

International Equity Flows and Returns: A Quantitative Equilibrium Approach¹

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This paper considers the role of foreign investors in developed country equity markets. It presents a quantitative model of trading that is built around two new assumptions about investor sophistication: (i) both the foreign and domestic populations contain investors with superior information sets; and (ii) these knowledgeable investors have access to both public equity markets and private investment opportunities. The model delivers a unified explanation for three stylized facts about U.S. investors' international equity trades: (i) trading by U.S. investors occurs in waves of *simultaneous* buying and selling; (ii) U.S. investors build and unwind foreign equity positions gradually; and (iii) U.S. investors increase their market share in a country when stock prices there have recently been rising. The results suggest that heterogeneity *within* the foreign investor population is much more important than heterogeneity of investors across countries.

1. INTRODUCTION

Understanding the role of foreign investors in financial markets is an important unresolved issue in international finance. Existing empirical work has shown that foreign investors behave differently from local investors. In particular, foreign investors tend to buy local stocks following high local stock returns. Foreign investors also tend to build positions slowly: their net purchases can be predicted from their own past purchases. Together these facts suggest systematic *cross-country* heterogeneity of investor populations. For example, foreign investors might know less about local stocks than local investors. However, we document below that American investors simultaneously buy and sell large quantities of equity in other countries within a quarter. This suggests a role for *within-country* heterogeneity: some foreign investors buy while others sell. This paper builds a quantitative model of asset trading to explain the above stylized facts and to assess the link between investor heterogeneity and international equity flows.

We make two new assumptions. First, we allow for within-country differences in investor information sets. The existing literature focuses on cross-country heterogeneity: all foreign investors know less about the domestic market than local investors. In our model, the *average*

1. The views expressed herein are those of the authors and not necessarily those of the Bank of Canada, the European Central Bank or the Eurosystem, or of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

foreign investor may still know less about the domestic market than the *average* local investor. However, *some* foreigners manage to obtain as much local knowledge as the smartest local investors. This assumption is particularly suitable for modern industrial country stock markets where the best foreign and local traders tend to have very similar backgrounds and skills and, indeed, may use the same asset manager. It is also supported by recent empirical studies on individual trading behaviour and performance.

Our second assumption is that knowledgeable investors not only have better information about stocks, but also have a greater ability to locate off-market (*i.e.* private) investment opportunities. We label such investors “sophisticated”. In contrast, investors with inferior information and no private investment opportunities are labelled “unsophisticated”. The assumption of differing investment opportunity sets is in the spirit of Merton’s (1987) investor recognition hypothesis: some investors scan the economy more carefully for investment opportunities than do others. Sophisticated investors are thus not only better at market research, but are more likely to find profitable private investment opportunities that are not recognized by unsophisticated investors. This second assumption also seems suitable in a world where private equity, real estate, foreign exchange, and derivatives markets are accessible to only a subset of investors.

Under these two assumptions, asking about the role of foreign investors is essentially asking whether the within-country difference or the cross-country difference in investor sophistication is more important. To provide a quantitative answer, we construct an asymmetric information model of the local stock market in a non-U.S. G7 economy. Market participants differ in sophistication, but they do not inherently differ by nationality. However, the populations of local and U.S.-based participants contain different shares of sophisticated and unsophisticated investors. We calibrate the model to quarterly data on dividends, stock returns, trading volumes, and U.S. investors’ aggregate gross and net purchases of foreign equities in the G7 countries. Our main result is that *within-country heterogeneity is much more important than cross-country heterogeneity*. We do find, in line with the previous literature, that the *average* U.S.-based participant in a foreign market has less local knowledge than the *average* local participant. However, for all countries, our calibration implies that cross-country differences in average investor type are much smaller than within-country differences between sophisticated and unsophisticated investors.² Otherwise, the model could not match the fact that the volatility of U.S. net purchases of equities in each foreign country is much smaller than the average trading volume for that country.

Our model accounts for two regularities about U.S. investors’ net purchases that are prominent in the empirical literature. One is *flow momentum* (*i.e.* persistence) in net purchases. In all non-U.S. G7 country stock markets, Americans build and unwind foreign positions gradually: a net purchase of foreign equity by U.S. investors in some quarter predicts additional net purchases over at least the following two quarters (see Bohn and Tesar, 1996; Froot and Donohue, 2004). In addition, the model generates *return chasing*: the fact that U.S. net purchases, normalized by foreign market capitalization, are positively correlated with both current and lagged local stock returns. U.S. investors thus chase returns: when they see foreign stock prices increase, they buy foreign shares from local investors.

The model not only speaks to the behaviour of *net* international equity flows, but also makes predictions for *gross* flows. If there is a lot of within-country heterogeneity and little cross-country heterogeneity, one should expect to observe positive contemporaneous correlation between U.S. investors’ gross purchases and gross sales in a foreign market. Indeed, consider a shock that makes sophisticated investors buy shares from unsophisticated investors. Such a shock

2. Direct evidence on within-country investor heterogeneity is provided by Grinblatt and Keloharju (2000) and Choe, Kho and Stulz (2001). In addition, studies of investor performance have found that whether local investors do better or worse than foreigners depends on the time period and data-set used (see Stulz, 1999 for an overview). This can be interpreted as indirect evidence of within-country investor heterogeneity.

should generate a wave of *simultaneous* buying and selling by the population of Americans that contains members of both groups. It should therefore induce positive correlation between aggregate gross sales and purchases. We document this new stylized fact in the data for all the G7 countries.³ It rules out many models in international economics and finance in which representative agents live in different countries and trade country–stock indices with each other (or accumulate aggregate capital stocks).

To see how our model accounts for the above stylized facts, it is important to first clarify why investors trade. One motive for trade is *risk sharing*. Pay-offs from private opportunities, available only to sophisticated investors, tend to be high in business cycle booms when local stock prices also rise. Sophisticated investors thus perceive stocks and private opportunities as substitutes and try to sell stocks to share business cycle risk with unsophisticated investors. The second motive for trade is *disagreement* about expected stock returns. It occurs in equilibrium because stock prices do not reveal all of the sophisticated investors' information. While private opportunities are procyclical and thus provide information about the stock market, they may also be driven by factors orthogonal to the stock market. When unsophisticated investors see stock prices move, they cannot determine the type of information inducing sophisticated investors to trade.

Now consider the beginning of a typical boom. As good news about the business cycle arrives, all investors update their assessments of future cash flows, and local stock prices begin to rise. At the same time, sophisticated investors increasingly locate profitable off-market opportunities. They begin to sell local stocks to exploit these private opportunities without unduly increasing their exposure to business cycle risk. This generates both volume and, when there is within-country heterogeneity, a wave of simultaneous gross purchases and sales of foreign equity. Moreover, since the average U.S. investor is less sophisticated than the average local investor, the U.S. population is buying foreign stocks as prices are rising. Thus, U.S. investors chase returns as is observed in the data.

The above risk-sharing trades are slowed down by disagreement: unsophisticated investors, who have less information about the state of the business cycle, are initially less optimistic and buy stocks only at a discount. However, a string of favourable returns can help convince them that a boom is underway. This leads to more net purchases by unsophisticated investors and hence more net purchases by Americans. In contrast, sophisticated investors sell more and more stocks as the peak of the boom is approached. Only as the economy weakens and profitable private opportunities dry up do sophisticated investors return to the market. Again, the transition is slow as unsophisticated investors, who were overly optimistic at the peak, gradually revise their opinion and as sophisticated investors undo their risk-sharing trades.

The calibrated models do a good job of matching the autocorrelation functions of U.S. investors' net purchases in the different countries. Indeed, the models predict not only flow momentum (positive autocorrelation at short horizons of one to three quarters), but also *flow reversal*, that is, negative autocorrelation at longer horizons (five to seven quarters). This prediction derives from business cycle swings in net purchases—momentum and reversal are also features of the persistent component of dividends. In the data, there is strong evidence for flow reversal in Canada, France, and Germany, and somewhat weaker evidence for Japan and Italy. By and large, the model also does a decent job on the cross-correlogram of flows and returns.

The existing literature has discussed a number of other properties about return chasing. First, Bohn and Tesar (1996) show that U.S. investors are net buyers when estimated expected returns based on public information are also high. Second, Choe, Kho and Stulz (1999) showed a strong correlation of flows with lagged returns. Finally, Froot, O'Connell and Seasholes (2001) showed

3. In independent work, Dvorak (2003) finds the same stylized fact.

that the contemporaneous correlation of flows and returns over longer periods is due in part to positive correlation of flows with lagged returns at higher frequencies. Our model captures all three features: there is contemporaneous correlation between flows with current and expected returns, and returns predict flows. This suggests that the effects we identify could also be of interest for models calibrated to higher-frequency data.

The structure of our model is similar to that in Wang's (1994) seminal paper on trading volume. In both models, there is a group of agents who obtain private information and invest in a private asset. They perceive the private asset as a substitute to stocks, which leads to trading as well as disagreement in equilibrium. Our set-up differs from Wang's because a persistent component of dividends (*i*) exhibits both momentum and reversal, as in the data; (*ii*) is imperfectly observed by all investors; and (*iii*) is positively correlated with private returns. As we discuss in Section 6, all three properties are critical to our results. In particular, Wang's model, which does not share these properties, predicts negative serial correlation in net purchases between investor types and can thus not be used to address the persistence of net equity flows.

