (\widehat{D}_I + \widehat{W}_I)(Q_I/\overline{Q}) + (\widehat{D}_L + \widehat{W}_{L,j})(Q_L/\overline{Q}) = [(\widehat{D}_I - \widehat{D}_L) + (\widehat{W}_I - \widehat{W}_{L,j})](Q_I/\overline{Q}) + \widehat{D}_L + \widehat{W}_{L,j}$. $\widehat{Q}^*_I$ follows directly.

In the equilibrium, the key quantity is $\left[(\widehat{D}_{I,j} - \widehat{D}_{L,j}) + (\widehat{W}_I - \widehat{W}_{L,j})\right]$, the wealth-adjusted excess demand of internationals *relative* to locals. Since this is a relative measure, any shock to expected returns and risk that is global—i.e., shared by both internationals and locals — will be "netted out," and the remaining common component of $\widehat{Q}_j$ will reflect only changes in internationals' relative wealth or risk tolerance. Thus, an overall improvement in underlying global fundamentals will positively affect prices though $\widehat{D}_{L,j} + \widehat{W}_{L,j}$. Since this improvement has no impact on the *relative* wealth-adjusted demands of internationals, there is no impact on relative holdings, $\widehat{Q}^*_{I,j}$.

To see this differently, express international and local demand as

$$\widehat{D}_{I,j} = \widehat{\theta}_I - \gamma \widehat{W}_I + \eta_j + \nu_{I,j} \tag{2.10}$$

$$\widehat{D}_{L,j} = \widehat{\theta}_L - \gamma \widehat{W}_{L,j} + \eta_j + \nu_{L,j}, \tag{2.11}$$

where η_j is a global shock to demand shared by locals and internationals, and the ν_j terms are investor-specific residuals. Global changes in fundamentals are picked up by η_j. Then equations (2.9) and (2.8) become

$$\widehat{Q}^*_{I,j} = \left[(\widehat{\theta}_I - \widehat{\theta}_L) + (1-\gamma)(\widehat{W}_I - \widehat{W}_{L,j}) + (\nu_{I,j} - \nu_{L,j})\right] \frac{Q_{L,j}}{\overline{Q}_j} \tag{2.12}$$

$$\widehat{P}_j = \left[(\widehat{\theta}_I - \widehat{\theta}_L) + (1-\gamma)(\widehat{W}_I - \widehat{W}_{L,j}) + (\nu_{I,j} - \nu_{L,j})\right] \frac{Q_{I,j}}{\overline{Q}_j} + \widehat{\theta}_L - (1-\gamma)\widehat{W}_{L,j} + \eta_j + \nu_{L,j}. \tag{2.13}$$

Equation (2.12) says that changes in holdings depend on relative changes in risk tolerance and wealth, $(\widehat{\theta}_I - \widehat{\theta}_L) + (1-\gamma)(\widehat{W}_I - \widehat{W}_{L,j})$, plus an error term, $(\nu_{I,j} - \nu_{L,j})$. These changes affect all assets in the international portfolio and can therefore be identified from the cross-section of portfolio reallocations. This is the strategy we pursue in Section 4. Notice that prices cannot be used in the same way. Equation (2.13) contains the additional terms $\widehat{\theta}_L - (1-\gamma)\widehat{W}_{L,j} + \eta_j + \nu_{L,j}$ and includes the common shocks to fundamentals, η_j. Prices respond to any global shock to demand shared by locals and internationals. The source of this shock could be a change in global fundamentals (i.e., an loosening of major-country monetary policy), a change in common risk appetite, or a common change in wealth. Price changes alone cannot determine the source of the shock. It is in this sense that holdings data is much more potent than price data for the purposes of measuring risk appetite.

2.2 Cross-correlation and short-run dynamics

The schema laid out above ignores two stylized facts about real-world holdings and portfolio flow data. The first is that flows tend to be cross-sectionally correlated across regions. The second is that flows tend to be persistent over time, rather than random. These facts are documented in Froot, O'Connell and Seasholes (2001) and Griffin, Nardari and Stulz (2002), and together they necessitate some modifications to the basic model.

From Equation (2.12), regional correlation in flows cannot arise from shifts in risk appetite or wealth, since these would affect all countries simultaneously. Nor can it be driven by covariation in the common beliefs about country risk and return shared by both internationals and locals, since the term η_j does not appear in the holdings equation.[6] Instead, it must arise from cross-sectional correlation in the relative assessments of risk and return by internationals and locals, captured in $\nu_{I,j} - \nu_{L,j}$. For example, if international investors become more bullish about Asia as a whole than domestic Asian investors, then flows into individual Asian countries would be correlated, even after accounting for global shocks. To allow for such regional comovement, we allow for separate regional covariation in $\nu_{I,j} - \nu_{L,j}$ in the estimation stage below.

The observed persistence of flows deserves somewhat more thought. If we think of the holding horizon as relatively long, then by the law of iterated expectations, short-term updates in expected returns and expected covariances should be unpredictable. Changes in expected returns and risk should therefore be serially uncorrelated. The same seems sensible for shocks to risk tolerance. However, unlike returns and wealth changes, raw changes in portfolio holdings are highly positively autocorrelated in high frequency data. Typically, once initiated, portfolio rebalancings are persistent for between three and five weeks.

Such persistent behavior could of course be rational. It is certainly rational for traders with private information. Large traders can maximize the value of their private information by breaking up desired portfolio changes over time and thereby hiding their private information about value. In effect, their demands are less detectable if they substitute current trades for future trades to hide amongst more random transactions by uninformed investors.[7]

There are other potential reasons for persistent flows and sluggish adjustment in holdings. For example, it is well known that, based on risk and return alone, the optimal level of international diversification is much higher than it appears historically (i.e., there is a "home bias" in investor portfolios). Over time, it seems that the degree of "home bias" has consistently diminished. The

[6] Of course, co-movement among the η_j terms is the likely driver for the very high levels of *price* co-movement within regions.

[7] Note that in most market-microstructure models with this property (e.g., Kyle 1985), informed order flow is not *un*conditionally autocorrelated; the autocorrelation is conditional on the information. This is not the case with the actual flow data, which appear unconditionally autocorrelated. However, in the real world, market makers can't detect all international investor flows across markets and apart from the local investor flows. In effect, this makes aggregate order flow less than perfectly observable, which is the assumption in Kyle.

undoing of this initial home bias may partially account for the persistence in flows. Agency issues which lead managers to anchor their asset allocations partly on peer-portfolio concerns would also suggest a slow adjustment toward otherwise desired levels.

A third possible explanation for the observed short-term dynamics is that risk tolerance itself adjusts with some stickiness. There is less in the way of theory to support this explanation. However, it is possible that new information about risk might both change current prices and cause follow-on trading demand. For example, the large changes in asset prices that accompanied the Russian default in August 1998 caused many investors to update their beliefs about the riskiness of the credit markets. Prices fell as anticipated volatility rose. But the higher levels of volatility then created additional, follow-on sales by institutions that have risk (or VAR) budgets. This may have magnified future negative price changes and volatilities, leading to persistence in flows.

Together these explanations suggest that we ought to allow for serial correlation in both $\nu_{I,j} - \nu_{L,j}$ and in risk tolerance θ_I. The Kalman filter, which we use to estimate the model in Section 4, is well-suited to this purpose. It allows us distinguish the importance of each type of persistence.

3 Data

The data used to estimate the model are provided by State Street Corporation, one of the world's largest investor services providers. State Street clients are primarily large institutional global money managers, and the total of all funds serviced by the Corporation is currently USD 8.5 trillion, approximately 16 percent of total global assets. Given the nature and sophistication of this globally footloose client base, we identify all SSC clients as "International" investors for the purpose of estimating the model. Our sample covers the period from January 1996–July 2003, and encompasses both the flows and holdings of this client group in 29 equity markets. The country coverage is shown in Table 1.