To our knowledge, there is no prior theoretical work on gross international equity flows and their connection to volume and net flows. Brennan and Cao (1997) started the literature on net flows, focusing on the positive contemporaneous correlation of foreigners' net purchases and returns.⁴ They show that this property can obtain in a model where less informed foreign investors react more strongly to public information than domestic investors, provided that private information accumulates sufficiently slowly. An "overreaction" effect is also present in our model: unsophisticated investors mistake a temporary shock to dividends (a public signal) for a persistent shock and become net buyers. However, this effect is quantitatively unimportant, since 96% of covariance of flows and returns is contributed by business cycle shocks.⁵

Section 2 documents the stylized facts studied in the paper about dividends, returns, trading volumes, and equity investments by U.S. investors. Section 3 presents the model of equity trading, and Section 4 discusses its properties. Section 5 presents the calibration and shows how we infer the nature of heterogeneity. Section 6 discusses the performance of the model. Section 7 concludes.

2. FACTS ON INTERNATIONAL DIVIDENDS, EQUITY FLOWS, AND RETURNS

We use quarterly data from the G7 countries over the period 1977:1 through 2000:3. Apart from the U.S., these are Germany, Japan, the U.K., France, Canada, and Italy. We have selected these countries because they best fit the assumptions of the model we develop below. First, flows and returns in these countries are likely to be driven by stable economic relationships. In contrast, the ongoing process of liberalization of equity markets in developing countries may lead to capital flows that are driven by changing risk-sharing opportunities or declining transactions costs. Second, the absence of trading frictions in our model is more at odds with the institutional environment of emerging markets.

2.1. *Facts on dividends*

We use data on the dividend yield and the price index of Datastream's international stock market indices, with all variables converted to constant U.S. dollars. Table 1 presents key first and second

4. See also Coval (1999), Griffin, Nardari and Stulz (2004), and Hau and Rey (2006). These papers are not interested in the stylized facts we study, except for the contemporaneous flow–return correlation.

5. Our calibration procedure finds only a small role for overreaction because trades due to temporary dividend shocks are quickly reversed and contribute negatively to the autocovariance. Since flows are persistent, the contribution of these shocks must be small.

TABLE 1

Summary statistics of dividends

Country	$\mu(D)$	$\sigma(D)$	$\rho_1(D)$
CAN	4.89	0.34	0.93
FRA	2.19	0.47	0.96
GER	5.50	1.41	0.97
ITA	0.57	0.27	0.98
JAP	14.81	2.87	0.98
U.K.	12.91	2.23	0.92
U.S.	91.51	3.61	0.90

Notes: Mean μ , S.D. σ , and first autocorrelation ρ_1 of detrended, seasonally adjusted dividends, deflated by U.S. CPI; 1977:1–2000:3.

moments of dividends, after removal of an exponential trend. We choose units such that the price index in 1977:1 equals market capitalization, and the mean dividend reflects the size of the stock market. Preliminary specification analysis of the dynamic behaviour of dividends reveals two features. First, the autocorrelation function switches from positive to negative values after three to four quarters. Second, while the first two partial autocorrelation coefficients are significant for all countries except Canada, all countries exhibit several significant partial autocorrelation coefficients beyond the first two.

As the forcing process for our model, we would like a dividend process that accommodates both properties in a parsimonious way. We thus decompose dividends D_t into a persistent cyclical component F_t^D , captured by an AR(2) process, and a transitory shock ε_t^D :

$$\begin{aligned} D_t &= \bar{D} + F_t^D + \varepsilon_t^D \\ F_t^D &= a_1 F_{t-1}^D + a_2 F_{t-2}^D + \varepsilon_t^{FD}, \end{aligned} \quad (1)$$

where ε_t^D and ε_t^{FD} are uncorrelated i.i.d. sequences of shocks with zero mean and S.D. σ_{ε^D} and $\sigma_{\varepsilon^{FD}}$, respectively. Here F_t^D captures the oscillatory behaviour of the correlogram that is typical of variables affected by the business cycle. The presence of the transitory noise ε_t^D that cannot be distinguished from the underlying business cycle movement implies that lags longer than two are still helpful in forecasting dividends. The true dividend process follows a truncated distribution, which we approximate by modelling the dividend as normally distributed in levels. Table 1 confirms that the approximation is sensible, as mean dividends are more than 3.5 S.D. above zero for all countries except Italy.

Table 2 presents the estimated moments for (1).⁶ The persistent component F_t^D is stationary: the roots of the autoregressive polynomial are outside the unit circle. For most countries, the roots are complex, which accounts for oscillations in the correlogram. In addition, the persistent component has persistent differences. Indeed, the process of changes in F_t^D satisfies

$$\Delta F_t^D = (-a_2)\Delta F_{t-1}^D - (1 - a_1 - a_2)F_{t-1}^D + \varepsilon_t^{FD}.$$

For all countries, we have that $0 < (-a_2) < 1$ and that $(1 - a_1 - a_2)$ is a small positive number. After a shock hits, two counteracting effects are at work. First, any change in a certain direction leads to more changes in the same direction, although at a decreasing rate since $(-a_2) < 1$. If this was the only effect, the level F_t^D would be non-stationary. However, the second term causes mean

6. The estimation method is explained in the appendix available at the *Review's* website: <http://www.restud.org/supplements.htm>. The autoregressive parameters a_1 and a_2 are statistically significant for all countries at the 1% level except for Japan's a_2 .

TABLE 2
Estimated dividend process

	a_1	ta_1	a_2	ta_2	$\sigma_{\varepsilon FD}$	$\sigma_{\varepsilon D}$	$\sigma(F^D)$	$\rho_1(\Delta F^D)$	Roots	$\rho_1(\Delta D)$
CAN	1.859	6.59	-0.896	-3.94	0.036	0.073	0.409	0.88	1.04 ± 0.20i	-0.002
FRA	1.369	33.39	-0.420	-20.60	0.110	0.026	0.458	0.39	1.11; 2.15	0.327
GER	1.734	19.47	-0.773	-8.99	0.143	0.183	1.095	0.75	1.12 ± 0.19i	0.217
ITA	1.685	51.41	-0.708	-32.03	0.031	0.017	0.272	0.70	1.12; 1.26	0.454
JAP	1.212	4.884	-0.275	-0.295	0.783	0.031	2.988	0.24	1.10; 3.30	0.248
U.K.	1.223	16.408	-0.294	-5.464	0.572	0.031	2.403	0.26	1.12; 3.04	0.252
U.S.	1.679	6.60	-0.747	-3.18	0.698	0.818	3.836	0.71	1.12 ± 0.28i	0.088

Notes: $\sigma(x)$ is the S.D. and $\rho_1(x)$ the first autocorrelation of variable x . Roots are computed for the autoregressive polynomial of F_t^D . t_x is the Newey–West t -statistic of the statistic x .

reversion in the level by pulling F_t^D toward its mean of zero whenever it is positive and by pulling it up when it is negative. For the impulse response of the level, the first effect dominates early on, before the second effect takes over. The result is a hump-shaped impulse response function.

The persistent component explains almost all the variation in dividends: its share of total variance is larger than 96% for all countries except Italy. For three of the seven countries, the volatilities of the shocks hitting the persistent component in any given quarter are also higher than that of transitory shocks. Still, changes in dividends are typically less persistent than changes in the persistent component. Changes in dividends can be decomposed into changes in F_t^D , which are positively serially correlated, and changes in the temporary component, which are negatively serially correlated, and thus reduce overall persistence.

2.2. Facts on equity flows and returns

Data on international equity flows of U.S. investors are from the Treasury International Capital reporting system of the U.S. Treasury. Trading volume data are from Datastream's Global Equity Indices. Both flow and volume data report all transactions in a given quarter. Figure 1 plots the net purchases and gross flows of foreign stocks by U.S. investors, divided by total market capitalization at the beginning of the period.

Table 3(a) presents summary statistics for net purchases of foreign stocks by U.S. investors as well as excess returns on the indices for the countries we consider. The mean excess returns in this table are based on detrended data, which means that the effects of dividend growth are already removed. This explains why excess returns are smaller than the mean equity premia usually reported from raw data and why Sharpe ratios implied by the table are unusually low. In our set of countries, changes in American investors' holdings are small relative to total market capitalization. Within a given quarter, it is rare to see a change in position of more than 1% of market capitalization.

Figure 2 displays serial correlograms of net purchases of U.S. investors (in the first column) and cross-correlograms of net purchases and local stock returns (in the second column). It documents three stylized facts about the joint distribution of net inflows and excess returns. First, net inflows are persistent. The first autocorrelation coefficient (also listed in Table 3(a)) ranges from 0.16 for Italy to 0.52 for Canada. The autocorrelation coefficient is statistically significant at the 5% level in all countries.⁷ Second, the serial correlogram of flows further indicates a reversal of flows five to six quarters out for all countries except U.K. The third fact is return chasing: U.S.

7. The persistence of net inflows is not due to trends. The first column in Figure 1 plots the net inflow series for all our countries. It is apparent that the main feature is slow transitions from periods of high to low net inflows.