The percentage change in international holdings for a given country and day is calculated as the dollar flow for that day divided by the dollar holdings as of the previous day:

$$\widehat{Q}_{I,j,t} = \frac{F_{I,j,t}}{P_{j,t-1} Q_{I,j,t-1}}, \tag{3.1}$$

where $F_{I,j,t}$ is the flows of internationals into country j. Implicit here is the assumption that flows take place at the start of the day—the quantity $F_{I,j,t} / \ P_{I,j,t-1}$ is purchased at price $P_{I,j,t-1}$. An alternative assumption would be that the flows $F_{I,j,t}$ take place at the end of the day, and are priced at $P_{I,j,t}$, but in practice the difference between the two definitions is very small. Weekly changes in holdings are calculated as the sum of the daily percentage changes. Table 1 below presents some descriptive statistics for our countries and regions as of June 30th, 2003: MSCI market capitalization and the percentage of this market capitalization held by the internationl investors in our sample, the mean weekly percentage change in holdings and the standard deviation of the weekly change in portfolio holdings.

A key ingredient in the model is the foreign ownership share. To capture this we measure holdings as a share of market capitalization in each country over time. We use MSCI's measure of market capitalization, adjusted to control for the recent implmentation of MSCI's Enhanced Methodology.[8] This share will underestimate foreign ownership by a factor equal to SSC's share of the global custody marketplace. However, this turns out not to matter very much for our analysis, since it is the *relative* international share across countries that is the key driver, not the absolute level. Accordingly we make no adjustment for market share. We do, however, wish to mute some of the "within variation" across the country shares, the idea being that the dispersion of ownership shares reported by SSC may be partly driven by idiosyncratic factors.[9] Toward this end, we average the individual country foreign ownership share with the global mean foreign ownership share in calculating our estimate.

[8]The MSCI Enhanced Methodology adjusts the market capitalization of index constituents for free float and targets for index inclusion 85% of free float-adjusted market capitalization in each industry group and in each country. The Enhanced Methodology was implemented in two phases. The first, on November 30, 2001, reduced the measured market capitalization of the developed countries in our sample by an average of 6.6%, and that of emerging markets in our sample by an average of 21%. The second phase, on May 31, 2002, reduced developed country market capitalization by an average of 4.7% and emerging markets capitalization by 29%. Accordingly, we scale down our market capitalization prior to both adjustment dates to avoid any discrete change in the series. See `www.msci.com` for details.

[9]For example, SSC tends to service a disproportionate share of Anglo-Saxon investors.

Table 1: Descriptive statistics on portfolio holdings, January 1996–June 2003

Country	Market capitalization $bn, May 2002	Percentage in dataset %, May 2002	Mean weekly holdings change %	St. dev. weekly holdings change %
		(a) Developed countries		
Australia	300	8.21	0.20	0.45
Canada	371	14.80	0.33	0.74
Eurozone	1962	6.09	0.22	0.43
Japan	1190	5.25	0.28	0.48
New Zealand	13	10.67	-0.03	0.66
Norway	26	6.68	0.08	0.83
Sweden	124	7.43	-0.16	0.94
Switzerland	439	5.86	0.27	0.62
United Kingdom	1581	7.02	0.19	0.36
United States	8358	16.43	0.19	0.18
		(b) Latin America		
Argentina	4	2.43	-0.12	1.42
Brazil	47	6.08	0.46	1.43
Mexico	47	6.49	0.08	1.33
Peru	3	3.90	-0.17	1.22
		(c) East Asia		
Hong Kong	89	9.57	0.07	0.89
India	27	7.79	0.37	0.95
Indonesia	9	8.61	0.13	0.85
Korea	118	7.14	0.57	1.31
Malaysia	32	4.60	-0.09	0.83
Philippines	4	8.50	0.22	0.91
Singapore	47	11.18	0.19	0.63
Taiwan	76	5.67	0.68	1.27
Thailand	14	11.60	0.30	0.88
		(d) Emerging Europe		
Czech Republic	3	7.37	-0.07	0.82
Hungary	6	9.35	0.23	1.19
Poland	8	3.94	0.12	1.21
Turkey	8	3.93	0.11	1.47
		(e) Other Emerging		
Israel	26	11.57	0.51	1.48
South Africa	82	4.09	0.33	0.55

Descriptive statistics for holdings data as of June 30th, 2003. The change in holdings for a given day is calculated as the dollar flow for that day divided by the dollar holdings as of the previous day—i.e. the assumption is that flows take place at the start of the day. Weekly changes in holdings are the sum of the daily changes.

4 Risk tolerance

4.1 Methodology

As discussed, Equation (2.12) applies to each country in the sample. We use a factor model to extract $\left[(\widehat{\theta}_I - \widehat{\theta}_L) + (1-\gamma)(\widehat{W}_I - \widehat{W}_{L,j})\right]$ from the cross-section of the data. In particular, we estimate a single factor model of the form

$$\widehat{Q}_{I,j}\frac{\overline{Q}}{Q_{L,j}} = a_j + r_t + u_{j,t}, \quad j = 1, \ldots, N, \tag{4.1}$$

where the a_j are country-specific means, r_t is the common factor capturing the effects of *relative* wealth and risk tolerance on all country exposures, and $u_{j,t} \equiv \widehat{\nu}_{I,j} - \widehat{\nu}_{L,j}$ are the orthogonalized residuals driven by idiosyncratic fundamentals. To cater to the presence of cross-sectional and serial correlation, we allow r_t and $u_{j,t}$ to have autoregressive dynamics, and the residuals to covary within regions.

To gauge the amount of persistence present in the data, we look first at the sample partial autocorrelation functions of the data. The partial autocorrelation at one lag is significant for all 26 countries. As the lags increase, the number of significant statistics declines: 16 at lag 2, 10 at lag 3, 8 at lag 4, 5 at lag 5, and 2 at lag 6.[10] This suggests that adjustment can take up to 5 weeks, and accordingly we allow for up to fifth-order dynamics in r_t and $u_{j,t}$.

To estimate r_t, we use a framework very similar to that used in Stock and Watson (1991). Let $\boldsymbol{\xi}_t$ capture the state of demand at time t:

$$\boldsymbol{\xi}_t = [r_t \;\; u_{1,t} \;\; u_{2,t} \;\; \cdots \;\; u_{N,t}]'. \tag{4.2}$$

The elements of $\boldsymbol{\xi}_t$ each have $AR(p)$ dynamics, and disturbances that are cross-sectionally related within regions:

$$\boldsymbol{\xi}_t = \boldsymbol{\Phi}_1\boldsymbol{\xi}_{t-1} + \boldsymbol{\Phi}_2\boldsymbol{\xi}_{t-2} + \ldots + \boldsymbol{\Phi}_p\boldsymbol{\xi}_{t-p} + \boldsymbol{\epsilon}_t, \tag{4.3}$$

where the $\boldsymbol{\Phi}$ matrices are diagonal matrices containing the autoregressive parameters, and $\boldsymbol{\epsilon}_t$ is distributed as

$$\boldsymbol{\epsilon}_t \sim N(\mathbf{0}, \boldsymbol{\Sigma}), \tag{4.4}$$

[10] Results available from the authors on request.

with

$$\mathbf{\Sigma} = \begin{bmatrix} \sigma_r & 0 & 0 & \cdots & 0 \\ 0 & \mathbf{\Sigma}_1 & \mathbf{0} & \cdots & \mathbf{0} \\ 0 & \mathbf{0} & \mathbf{\Sigma}_2 & \cdots & \mathbf{0} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & \mathbf{0} & \mathbf{0} & \cdots & \mathbf{\Sigma}_5 \end{bmatrix}.$$

The sub-matrices $\mathbf{\Sigma}_1$ through $\mathbf{\Sigma}_5$ are the covariance matrices for our five regions identified in Table 1. In each case, the diagonals capture country variances, and the off-diagonals capture within-region covariation. To avoid over-parametrization, we assume that the correlation between all countries in a region is the same.

With $\boldsymbol{\xi}_t$ as the state vector, we can set up the data-generating process in state space form by adding the observation equation

$$\mathbf{y}_t = \mathbf{a} + \mathbf{H}'\boldsymbol{\xi}_t, \tag{4.5}$$

where

$$\begin{aligned} \mathbf{y}_t &= \left[\widehat{Q}_{I,1}\frac{\overline{Q}}{Q_{L,1}} \;\; \widehat{Q}_{I,2}\frac{\overline{Q}}{Q_{L,2}} \;\; \cdots \;\; \widehat{Q}_{I,N}\frac{\overline{Q}}{Q_{L,N}} \right]', \\ \mathbf{a} &= [a_1 \;\; a_2 \;\; \cdots \;\; a_N]', \\ \mathbf{H} &= \begin{bmatrix} 1 & 1 & \cdots & 1 \\ 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 \end{bmatrix}. \end{aligned}$$

4.2 Results

We estimate the model for autoregressive lags of $p \in \{1, \ldots, 5\}$. The likelihood ratio statistics for the nested models reject $p = 5$ in favor of $p = 4$ at the 1% level, but fail to reject $p = 4$ in favor of $p < 4$ at any reasonable significance level. In addition, they fail to reject regional correlation in favor of no regional correlation.[11] Accordingly, we set $p = 4$. The key results are displayed in Table 2.