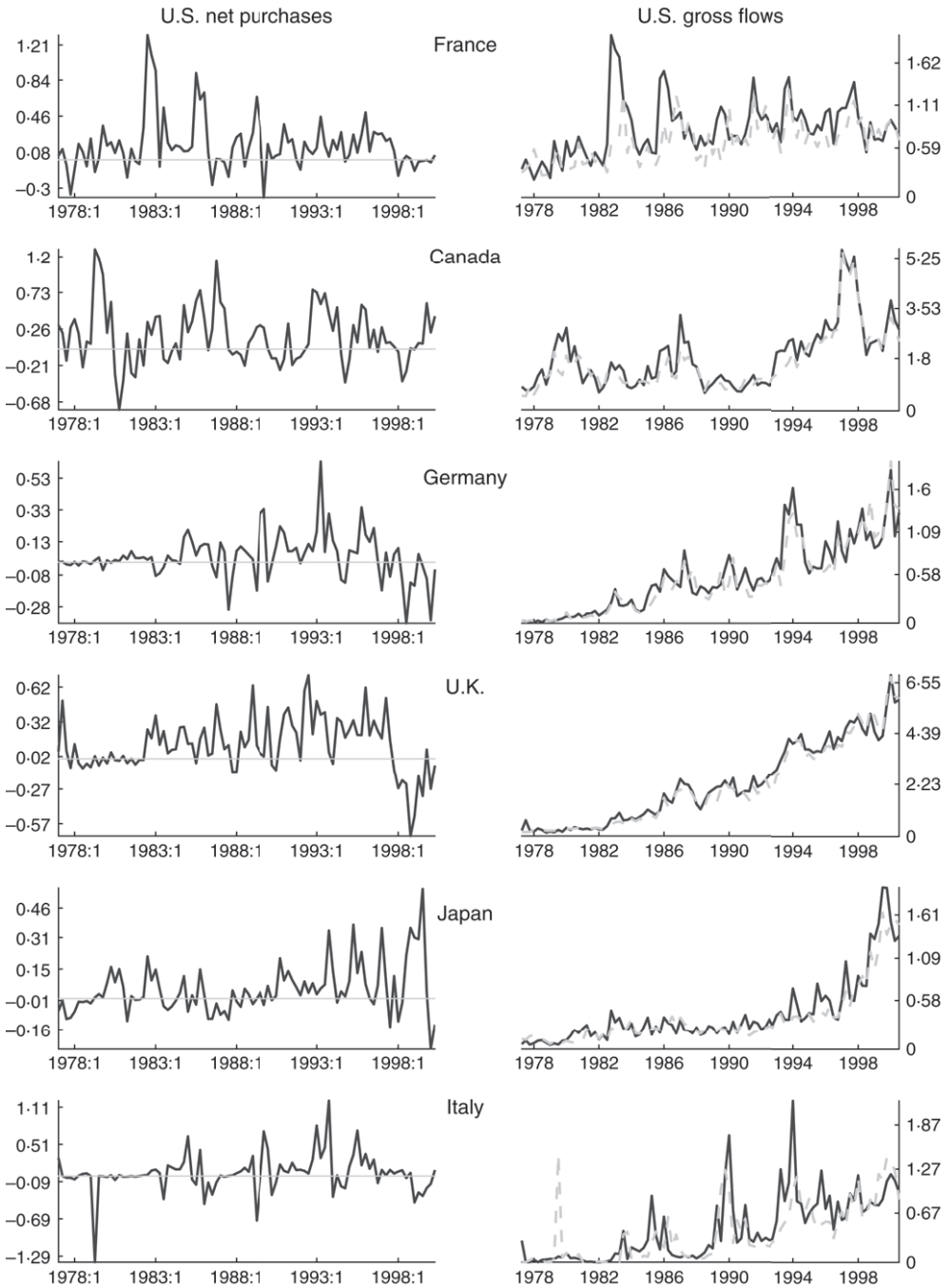


FIGURE 1

U.S. investors' net purchases (left column) as well as gross purchases (right column; solid black line) and gross sales (right column; dashed grey line) to the six non-U.S. G7 countries. All flows are quarterly 1977:1–2000:4 and stated as a percentage of beginning-of-quarter market capitalization.

TABLE 3(a)
Excess returns and net purchases

	Excess returns (%)		Net inflows (%)				$\rho(R^D, \Delta\theta^*)$	$t_\rho(R^D, \Delta\theta^*)$
	$\mu(R^D)$	$\sigma(R^D)$	$\mu(\Delta\theta^*)$	$\sigma(\Delta\theta^*)$	$\rho_1(\Delta\theta^*)$	$t_{\rho_1}(\Delta\theta^*)$		
CAN	1.4	8.1	0.17	0.37	0.52	11.68	0.27	3.98
FRA	1.5	11.7	0.15	0.28	0.46	5.23	0.17	1.61
GER	0.7	9.8	0.03	0.14	0.35	4.98	0.28	3.81
ITA	0.9	15.0	0.05	0.31	0.16	2.47	0.13	1.73
JAP	0.8	13.0	0.05	0.13	0.45	5.69	0.40	2.93
U.K.	0.8	9.3	0.12	0.24	0.51	4.43	0.16	2.25
U.S.	1.9	7.4	—	—	—	—	—	—

Notes: Means μ , S.D. σ , and first autocorrelations ρ_1 for U.S.\$ excess returns R^D and net purchases by U.S. investors $\Delta\theta^*$. $\rho(R^D, \Delta\theta^*)$ is the contemporaneous correlation of excess returns and net purchases. Quarterly data, 1977:2–2000:3. t_x is the Newey–West t -statistic of the statistic x .

TABLE 3(b)
Holdings, turnover, and gross flows

	U.S. holdings (%)	Volume (%)		Gross flows (%)		
	θ^*	$\mu(\text{VOL})$	$\sigma(\text{VOL})$	$\mu(\text{GP}^*)$	$\mu(\text{GS}^*)$	$\rho(\text{GP}^*, \text{GS}^*)$
CAN	14.3	14.1	2.7	3.2	3.0	0.97
FRA	12.7	16.0	3.4	0.9	0.9	0.63
GER	9.9	51.6	13.2	1.0	1.0	0.87
ITA	1.1	86.2	35.1	0.8	0.8	0.60
JAP	8.0	4.8	2.7	0.9	0.8	0.91
U.K.	12.4	3.9	2.1	4.5	4.5	0.95

Notes: U.S. holdings (θ^*) are expressed as a fraction of local market capitalization, as of 12/31/1999. Volume (VOL) is total value of shares traded divided by market capitalization. Gross purchases (GP^{*}) and gross sales (GS^{*}) are divided by market capitalization. Gross flow and volume statistics are averages over 1995:1–2000:3. $\mu(x)$ is the mean and $\sigma(x)$ is the S.D. of x , and $\rho(\text{GP}^*, \text{GS}^*)$ is the correlation of gross purchases and gross sales.

investors' net purchases in a country are positively correlated with both current and lagged local stock returns.

Table 3(b) collects summary statistics for holdings, gross flows, and volume. U.S. investors hold significant fractions of the market in all countries except Italy. Gross purchases and sales are of the same order of magnitude in all countries. The stylized fact that gross sales and purchases are highly positively correlated holds both in the time series for every country and in the cross-section of countries. Importantly, the time series results do not only reflect trend behaviour. While there are trends in gross flows over the whole sample, behaviour over a five-year period is mostly driven by volatility that is common to both series. This is illustrated in the second column of Figure 1. Finally, volume varies widely across countries. However, holdings of U.S. investors turn over *less* frequently than holdings of other investors within the country, except for Canada and the U.K.

3. THE MODEL

Our model describes the stock market of a small, open economy. There are two types of investors, sophisticated (S) and unsophisticated (U). Investors also differ by nationality: there are U.S.-based investors and local investors. We assume that nationality does not lead to different

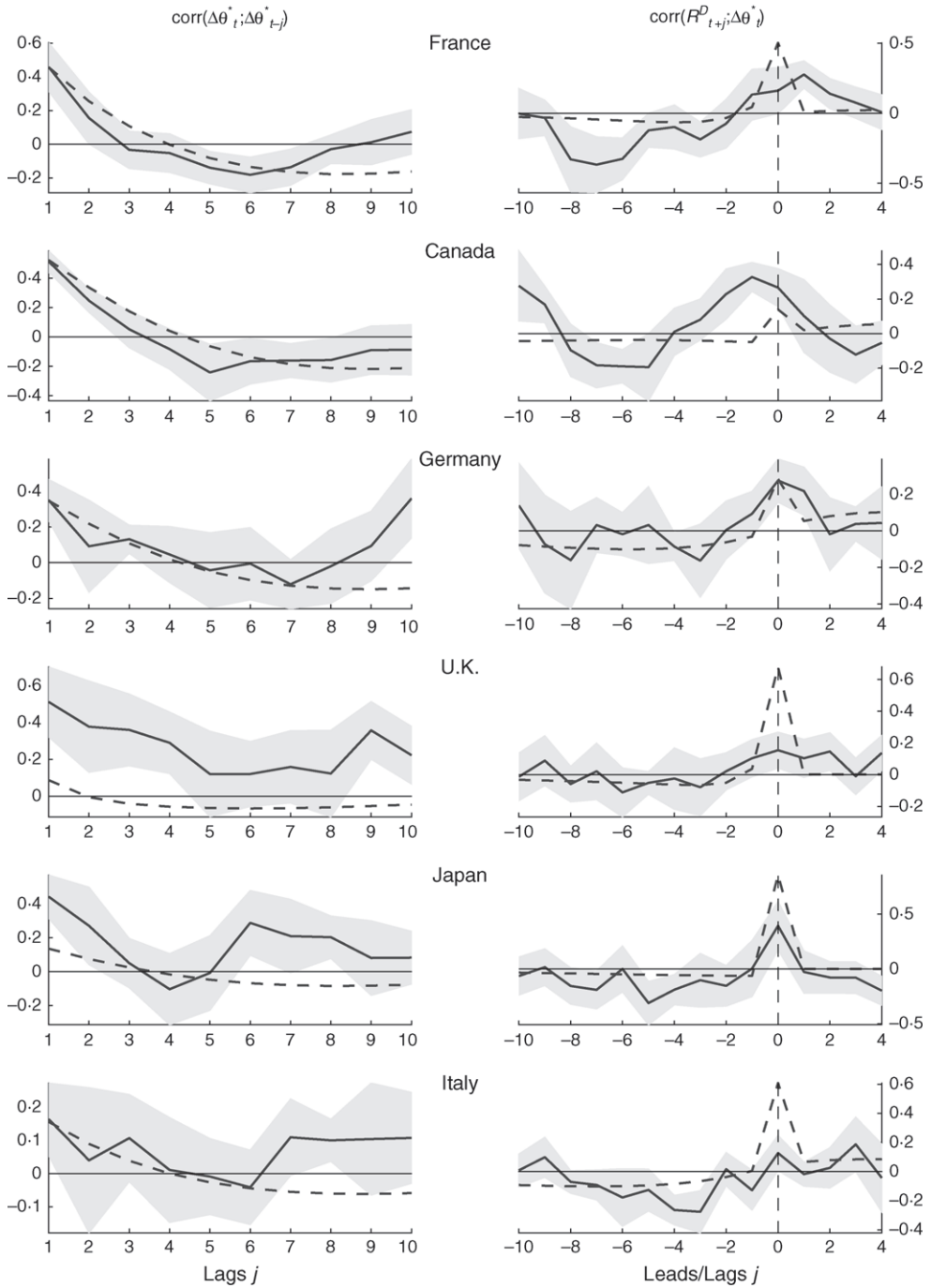


FIGURE 2

Autocorrelation of flows (left column) and cross-correlation of returns and flows (right column). $\Delta\theta_t^*$ is net purchases of the local asset by U.S. investors; R_t^D is the current excess return on the local asset. The shaded area is bounded by 90% confidence bands.

behaviour at the individual level: U.S. investors of type S (U) are identical to local investors of type S (U). However, the aggregate trades of U.S. investors will have distinctive properties if the composition of the U.S. investor population differs from that of the local population. Analysis of the model naturally proceeds in two steps. We describe the set-up as one of trade between S- and U-investors. In Section 4.2, we introduce nationality and derive model statistics that involve U.S. investors' trades.

3.1. Set-up

3.1.1. Preferences. There is a continuum of infinitely lived investors. A fraction ν_U of investors is unsophisticated (indexed by U), and a fraction $1 - \nu_U$ is sophisticated (indexed by S). Investors have identical expected utility preferences that exhibit constant absolute risk aversion (CARA). At time t , an investor of type $i \in \{U, S\}$ ranks contingent consumption plans $\{c_t^i\}_{t=0}^{\infty}$ according to

$$-E \left[\sum_{l=t}^{\infty} \beta^{(l-t)} \exp(-\gamma c_l^i) \mid \mathcal{I}_t^i \right], \quad (2)$$

where $\beta < 1$ is the discount factor, $\gamma > 0$ is the coefficient of absolute risk aversion, and \mathcal{I}_t^i is the information set at time t , to be specified below.

3.1.2. Investment opportunities. Two assets are available to all investors. A risk-free bond pays a constant gross rate of return of $R_f = 1/\beta$. Moreover, all investors participate in the domestic stock market. The single asset traded in this market is a claim to the dividend stream $\{D_t\}$. At date t , shares trade at a per-share, ex-dividend price of P_t and hence deliver a per-share excess return of $R_t^D = P_t + D_t - R_f P_{t-1}$. A single share is traded every period. A third asset is accessible to S-investors alone; we refer to it as a private, or off-market, investment opportunity and denote its simple excess return by R_t^B .

Dividends and asset returns are subject to both persistent and transitory shocks. Recall that F_t^D denotes the persistent component of dividends, which we also refer to as the *state of the business cycle*. Returns on off-market opportunities are predictable, and their conditional expected return is correlated with the business cycle. Other fluctuations in the expected return R_t^B are summarized by a state variable F_t^B , which is independent of F_t^D and labelled the *off-market factor*. Both F_t^D and F_t^B may depend on two lags of themselves. Letting $\mathbf{F}_t = (F_t^D, F_{t-1}^D, F_t^B, F_{t-1}^B)'$, the distribution of dividends and returns is

$$D_t = \bar{D} + F_t^D + \varepsilon_t^D, \quad (3)$$

$$R_t^B = \bar{R}^B + \eta_D F_{t-1}^D + \eta_B F_{t-1}^B + \varepsilon_t^B, \quad (4)$$

$$F_t = \rho \mathbf{F}_{t-1} + \varepsilon_t^F. \quad (5)$$

Boldfaced letters denote matrices, boldfaced letters in italics denote vectors, and variables with bars denote unconditional means. All shocks are components of the vector process $\boldsymbol{\varepsilon}_t = (\boldsymbol{\varepsilon}_t^F, \boldsymbol{\varepsilon}_t^D, \boldsymbol{\varepsilon}_t^B)'$ that is serially uncorrelated and normally distributed with mean zero and diagonal covariance matrix $\boldsymbol{\Sigma}_{\boldsymbol{\varepsilon}\boldsymbol{\varepsilon}}$. The matrix $\boldsymbol{\rho}$ is block diagonal.

3.1.3. Information. At date t , all investors know past and present stock prices and dividends, as well as returns on the world asset. U-investors have no additional information, that is, $\mathcal{I}_t^U = \{P_{t-l}, D_{t-l}\}_{l=0}^{\infty}$. S-investors not only know \mathcal{I}_t^U but also observe the off-market factor F_t^B , as well as past and present returns on their private opportunities. All S-investors observe the

same signals and thus share the information set $\mathcal{I}_t^S = \{P_{t-1}, D_{t-1}, R_{t-1}^B, F_{t-1}^B\}_{l=0}^\infty$. The private information that S-investors have about F_t^D comes from observing the off-market return R_t^B (see (4)) and F_t^B .

3.1.4. Portfolio choice. The budget constraint of investor i at date t is

$$w_{t+1}^i = R_f(w_t^i - c_t^i) + \boldsymbol{\psi}_t^{i'} \mathbf{R}_{t+1}^i, \quad (6)$$

where w_t^i is beginning-of-period wealth and the vectors $\boldsymbol{\psi}_t^i$ and \mathbf{R}_t^i denote holdings and returns on assets that are available to investor i , respectively. In particular, for S-investors $\boldsymbol{\psi}_t^S = (\theta_t^S, \psi_t^{BS})'$ and $\mathbf{R}_t^S = (R_t^D, R_t^B)'$, and for U-investors $\psi_t^U = \theta_t^U$ and $R_t^U = R_t^D$. Here, θ_t^S and θ_t^U denote the number of local stocks held by S- and U-investors, respectively. Investor i chooses contingent plans for consumption $\{c_t^i\}_{l=t}^\infty$ and asset holdings $\{\psi_t^i\}_{l=t}^\infty$ to maximize expected utility (2), conditional on the information set \mathcal{I}_t^i and the budget constraint (6).

3.1.5. Equilibrium. A rational expectations equilibrium is a collection of stochastic processes $\{c_t^U, c_t^S, \psi_t^U, \psi_t^S, P_t\}$ for consumption, asset holdings, and the domestic stock price such that: (i) both types of agents optimally choose consumption and portfolio plans given prices; and (ii) the domestic stock market clears

$$\nu_U \theta_t^U + (1 - \nu_U) \theta_t^S = 1. \quad (7)$$

Heterogeneity based on investor nationality does not affect trading and the equilibrium properties. It does, however, affect flows into and out of the U.S. We return to this in Section 4.2.

3.2. Stationary equilibria

To compare model predictions to data, we focus on *stationary equilibria*, that is, stationary processes for consumption, portfolios, and the stock price that satisfy the equilibrium conditions. A stationary equilibrium yields theoretical moments for trades and returns that are matched to the corresponding empirical moments. As in Wang (1994), the assumptions of normal shocks, exponential utility, and hierarchical information sets imply that stationary equilibria can be represented using a low-dimensional state vector that contains only agents' conditional expectations. In particular, we focus on equilibria in which the stock price is a linear function of these expectations.

Let $\hat{\mathbf{F}}_t^i = E[\mathbf{F}_t | \mathcal{I}_t^i]$ denote investor i 's conditional expectation of the vector \mathbf{F}_t that drives persistent movements in fundamentals. Since $\mathcal{I}_t^U \subset \mathcal{I}_t^S$, the law of iterated expectations implies $\hat{\mathbf{F}}_t^U = E[\hat{\mathbf{F}}_t^S | \mathcal{I}_t^U]$. In other words, $\hat{\mathbf{F}}_t^U$ not only represents U-investors' expectation of \mathbf{F}_t itself, but also their expectation of what S-investors expect \mathbf{F}_t to be. Investor i 's state variables at time t are her wealth w_t^i and her information vector $\boldsymbol{\phi}_t^i$, where $\boldsymbol{\phi}_t^S = (\hat{\mathbf{F}}_t^{S'}, \hat{\mathbf{F}}_t^{U'})'$ and $\boldsymbol{\phi}_t^U = \hat{\mathbf{F}}_t^U$.

Theorem 1. *There exists a rational expectations equilibrium such that prices and stock holdings are stationary and take the form*

$$P_t = \bar{\pi} + \boldsymbol{\pi}'_S \hat{\mathbf{F}}_t^S + \boldsymbol{\pi}'_U \hat{\mathbf{F}}_t^U, \quad (8)$$

$$\theta_t^i = \bar{\theta}^i + \boldsymbol{\Theta}^i \hat{\mathbf{F}}_t^U; i \in \{S, U\}. \quad (9)$$

Continuation utility is given by

$$V(w_t^i; \boldsymbol{\phi}_t^i) = -\exp \left[-\kappa^i - (1 - \beta)\gamma w_t^i - \mathbf{u}'_i \boldsymbol{\phi}_t^i - \frac{1}{2} \boldsymbol{\phi}_t^{i'} \mathbf{U}_i \boldsymbol{\phi}_t^i \right]. \quad (10)$$

The proof of Theorem 1 is contained in the appendix, available at the *Review's* website, where we construct the constants π_S , π_U , $\hat{\theta}^i$, Θ^i , κ^i , u_i , and U_i . The stationary equilibria have two important properties. First, equilibrium prices reveal neither the persistent components of dividends nor the expected return on private opportunities, but only investors' perceptions of these variables. This is because no investor has full information about the state of the business cycle F_t^D . Second, equilibrium holdings, and hence also trades, of both S- and U-investors depend only on U-investors' estimates of the persistent factors \hat{F}_t^U . Indeed, if the local asset demand of S-investors were to depend also on \hat{F}_t^S , then U-investors could learn more about \hat{F}_t^S by comparing \hat{F}_t^U and their own demand, which would lead them to adjust \hat{F}_t^U . Equilibrium expectations must therefore be such that holdings reflect only \hat{F}_t^U . It follows that trading volume, captured by $|\theta_t^U - \theta_{t-1}^U|$, for example, does not provide information beyond what is already in \mathcal{I}_t^S and \mathcal{I}_t^U . This distinguishes the present model from many noise-trader models, where agents must be forced by assumption not to condition on trading volume.