The most striking finding is the persistence of the relative risk tolerance and wealth factor r_t. The sum of its four autoregressive parameters is 0.89. The coefficients imply that a change in r_t can remain in evidence for quite some time: even after three months, 22 per cent of any shock will still be present. The idiosyncratic dynamics for each country are also persistent, though to a lesser

[11] These likelihood ratio tests are available from the authors on request.

degree—the sum of the first four autoregressive coefficients averages 0.49 across the countries. The fact that these idiosyncratic dynamics are present suggests that some of the stickiness we observe in real world flows is country-specific.

Recall from Equation (2.12) that the common factor is a hybrid of both risk tolerance and relative wealth. If r_t is to be interpreted purely as changes in risk appetite, the influence of wealth must be accounted for. Note first that, over short horizons, γ is likely to be close to one, in which case no adjustment is necessary. The most compelling evidence for this is that the volatility of ex post returns, and hence wealth, is much higher than the volatility of holdings. If CRRA investors were adjusting their holdings optimally in response to wealth changes, then from Equation (2.4), each series would have roughly the same percentage volatility. Instead, holdings are about one fifth to one quarter as volatile as wealth at the weekly frequency, implying that the elasticity of demand with respect to wealth is well below unity. Indeed, given that a portion of holdings volatility comes from shifts in relative moments $\nu_{I,j} - \nu_{L,j}$, the short run value of γ is likely to be above 0.75.

Having said this, we wish to allow for some elasticity of holdings with respect to wealth. To accomplish this we subtract an estimate of each period's percentage change in wealth, scaled by the local ownership share, from both sides of Equation (2.12). Note that this adjustment is country specific—for country j, we need to adjust by the percentage increase in the wealth of internationals—W_I—over and above the percentage increase in the wealth of locals—$W_{L,j}$. To simplify the calculation of this relative shift, we consider only equity wealth. Specifically, for country j, the adjustment is calculated as the percentage change in international's total equity holdings, less the percentage change in the market capitalization of country j.

Table 2: Estimated common factor model based on U.S. investor holdings August 1994–July 2002

Series	ϕ_1	ϕ_2	ϕ_3	ϕ_4	Reg. corr
r_t	0.267	0.234	0.275	0.113	
		(a) Developed countries			
Australia	0.183	-0.039	0.051	0.046	
Canada	0.206	0.028	0.091	0.258	
Eurozone	0.183	0.081	0.036	-0.025	
Japan	0.318	0.205	0.045	0.015	
New Zealand	0.226	0.158	0.030	0.066	0.032
Norway	0.237	0.023	0.170	0.168	
Sweden	0.374	0.122	0.028	0.046	
Switzerland	0.298	0.159	0.027	0.102	
United Kingdom	0.475	0.028	0.102	0.081	
United States	0.266	0.007	0.113	0.029	
		(b) Latin America			
Argentina	0.310	0.044	0.150	-0.041	
Brazil	0.223	0.110	0.117	-0.015	
Mexico	0.339	0.023	0.146	0.042	0.051
Peru	0.227	0.190	0.005	0.062	
		(c) East Asia			
Hong Kong	0.387	0.046	0.113	0.035	
India	0.262	0.116	0.154	0.041	
Indonesia	0.212	0.138	0.007	0.105	
Korea	0.356	0.132	0.099	-0.020	
Malaysia	0.294	0.174	0.131	0.071	0.083
Philippines	0.366	0.106	0.073	0.072	
Singapore	0.158	0.111	0.166	0.049	
Taiwan	0.319	0.089	0.034	0.126	
Thailand	0.243	0.006	0.013	-0.018	
		(d) Emerging Europe			
Czech Republic	0.160	0.113	-0.037	0.011	
Hungary	0.247	0.098	0.168	0.042	
Poland	0.301	0.136	0.136	0.060	0.095
Turkey	0.290	-0.083	0.045	-0.004	
		(e) Other Emerging			
Israel	0.183	-0.019	0.013	0.135	0.075
South Africa	0.266	-0.030	0.065	0.134	

Estimated autoregressive parameters for common factor r_t and country-specific disturbances. Estimation is carried out using the Kalman filter.