3.3. Discussion of assumptions

3.3.1. Information and nationality. Our set-up rules out any inherent advantage due to nationality *at the individual level*: the sophisticated U.S. investors know as much about the local economy as the sophisticated local investors. This assumption accommodates the fact that both U.S. and local investors can hire the best local portfolio managers and is especially suited in developed country markets where investors share similar backgrounds. Moreover, it makes the model parsimonious and easier to solve.

3.3.2. Small, open economy. In our model, the expected return on the domestic stock market is endogenous, while the riskless rate and the return on the off-market asset are taken as exogenous. In other words, we do not assume that there is one (exogenous) pricing kernel that can be used to price all assets. The simplest way to interpret our set-up is that there is market segmentation. The domestic market is used by domestic investors as well as by a subset of U.S. investors who are themselves small relative to the U.S. market. The riskless rate is determined by the majority of investors in the rest of the world (including the U.S.) who do not participate in the country under consideration. Evidence in support of this assumption is provided by Albuquerque, Bris and Schneider (2005), who document limited participation of U.S. investors in foreign markets.⁸

3.3.3. Private investment opportunities. We have referred to the fourth asset broadly as "private investment opportunities". These opportunities: (i) become available to a subset of market participants that is also well-informed about the market itself; and (ii) are too costly to observe and access by other market participants. Examples of such opportunities are private equity, real estate, foreign exchange or derivatives markets. Importantly, our story does not require that the type of opportunity always be the same. All that matters is that, from time to time, the well-informed part of the population discover some new way to invest that is not known to everybody.

Lack of knowledge by U-investors can simply mean that the private opportunity is secret. More generally, one can think of U-investors as people who only concentrate on a subset of the available public information. Even though in principle there may be data on the latest investment opportunity that S-investors exploit, U-investors, who are not sure where to look, prefer to focus

8. We thus assume that equity home bias exists and that it exists because of limited American participation in foreign markets. Our goal is not to explain the world distribution of asset holdings, or even the Americans' aggregate portfolio, but only trades made in the stock market under consideration, *conditional* on home bias.

just on stock market information which they know how to process. In our model, they process this information optimally: they know the stochastic processes for prices and update their beliefs by Bayes' rule. The ability of S-investors to recognize investment opportunities that are not readily (or costlessly) available to U-investors is also present in Merton (1987) and Shapiro (2002).

3.3.4. Exchange rates. Our focus on portfolio *equity* flows leads us to stress factors that are important for portfolio decisions of equity market participants, in particular time variation in expected excess returns on stocks and private investment opportunities. We abstract from other factors that are sometimes present in models of the current account. For example, a more general model might incorporate changes in the real exchange rate, so that foreign and domestic bonds are imperfect substitutes. Such a model would be of interest to study *bond* flows or total portfolio flows, but is left for future research.

While our results show that the factors we consider are sufficient to explain the moments of the joint distribution of equity flows and stock returns, we expect the behaviour of equity flows in our model to carry over to more general set-ups. In Albuquerque, Bauer and Schneider (2003), we find that U.S. investors' foreign portfolio equity flows are well explained by past flows and global variables, such as a world return, while real exchange rates do not add much explanatory power.⁹ This suggests that, even if real exchange rate movements affect the conditional distribution of returns on all assets available to investors (including bonds), they are not important for portfolio decisions on equity. A potential reason is that excess returns are, to first order, the same whatever the currency they are measured in; changes in the unit of account affect both risky assets and the riskless rate and hence cancel out of the definition of an excess return. The relative variability of expectations in these excess returns, the driver of equity flows in our model, is thus independent of the exchange rate.

3.3.5. Foreign equity. We focus on only two risky assets, domestic stocks and private opportunities. Trade derives from substitution between these assets over the course of the domestic business cycle. We thus isolate one mechanism that generates trade and show that it is qualitatively suitable and quantitatively important enough to generate observed patterns of equity flows. Of course, in reality investor wealth contains other assets, in particular foreign equity. It is thus useful to consider why the mechanism we emphasize is likely to be relevant also in a richer model.

Any model that successfully integrates a world (or U.S.) stock market as an additional asset will have to capture two pieces of evidence. The first is positive contemporaneous cross-country correlation of returns found by, among others, Dumas, Harvey and Ruiz (2003). The other is the weak relationship between U.S. returns and U.S. investors' net purchases in other countries, documented by Bohn and Tesar (1996). A successful model thus needs to incorporate a reason why shocks that affect both U.S. expected returns and domestic stock market prices are not accompanied by large trades.

The simplest model that generates this pattern has only one investor type so that no trading ever takes place. Instead, prices adjust to induce the homogeneous population to always hold the market. In a model with more than one investor type, one would expect similar effects provided that investors' access to the U.S. market is symmetric. To be more concrete, imagine a model with a world asset that both investor types can invest in without affecting its return, in line with our small, open economy assumption. Domestic dividends and opportunities can be hit by local shocks as well as by global shocks that also affect the expected world return.

9. Similarly, Portes and Rey (2005) find that the main determinant of the pattern of international equity flows is the geography of information proxied by variables that represent information transmission and information asymmetries between domestic and foreign investors.

Consider now a global shock that increases expected returns on U.S. stocks and private opportunities as well as domestic expected dividends. With positive correlation between all returns, this shock would lead S-investors, who want to shift to private opportunities, to sell domestic stocks. The intuition is the same as in the present model, where a business cycle shock hits both pay-offs on stocks and private opportunities. The new twist would be that both investor types would also try to sell more domestic stocks in order to shift to U.S. stocks. Since both investor types try to sell, the new effect would generate little additional trade between them. However, a larger correction in the price would be required to induce both to keep holding domestic stocks. With respect to global shocks, the economy would thus behave much like an economy with one investor type generating correlation of returns, but little trade. As a result, most trades would still be driven by local shocks as in the present model: an increase in local expected pay-offs would lead S-investors to sell local stocks to shed tradable risk.

4. EQUILIBRIUM FLOWS AND RETURNS

In this section, we characterize analytically S- and U-investors' motives for trade (Section 4.1) and link them to U.S. investors' aggregate equity flows (Section 4.2).

4.1. Trading motives

We need the following notation. Let $X_{t+1} = P_{t+1} + D_{t+1}$ denote the *pay-off* on stocks, and define the conditional moments $\sigma_U^2 = \text{var}_t^U(X_{t+1})$, $\sigma_S^2 = \text{var}_t^S(X_{t+1})$, $\sigma_B^2 = \text{var}_t^S(R_{t+1}^B)$, and $\rho_S = \text{corr}_t^S(X_{t+1}, R_{t+1}^B)$.¹⁰

4.1.1. Individual portfolio choice and asset substitutability. As is common in portfolio choice problems, the optimal demand for stocks by U- and S-investors can be decomposed into myopic and hedging demands:

$$\theta_t^U = \frac{1}{\gamma \sigma_U^2} \left(\underbrace{E_t^U X_{t+1} - R_f P_t}_{\text{Myopic demand}} + \underbrace{\bar{h}^U + \mathbf{H}^U \boldsymbol{\phi}_t^U}_{\text{Hedging demand}} \right), \quad (11)$$

$$\theta_t^S = \frac{1}{\gamma \sigma_S^2 (1 - \rho_S^2)} \left(\underbrace{E_t^S X_{t+1} - R_f P_t - \rho_S \frac{\sigma_S}{\sigma_B} E_t^S R_{t+1}^B}_{\text{Myopic demand}} + \underbrace{\bar{h}^S + \mathbf{H}^S \boldsymbol{\phi}_t^S}_{\text{Hedging demand}} \right). \quad (12)$$

Investors' myopic demands depend on the distribution of returns *over the next period only*. For both types of investors, the myopic demand is higher when the expected excess return on stocks over bonds $E_t^i X_{t+1} - R_f P_t$ is high and when (subjective) risk σ_i^2 is low. Investors' inter-temporal hedging demands are linear functions of the state variables $\boldsymbol{\phi}_t^i$ and depend on the conditional distribution of returns *beyond the next period*.¹¹ When investment opportunities are random, investors fear states that offer poor opportunities, for example, states where expected returns are

10. To simplify the formulas, these moments are computed under conditional distributions that are adjusted to capture agents' taste toward the variance in the state variables $\boldsymbol{\phi}_t^i$. This is spelled out in detail in the appendix.

11. The hedging demand is zero for myopic investors or when returns are i.i.d. More generally, investor i behaves as if he was holding a portfolio of non-tradable assets with return vector $\boldsymbol{\phi}_{t+1}^i$, where the vector of shares held in each "state variable asset" varies over time and is given by $\mathbf{u}_i + \mathbf{U}_i' E^i [\boldsymbol{\phi}_{t+1}^i | \boldsymbol{\phi}_t^i]$.

low, and this concern affects portfolio choice today. In particular, it leads investors to favour assets that pay off primarily in states with poor opportunities and thus provide a hedge against such states.

For S-investors, the decomposition highlights two distinct reasons why stocks and off-market opportunities can be perceived as substitutes. The first is a positive correlation between *realized* stock and off-market returns ($\rho_S > 0$). This effect is apparent from the myopic demand in (12). Intuitively, a positive correlation of returns implies that holding stocks is only attractive to the extent that they pay an expected excess return larger than the off-market expected excess return $E_t^S R_{t+1}^B$.

A second, and more subtle, reason for substitutability is a positive correlation between *realized* stock returns R_{t+1}^D and *expected* off-market returns $E_{t+1}^S R_{t+2}^B$, coupled with persistence in $E_t^S R_{t+1}^B$. The key effect here is that the hedging motive makes investors reluctant to hold assets that pay off more when opportunities are good. In particular, if realized stock returns are higher in booms when $E_{t+1}^S R_{t+2}^B$ is also high, it makes sense for investors to hold fewer stocks than they would if they were myopic. With persistent off-market opportunities, this negative hedging demand becomes stronger whenever the *current* expected off-market return is high, making investors substitute out of stocks into private opportunities.

Indeed, persistence in off-market opportunities means that a high *current* expected return $E_t^S R_{t+1}^B$ implies that $E_{t+1}^S R_{t+2}^B$ is anticipated to be higher than the (unconditional) average off-market return. But higher $E_{t+1}^S R_{t+2}^B$ implies that more funds will be invested off-market in $t + 1$, so that any shock to $E_{t+1}^S R_{t+2}^B$ will affect investor well-being more. Anticipation of a high average expected off-market return thus induces a greater need to hedge such shocks. The upshot is that an increase in the expected off-market return today lowers the demand for stocks, even if the contemporaneous correlation is $\rho_S = 0$.

4.1.2. Stock prices, predictability, and the information revealed by prices. To illustrate the impact of investor heterogeneity on the stock price, it is helpful to write the latter as a weighted average of individual investors' *valuations* P_t^U and P_t^S , hypothetical prices that would arise if stocks were held exclusively by U- or S-investors, respectively. Both valuations equal the subjective expected present discounted value of the pay-off X_{t+1} minus a risk premium:¹²

$$\begin{aligned} P_t &= \tilde{v}_U P_t^U + (1 - \tilde{v}_U) P_t^S, \\ P_t^U &= \beta E_t^U X_{t+1} - \beta \left[\gamma \sigma_U^2 - (\bar{h}^U + \mathbf{H}^U \phi_t^U) \right], \\ P_t^S &= \beta E_t^S X_{t+1} - \beta \left[\gamma \sigma_S^2 (1 - \rho_S^2) - (\bar{h}^S + \mathbf{H}^S \phi_t^S) \right] - \beta \rho_S \frac{\sigma_S}{\sigma_B} E_t^S R_{t+1}^B. \end{aligned} \tag{13}$$

The valuation P_t^U moves when there is news about the pay-off, a change in $E_t^U X_{t+1}$, or when the risk premium changes with U-investors' hedging demand. The risk premium contained in S-investors' valuation P_t^S depends also on S-investors' expected off-market return.

When stocks and off-market opportunities are substitutes, both the myopic and the hedging effects sketched above will be active: a drop in the expected off-market return increases S-investors' demand for stocks and hence the stock price. There are two important implications. First, stock returns become predictable for S-investors: predictability of off-market returns "spills

12. The weight $\tilde{v}_U = \left(1 + \frac{1 - \tilde{v}_U}{\tilde{v}_U} \frac{\sigma_U^2}{\sigma_S^2 (1 - \rho_S^2)} \right)^{-1}$ measures U-investors' ability to "move the market". It is higher the larger the share of U-investors in the population and the lower their subjective risk σ_U^2 relative to that perceived by S-investors.

over” to the local stock market. Second, prices cannot fully reveal S-investors’ information: given a price increase, U-investors cannot discern whether it is due to good news about the business cycle or whether it is triggered by bad off-market opportunities.¹³

4.1.3. Equilibrium trades. Combining the portfolio choice and price equations, we obtain that trading occurs if individual valuations change in different ways. This can happen for two distinct reasons, disagreement and risk sharing:

$$\Delta\theta_t^U = \frac{1-\tilde{\nu}}{\beta\gamma\sigma_U^2} \left(\Delta P_t^U - \Delta P_t^S \right) \quad (14)$$

$$\propto \underbrace{\Delta E_t^U X_{t+1} - \Delta E_t^S X_{t+1}}_{\text{Disagreement}} + \underbrace{\rho_S \frac{\sigma_S}{\sigma_B} \Delta E_t^S R_{t+1}^B + \mathbf{H}^U \Delta\phi_t^U - \mathbf{H}^S \Delta\phi_t^S}_{\text{Risk sharing}}.$$

Naturally, U-investors buy stocks from S-investors if they are more optimistic about pay-offs. But even if both investors agree on the distribution of pay-offs, there may be gains from trade if the need for risk sharing has changed. In particular, when S-investors perceive stocks and off-market opportunities as substitutes, they will sell stocks in equilibrium when the expected off-market return increases. Again, both the myopic and the hedging demand effects contribute to trading in the same direction.

We will use equations (13) and (14) below to interpret the responses of the stock price and trading volume to different shocks in the calibrated model. Shocks can affect prices and trading either by changing investors’ expected pay-off on stocks or by changing the expected return on off-market opportunities. As a general rule, shocks that move the expected pay-off on stocks generate a strong price response and a weak quantity response (*i.e.* little trading volume), whereas shocks that affect the expected off-market return generate a strong quantity response but a weak price response. The reason lies in the map from investor valuations to prices and quantities.

Consider first shocks to the expected pay-off on stocks. Such shocks typically move *both* investors’ valuations in the same direction, which produces a price response but not necessarily a trade. This is because the price depends on the average of the individual valuations, whereas a trade requires differences in those valuations. A polar case would be a shock that increases only the expected pay-off on stocks but does not change off-market returns at all. Since both investors care about future pay-offs, there is relatively little incentive for trade. Nevertheless, the stock price must rise to prevent excess demand for stocks.

In contrast, shocks to S-investors’ valuation alone generate trades but only a muted price response. The polar case here is a shock to off-market expected returns that are orthogonal to stock pay-offs. The quantity response to such a shock is relatively large, since the change in S-investors’ valuation amounts to a change in the difference in valuations across investors. At the same time, the price response is relatively small because the average valuation moves less than S-investors’ valuations. Intuitively, as long as a shock affects S-investors’ appetite for stocks only, U-investors are happy to absorb stocks even in the absence of a large price change.

4.2. International equity flows

The U.S. and the local populations both contain sophisticated and unsophisticated types. Let ν^* denote the fraction of U.S. investors in the total population and let ν_U^* denote the fraction of

13. More formally, substitutability of stocks and private opportunities implies that the price must depend on any variable that affects S-investors’ expected off-market return. It thus depends on both state variables $\hat{F}_t^{D,S}$ and $\hat{F}_t^{B,S}$, so that the price cannot be inverted to recover both of these variables.

unsophisticated U.S. investors relative to all U.S. investors. Aggregate U.S. holdings of the local asset are given by

$$\theta_t^* = v^* [v_U^* \theta_t^U + (1 - v_U^*) \theta_t^S].$$

Trade occurs only because there are two distinct investor types, S and U. The market-clearing condition (7) implies that we can write all relevant aggregate statistics in terms of the holdings or trades of just one type. We choose to express everything in terms of U-investors' holdings. U.S. holdings of local equities can be written as

$$\theta_t^* = v^* \left[\frac{1 - v_U^*}{1 - v_U} + \frac{v_U^* - v_U}{1 - v_U} \theta_t^U \right]. \quad (15)$$

Taking differences, U.S. investors' net purchases are

$$\Delta \theta_t^* = v^* \frac{v_U^* - v_U}{1 - v_U} \Delta \theta_t^U \equiv \delta v_U \Delta \theta_t^U. \quad (16)$$

The net purchases of U-investors are given by $v_U \Delta \theta_t^U$. In fact, this quantity captures all the stocks that change hands in the model at date t : if it is positive (negative), it represents stocks bought (sold) by U-investors and hence sold (bought) by S-investors.

The parameter δ is the share of trades between the two investor types that translates into net purchases of the U.S. investor population. It can also be viewed as a measure of the relative importance of cross-country vs. within-country heterogeneity.¹⁴ To illustrate, consider two polar cases for the distribution of nationality and type. The first is perfect correlation: if the populations of U.S. and U-investors are identical, that is, $v_U^* = 1$ and $v^* = v_U$, then we have $\delta = 1$. There is no within-country heterogeneity, but only cross-country heterogeneity. As a result, every trade is a cross-border trade and both U.S. and U-investors' total net purchases are given by $v_U \Delta \theta_t^U$. In the second polar case, nationality and type are independent characteristics, that is, $v_U^* = v_U$, and hence $\delta = 0$. The U.S. investor population is now simply a scaled version (by a factor v^*) of the total population as both the U.S. and local populations contain the same proportions of U- and S-investors. In other words, while there is within-country heterogeneity of investors, there is no cross-country heterogeneity of populations. As a result, U.S. investors' aggregate gross sales and purchases are equal, and their net purchases are 0. Our model allows for anything in between the two polar cases.

5. CALIBRATION

We start by assigning values to model parameters and then discuss the implications of the calibration for investor heterogeneity.