Figure 1 plots the two resulting estimates of changes in risk tolerance. The upper panel shows risk tolerance r_t under the assumption that $\gamma = 1$, while the lower panel assumes $\gamma = 0.75$—i.e. some wealth adjustment. Both are qualitatively similar at the weekly frequency, and indeed the weekly correlation is 0.87. The wealth-adjusted series does appear to be somewhat less volatile

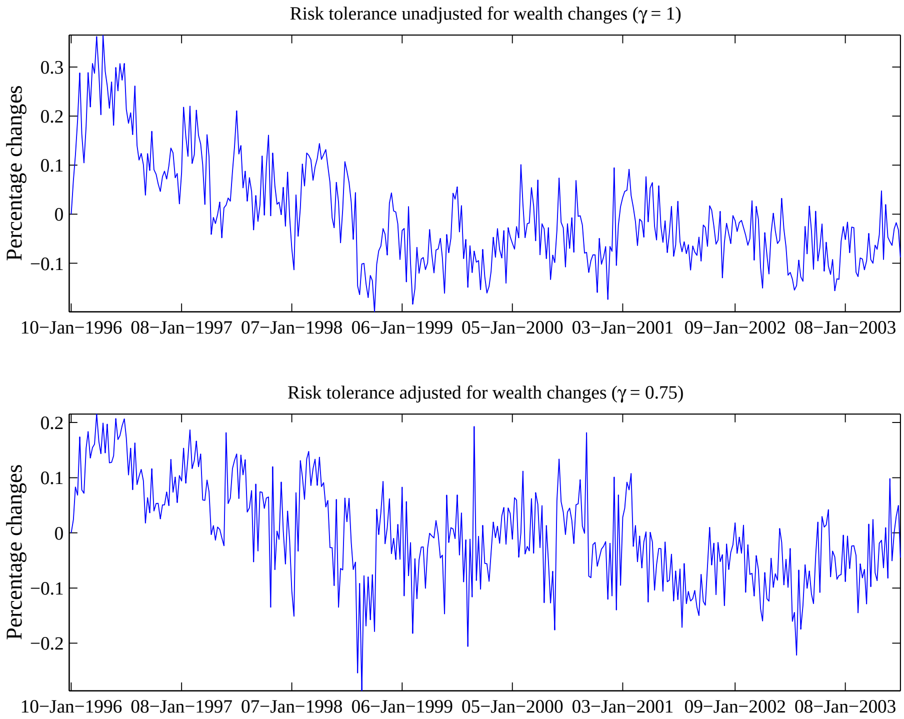

Figure 1: Estimated risk tolerance, with and without wealth adjustments, August 1994-July 2002

week-to-week.

Interestingly, the series appear to reflect a number of the more volatile periods in recent years, including the onset of the Asian crisis at end 1997, the LTCM collapse accompanied by the Russian default in August 1998, the global equity turn-down in 2000, and more recently the global equity market volatility of July 2002.[12] This is striking given that no prices or returns are used in the construction of the series.[13]

5 Risk tolerance and prices

We investigate the importance of our measure of risk tolerance in two ways. First, we undertake the variance decompositions suggested by Equations (2.12) and (2.13). Specifically, we calculate the share of unconditional flow and return variation that is accounted for by the (appropriately scaled) common factor. Second we investigate whether the risk tolerance measure has any forecasting power for returns.

[12] Six of the ten highest volume days ever recorded on the New York Stock Exchange occurred in July 2002.

[13] Of course, prices do affect wealth, which is a component of the second, adjusted series.