5.1. Parameter choice

5.1.1. Preference parameters. The preference parameters are standard. One period in the model corresponds to one quarter. We choose an annual real discount rate of 4%, that is,

14. Formally, δ works like a regression coefficient of nationality on type. Consider an investor chosen at random from the entire investor population. A natural measure of how well type predicts nationality is

$$\begin{aligned} & \Pr(\text{nationality} = \text{U.S.} \mid \text{type} = \text{U}) - \Pr(\text{nationality} = \text{U.S.} \mid \text{type} = \text{S}) \\ &= \frac{v^* v_U^*}{v_U} - \frac{v^* (1 - v_U^*)}{1 - v_U} = v^* \frac{v_U^* - v_U}{v_U (1 - v_U)} = \delta. \end{aligned}$$

$\beta = 1/R_f = 0.9901$. This value is within the range used in the real business cycle literature. Cooley and Prescott (1995) calibrate the annual real discount rate to 5.2% to match the U.S. capital–output ratio, and King and Rebelo (1999) calibrate it to match the U.S. real return to capital of 6.5%. On the low side, Hansen and Singleton (1982) estimate an annual rate of time preference of 1%. The coefficient of absolute risk aversion is set to $\gamma = 10$. In our calibrations below, this corresponds to an average coefficient of relative risk aversion of approximately five.

5.1.2. Stock market data. To calibrate local dividends, we use the detrended processes estimated in Section 2.1. The data on U.S. investors' stock market trades and trading volume were summarized in Section 2. One technical issue is that both flow and volume data report all transactions in a given quarter, whereas our discrete time model makes predictions about holdings at a point in time. We match model-implied changes in holdings, such as U.S. investors' net purchases $\Delta\theta_t^*$, to the ratio of flows to total market capitalization at the beginning of the period.¹⁵

5.1.3. Private investment opportunities. It is difficult to construct an observable counterpart for the returns to private investment opportunities. Our strategy is to first impose a number of *a priori* plausible restrictions that give rise to a two-parameter family of processes, with the free parameters η_D and η_B introduced in (4). We then fix the remaining parameters to match selected moments on stock market trading activity. We postulate four specific features of private returns. First, private returns are predictable. Predictability has been documented in many securities markets, and it is certainly prevalent for non-traded assets, where returns need not be competed away quickly. Second, only the predictable component of returns is correlated with the local business cycle. Third, there are persistent factors other than the local business cycle that affect expected private returns. Finally, we assume that the unconditional mean and variance of private returns are the same as those of stock returns in the U.S. market (see Table 3(a)).

According to (4), the first component of private expected returns is proportional to the persistent component of local dividends F_t^D . The second component is driven by a process F_t^B that is independent of F_t^D and also has an AR(2) structure. We impose that it captures oscillations at business cycle frequencies by setting the AR(2) parameters equal to those of the persistent component in U.S. dividends. As a normalization, the variance of shocks to F_t^B is set equal to that of F_t^D . The overall volatility of expected returns and the relative importance of the local business cycle is then governed by the parameters η_D and η_B . Given values for η_D and η_B , the variance of unexpected returns $\sigma_{\varepsilon_B}^2$ must be chosen to ensure that the unconditional variance of private returns matches that of the world asset return. Our specification of investment opportunities thus leaves two degrees of freedom that can be used to match statistics of trading activity. The fact that we use the same calibration procedure for all countries further constrains our approach.

5.1.4. Matching portfolio and trading moments. In total, we are left to choose five parameters. The fractions ν^* , ν_U , and ν_U^* govern the composition of the investor population. Picking these three fractions is equivalent to picking a triple (ν^*, ν_U, δ) , where δ was defined in (16). We use the latter parametrization since it permits simpler formulas. In addition, we must pick the parameters η_D and η_B that govern the volatility and business cycle correlation of private returns. We use five moments of trading: mean U.S. holdings of domestic equity, the volatility

15. An appendix, available at the *Review's* website: <http://www.restud.org/supplements.htm>, explains that exponential detrending is consistent with CARA preferences in our model, as in Campbell and Kyle (1993). It also explains why normalizing flows by market capitalization is reasonable and how it interacts with our detrending approach.

and first autocorrelation of U.S. net purchases, mean U.S. gross purchases, and mean volume in the domestic equity market.

To describe the calibration procedure, it is helpful to express the target moments in terms of the moments of type U-investor trades. Mean U.S. holdings and the volatility of U.S. net purchases can be written as

$$\mu(\theta_t^*) = v^* - \delta v_U(1 - \mu(\theta_t^U)), \quad (17)$$

$$\sigma(\Delta\theta_t^*) = |\delta| v_U \sigma(\Delta\theta_t^U). \quad (18)$$

Here $\mu(\theta_t^U)$ and $\sigma(\Delta\theta_t^U)$ are independent of the parameters v^* and δ that determine the U.S. population; they depend only on the parameters v_U , η_D , and η_B that determine trade between the U- and S-investor types.

We measure trading volume by the turnover of shares. Since every trade in the model is an exchange of shares between the two investor types, turnover is $\text{VOL}_t = v_U |\Delta\theta_t^U|$. Gross purchases by U.S. investors in period t are determined by which investor type is a net buyer during the period. Let $\mathbf{1}_{\Delta\theta_t^U > 0}$ denote the indicator function for the event that U-investors are net buyers. The remaining target moments are

$$\text{corr}(\Delta\theta_t^*, \Delta\theta_{t-1}^*) = \text{corr}(\Delta\theta_t^U, \Delta\theta_{t-1}^U), \quad (19)$$

$$\mu(\text{VOL}_t) = v_U \sqrt{2/\pi} \sigma(\Delta\theta_t^U), \quad (20)$$

$$\begin{aligned} \mu(\text{GP}_t^*) &= v^* E[\mathbf{1}_{\Delta\theta_t^U > 0} v_U^* \Delta\theta_t^U + \mathbf{1}_{\Delta\theta_t^U < 0} (1 - v_U^*) \Delta\theta_t^S] \\ &= (v^* + \delta(1/2 - v_U)) \mu(\text{VOL}_t). \end{aligned} \quad (21)$$

The autocorrelation of U.S. net purchases and mean volume are independent of the U.S. population parameters, while mean gross purchases generally depend on all five parameters.

The structure of the five equations suggests the following iterative calibration procedure. For fixed v_U , we first find values of η^D and η^B that match the autocorrelation of flows and mean volume. This amounts to solving two non-linear equations in two unknowns. Mean holdings and the volatility of flows can then be matched by choosing v^* and δ to solve (17) and (18). The latter two equations permit two solutions, indexed by the sign of δ . To pin down the solution, we use the fact that (16) implies

$$\text{cov}(\Delta\theta_t^*, R_t^D) = \text{sign}(\delta) \text{cov}(\Delta\theta_t^U, R_t^D).$$

Since $\text{cov}(\Delta\theta_t^*, R_t^D)$ is positive in the data for all countries, we take $\text{sign}(\delta) > 0$ if and only if $\text{cov}(\Delta\theta_t^U, R_t^D)$, a function of v_U , η_D , and η_B , is positive. Finally, we repeat the preceding steps to search for a value of v_U that best matches mean gross purchases. This baseline procedure works well for three of our six countries. We discuss modifications for the other countries below.

5.1.5. Identification. To obtain further intuition on identification, consider the map from the parameters (v_U , η_D , η_B) to the moments (19) and (21). Trading volume and mean U.S. gross purchases depend positively on η_D , the sensitivity of the off-market expected return to the business cycle factor, but negatively on η_B , the sensitivity of the off-market expected return to the off-market factor. Intuitively, the more the off-market expected return is correlated with the business cycle, the more stocks and private opportunities are viewed as substitutes by S-investors, which in turn generates risk-sharing trades, as discussed in Section 4.¹⁶ The persistence of net

16. We return to the mechanism that generates asset substitutability in Section 6.2 below, where we present impulse responses for the different shocks.

purchases depends positively on both η_D and η_B , since both parameters induce persistence in the expected off-market returns that drives the risk-sharing trades.

Increasing investor heterogeneity by setting ν_U closer to its maximum at $\nu_U = 1/2$ increases trading volume. The effect of ν_U on mean gross purchases is *a priori* ambiguous. Equation (21) shows that ν_U matters in two ways for mean gross purchases or for U.S. investors' trading volume. On the one hand, U.S. investors' volume is proportional to total volume. This feature suggests that, as the overall population becomes more heterogeneous (*i.e.* as ν_U becomes closer to $1/2$), U.S. volume should increase along with total volume. On the other hand, equation (21) shows that U.S. investors' volume is higher, as the more heterogeneous the U.S. population is, relative to the total population.

Indeed, in the absence of cross-country heterogeneity ($\delta = 0$), or if investor heterogeneity is maximal ($\nu_U = 1/2$), the U.S. simply absorbs a fraction of total volume equal to its population share ν^* . More generally, U.S. investors' volume is higher than ν^* times total volume if the U.S. investor population is more heterogeneous than the local investor population. This is true if ν_U^* is further away from $1/2$ than ν_U , such as in the numerically relevant case $\nu_U < 1/2$ and $\delta > 0$ (*i.e.* $\nu_U < \nu_U^*$). This feature suggests that, as the overall population becomes more heterogeneous, U.S. volume should decline, since the U.S. population becomes less heterogeneous relative to the overall population. In our numerical calculations, the latter effect turns out to be small, so that mean gross purchases increase as ν_U becomes closer to $1/2$. Another numerical result is that persistence is insensitive to ν_U , so that this parameter is identified by total volume and U.S. gross purchases only.

5.1.6. Calibration results. Table 4 lists the calibrated parameter values together with data and model values of the target moments. For France, Canada, and Italy, the results simply reflect the baseline calibration procedure discussed above. With the exception of mean gross purchases, all target moments are matched exactly. Our matching procedure does not work as well for Germany, U.K., and Japan.

For Germany, the large observed volume can be matched only if the model implied U.S. mean gross purchases are much larger than their observable counterparts. The model thus cannot reconcile the huge domestically generated volume with the small volume generated by U.S. investors participating in Germany. One possible reason is that we measure volume from a small sample in the 1990's, when the German market was growing rapidly and saw a fair amount of merger and privatization activity. Total volume might thus be due to extraordinary domestic trades that Americans did not participate in. Our reported calibration is thus guided by volume in France, which is quite similar to Germany in terms of all other trading statistics.