5.1 Variance decomposition

Table 3 reports the share of holdings and price variation that stems from variation in risk tolerance at various frequencies from 1 to 26 weeks.[14] In each case, the figures are the R^2 statistics from regressions using overlapping intervals. Changes in risk tolerance (scaled by local ownership share) are seen to be quite important in accounting for variation in holdings. For the major markets, up to one-third of the one-week change in holdings stems from a change in risk tolerance, and this percentage rises substantially as the horizon lengthens, reaching as much as 74 per cent for the euro region at the half-year frequency. For developing markets, the shares are generally smaller though important nonetheless. Turning to prices, the variation accounted for by changes in risk tolerance (scaled now by the foreign ownership shaer) is in the range of 1–2 percent at the one-week horizon, rising to an average of 11.7 percent at the half-year frequency. These somewhat lower levels should not be surprising: Equation (2.13) indicates that the bulk of the variation in prices will come from variation in local wealth, and critically, variation in commonly perceived fundamentals. In fact, the low variance decomposition numbers belie the importance of r_t for forecasting returns, and it is to this that we now turn.

[14]For holdings changes, we could also look at the variance decomposition for k-step ahead prediction errors based on the state-space model set out in Section 3. The results are qualitatively similar to the simpler decomposition reported here.

Table 3: Percentage of variation accounted for by unadjusted estimate of changes in risk tolerance

	Flows				Returns			
Horizon (weeks)	1	4	13	26	1	4	13	26
	(a) Developed countries							
Australia	4.2	7.1	12.5	12.9	0.6	0.1	0.2	0.8
Canada	0.2	0.0	0.8	3.0	1.6	3.5	1.8	2.0
Eurozone	34.2	52.7	68.6	74.4	1.8	5.8	9.5	16.5
Japan	21.3	27.3	31.9	29.8	0.1	0.0	2.3	5.1
New Zealand	2.8	3.7	6.9	10.7	0.4	5.4	0.0	0.4
Norway	3.7	5.5	7.8	7.9	1.2	9.9	6.9	10.0
Sweden	2.8	3.3	2.0	0.0	1.4	6.9	4.4	5.8
Switzerland	6.6	9.3	8.6	7.9	1.4	6.1	9.1	25.5
United Kingdom	31.2	38.5	48.7	59.5	1.6	11.4	12.1	33.5
United States	30.1	41.4	48.2	44.6	1.2	6.4	8.2	17.3
	(b) Latin America							
Argentina	7.8	12.5	25.0	31.4	0.2	6.9	0.6	1.3
Brazil	17.2	33.7	56.3	64.5	0.4	8.0	1.4	3.8
Mexico	3.3	5.9	13.2	17.8	0.8	2.8	1.2	0.2
Peru	7.1	9.7	8.4	8.1	0.1	10.9	0.6	0.5
	(c) East Asia							
Hong Kong	10.7	19.9	29.6	37.8	0.0	0.6	4.6	11.0
India	3.0	5.0	6.9	7.8	0.0	5.3	5.8	17.2
Indonesia	11.7	17.2	21.5	26.2	0.0	0.2	3.7	8.5
Korea	29.1	49.2	64.7	74.2	0.5	1.4	0.1	0.9
Malaysia	6.1	6.9	7.0	7.1	0.0	0.1	7.4	13.1
Philippines	6.9	15.7	35.8	48.0	0.1	0.3	14.4	33.5
Singapore	9.0	20.0	38.1	51.3	1.2	0.6	0.5	2.1
Taiwan	5.2	9.3	15.6	17.0	2.5	8.0	9.3	13.4
Thailand	12.0	23.5	37.6	44.8	1.5	1.6	3.8	1.7
	(d) Emerging Europe							
Czech Republic	0.7	0.5	0.4	0.0	0.5	3.5	0.3	0.3
Hungary	13.9	33.7	56.9	65.2	0.4	17.3	0.1	0.0
Poland	20.4	40.3	55.6	60.8	0.1	6.9	1.9	6.3
Turkey	6.5	10.5	17.8	28.6	0.8	1.6	1.6	2.9
	(e) Other Emerging							
Israel	21.4	38.9	55.3	61.3	1.4	1.1	1.1	0.4
South Africa	17.0	30.7	46.6	52.7	1.7	0.9	0.9	0.4

Variance decomposition for flows and returns based on estimated risk tolerance factor (unadjusted for wealth). Results are similar using wealth-adjusted factor. Each entry shows the percentage share of unconditional variance that is accounted for by variation in the common factor.

5.2 Return forecasting

To provide a baseline for the forecasting value of r_t, we first estimate a naïve momentum model of equity returns. Specifically, we attempt to forecast next week's return on the basis of the last four weeks of returns. Whether carried out for individual countries or in a panel setting, the results for this baseline model are, unsurprisingly, mixed. Table 4 displays the panel estimates. They suggest that, for all countries, the returns over the recent four weeks are informative about the next week's returns, but the R^2's are modest, averaging under 1%. The same is true when developed and emerging markets are separated. For emerging markets, there is some reasonable evidence of equity return momentum, consistent with the stylized facts established elsewhere in the literature, while for developed markets, there is some evidence of high-frequency reversal.

Introducing lags of the estimated risk tolerance factor into the regression brings a meaningful improvement in explanatory power. For developed markets, the change in risk tolerance recorded in the last week has a strong, statistically significant impact on the forecast return for this week. The effect is economically significant too: a one-standard deviation increase in risk tolerance (scaled by foreign ownership share) translates to an increase in forecasted return of between 10 and 20 basis points for the next week in developed markets. For emerging markets, which the coefficient on the first lag is insignificant, the coefficients on the second and third lags also indicate a positive relationship between returns and lagged changes in risk tolerance. Interestingly, there is evidence that only a portion of this return effect is permanent. The coefficent on the fourth lag of the risk tolerance measure is strongly negative for all countries, suggesting that some, but not all, of the impact effect on returns is reversed over the course of the subsequent month. The introduction of the risk tolerance factor causes the R^2 to double in all specifications. The average explained variation for developed markets is almost 1.5%. This is economically significant, since it implies an (in-sample) informatio ratio moment of approximately 0.88 for each country, before transactions costs.

Similar results were obtained using the wealth-adjusted measure of risk tolerance. We conclude, then, that the preference factor contains some information about future returns.

Table 4: Panel regression estimates of return forecasting models, weekly frequency, 08/1994–7/2002

	Lagged returns				Lagged risk tolerance				$R^2(\%)$
Lag	1	2	3	4	1	2	3	4	
				(a) All countries					
Coeffic.	0.002	0.066	0.066	-0.021					0.643
St. err.	0.010	0.010	0.010	0.010					
Coeffic.	0.000	0.060	0.055	-0.013	-0.034	0.612	0.254	-1.260	1.394
St. err.	0.010	0.010	0.010	0.010	0.131	0.135	0.134	0.129	
				(b) Developed countries					
Coeffic.	-0.066	0.046	0.026	-0.022					0.713
St. err.	0.016	0.016	0.016	0.016					
Coeffic.	-0.072	0.036	0.018	-0.016	0.235	0.396	0.054	-0.725	1.487
St. err.	0.016	0.017	0.017	0.016	0.150	0.153	0.152	0.147	
				(c) Emerging markets					
Coeffic.	0.014	0.068	0.073	-0.022					0.977
St. err.	0.012	0.012	0.012	0.012					
Coeffic.	0.013	0.061	0.060	-0.013	-0.154	0.742	0.372	-1.570	2.176
St. err.	0.012	0.012	0.012	0.012	0.184	0.189	0.189	0.182	

Panel regression estimates of return forecasting model without and with estimated risk tolerance factor (unadjusted for wealth). Results are similar using wealth-adjusted factor. Estimation is carried out by OLS.

6 Conclusion

In this paper, we have proposed a methodology for measuring investor confidence by decomposing investor demand for international assets. The framework is based on an examination of the cross-section of international portfolio holdings and flows of international institutional investors over time. We estimate our model using data that provides comprehensive coverage on the equity holdings of U.S. investors across 29 countries over the period January 1996 through July 2003. Using these data, we decompose observed shifts in aggregate investor demand into expected risk and return, wealth and risk tolerance components. The risk tolerance component turns out to account for a substantial portion of variation in portfolio holdings and a smaller but meaningful amount of variation in equity returns. In addition, it appears to be informative about future returns.

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