For U.K. and Japan, there do not exist values of ν_U such that we can choose η_D and η_B to match both persistence and mean volume. The dividend process in these countries is special in two ways. On the one hand, $\sigma(\varepsilon^{FD})$ in Table 2 is large relative to $\sigma(\varepsilon^D)$, which implies that there is little incomplete information about the state of the business cycle. On the other hand, dividends exhibit only weak momentum with an estimated serial correlation of ΔF^D that is much lower than that in other countries. The first fact, on the near-absence of incomplete information, leads to lower flow momentum because it lowers the correlation of realized off-market returns with the business cycle. The second fact implies that the business cycle factor does not contribute much to the persistence of flows. If the calibration procedure is to match persistence, it must therefore assign a prominent role to the off-market factor (higher η_B). However, increasing η_B reduces volume, since it lowers the correlation of expected off-market returns with the business cycle, which is important for generating risk-sharing trades.

While it is possible to select parameters to match persistence, the implied trading volume is at most one-fifth the value in the data. For the reported results in Table 4, we have instead selected

TABLE 4

Parameters and calibrated moments

Parameters	France		Canada		Germany		U.K.		Japan		Italy	
	η_D	η_B	η_D	η_B	η_D	η_B	η_D	η_B	η_D	η_B	η_D	η_B
Private return, %	0.94	1.02	0.25	1.07	0.66	0.79	0.92	0.57	0.63	0.00	0.68	0.43
# U-investors		v_U		v_U		v_U		v_U		v_U		v_U
		0.42		0.41		0.43		0.30		0.57		0.294
U.S. population	v^*	v_U^*	v^*	v_U^*	v^*	v_U^*	v^*	v_U^*	v^*	v_U^*	v^*	v_U^*
	0.12	0.44	0.14	0.44	0.098	0.45	0.119	0.41	0.075	0.77	0.008	0.37
Moments	Data	Model	Data	Model	Data	Model	Data	Model	Data	Model	Data	Model
$\mu(\theta^*)$, %	12.7	12.7	14.3	14.3	9.9	9.9	12.4	12.4	8.0	8.0	1.1	1.1
$\sigma(\Delta\theta^*)$, %	0.28	0.28	0.37	0.37	0.14	0.14	0.24	0.24	0.13	0.13	0.31	0.31
$\rho_1(\Delta\theta^*)$	0.46	0.46	0.52	0.52	0.35	0.35	0.51	0.09	0.45	0.14	0.16	0.16
$\mu(\text{VOL})$, %	16.9	16.9	14.1	14.1	51.6	15.1	3.9	3.2	4.8	1.7	86.2	86.2
$\mu(\text{GP}^*)$, %	0.9	2.1	3.2	2.0	1.0	1.5	4.5	0.42	0.9	0.12	0.8	0.74
δ , %	1.32	1.32	2.09	2.09	0.22	0.74	4.9	5.9	2.16	6.1	0.29	0.29

Notes: θ_t^* is U.S. holdings of foreign stocks, $\Delta\theta_t^*$ is net purchases by U.S. investors, VOL is local trading volume, GP_t^* is gross purchases of foreign stocks by U.S. investors, and δ is a measure of investor heterogeneity as given in (22). The calibrated parameters for private returns η_D and η_B are expressed as the product of the original parameter with $\sigma_{\varepsilon^{FD}}$ obtained from Table 2. v^* and v_U^* are respectively the fraction of U.S. investors in the total population and the fraction of unsophisticated U.S. in the U.S. investor population. $\mu(x)$ is the mean, $\sigma(x)$ is the S.D., and $\rho_1(x)$ the first autocorrelation of x .

a case in which neither volume nor persistence is matched exactly, but in which our measure of cross-country heterogeneity, discussed in the next subsection, is more in line with the data. An alternative approach is to drop the condition $\sigma(\varepsilon^{FB}) = \sigma(\varepsilon^{FD})$ that is imposed in our calibration procedure. To illustrate this possibility, we have recalibrated the U.K. with $\sigma(\varepsilon^{FB}) = 0.1$, the parameter value also used for France. Lower $\sigma(\varepsilon^{FB})$ means that we can increase η^B in order to match persistence without unduly lowering the trading volume moments. The alternative calibration delivers $\mu(\text{VOL}) = 1.9\%$, $\mu(\text{GP}^*) = 0.24\%$, and $\sigma(\text{VOL}) = 1.44\%$ while also matching flow persistence.

The differences between U.K. and Japan and the rest of the countries are reflected in the loadings on the factors in the off-market expected return (top line of Table 4). Each loading has been scaled to represent the impact of a one S.D. shock to the factor in order to make it comparable across countries. As our discussion above suggests, the impact of the off-market factor dominates that of the local business cycle factor for France, Canada, and Germany, but not for U.K. and Japan. As with U.K. and Japan, the impact of the local business cycle factor dominates that of the off-market factor for Italy, but for a different reason, discussed in Section 6.2.

5.2. Inferring the nature of investor heterogeneity

One important result of the calibration procedure is that it lets us infer the relative importance of within-country and cross-country heterogeneity, measured by the parameter δ . Combining (18) and (20) yields

$$\delta = \sqrt{\frac{2}{\pi}} \frac{\sigma(\Delta\theta_t^*)}{\mu(\text{VOL}_t)}. \quad (22)$$

According to the model, if nationality and type amount to the same characteristic ($\delta = 1$), then the volatility of U.S. net purchases should be roughly the same size as mean volume, since every trade is a cross-country trade. If within-country heterogeneity is more important (lower δ), then cross-country trades contribute less to total volume. As a result, volatility of net flows will be much smaller relative to volume.

Table 4 delivers estimates of the extent and nature of investor heterogeneity. With the exception of Japan, the average international U.S. investor is sophisticated: $\nu_U^* < 0.5$. However, the average U.S. international investor is less sophisticated than the average local investor for all countries: we have $\nu_U < \nu_U^*$ or, equivalently, $\delta > 0$. Aggregate net flows of U.S. investors are thus proportional to U-investors' net flows (cf. (16)). As a result, the average U.S. investor looks less informed than the average local investor, as is usually assumed in the literature on home bias.

At the same time, the association of unsophisticated and U.S. investors is far from perfect. Indeed, the parameter δ that measures the strength of this association is close to 0. Table 4 shows that its value in the data varies from 0.22% in Germany and 0.29% in Italy to 2.2% in Japan and 4.9% in the U.K. The model matches these values quite well. In comparison, a standard set-up where all U.S. investors are uninformed would imply $\delta = 100\%$. Our results thus suggest that within-country heterogeneity is much more important than cross-country heterogeneity in explaining observed trading behaviour.

It is interesting to note that this result does not depend on the particular mechanism that generates trade in our model. Indeed, while our matching procedure determines all five free parameters simultaneously, the correlation coefficient δ is pinned down by the ratio of mean volume to the volatility of U.S. investors (cf. (22) above). As long as the model is required to match both of these moments, it must feature small δ and within-country heterogeneity must be large relative to cross-country heterogeneity.

An alternative measure of investor heterogeneity is the contemporaneous correlation of U.S. gross purchases with U.S. gross sales:

$$\rho(GP_t^*, GS_t^*) = 1 - \frac{\text{cov}(GP_t^*, \Delta\theta_t^*)}{\text{var}(GP_t^*)}. \quad (23)$$

The ratio on the R.H.S. of (23) is the slope coefficient on the regression of $\Delta\theta_t^*$ on GP_t^* . This coefficient is always positive and is highest when there is no within-country heterogeneity (*i.e.* $\delta = 1$); positive GP_t^* translates into $\Delta\theta_t^*$ one-for-one and zero GP_t^* leads to negative $\Delta\theta_t^*$. In this case, $\rho(GP_t^*, GS_t^*) < 0$; if $GP_t^* > 0$ and $GS_t^* = 0$, then GP_t^* is likely to be above its mean whereas GS_t^* is below its mean and vice versa when $GP_t^* = 0$ and $GS_t^* > 0$. Introducing within-country heterogeneity raises this correlation. Indeed, it is possible to show that $\rho(GP_t^*, GS_t^*)$ is decreasing in δ , holding ν_U fixed (in the empirically relevant parameter range for δ/ν^*), and that matching δ/ν^* leads to high and positive values for $\rho(GP_t^*, GS_t^*)$.

6. QUANTITATIVE ANALYSIS

6.1. Flow reversal, gross flows, and return chasing

Out of the three stylized facts we set out to explain, only the persistence of net flows (as reflected in $\rho(\Delta\theta_t^U, \Delta\theta_{t-1}^U)$) was directly used to calibrate the model. Table 5 reports data and model statistics on the other stylized facts not used in the calibration. In addition, Figure 2 plots model-implied autocorrelograms of flows and cross-correlograms of returns and flows for all six countries together with the respective correlograms from the data. Ninety per cent confidence bands were computed using Newey–West S.E.

The first column in Figure 2 presents the autocorrelogram of U.S. investors' net purchases. Both the model and the data display a J-curve pattern, with flow momentum up to 3 (and sometimes 4) lags and flow reversal at lags 5 and 6. In addition, flow correlations eventually increase again, although the rebound is quicker in the data than in the model. For the U.K. and Japan these patterns are weaker, as discussed above. For all countries, the model produces high positive contemporaneous correlation between gross purchases and gross sales; gross trading activity

TABLE 5

Non-calibrated moments

	France		Canada		Germany		U.K.		Japan		Italy	
	Data	Model	Data	Model	Data	Model	Data	Model	Data	Model	Data	Model
$\rho(\Delta\theta_t^*, R_t^D)$	0.17	0.50	0.27	0.14	0.28	0.28	0.16	0.68	0.40	0.86	0.13	0.60
$\rho(\Delta\theta_t^*, E_t^U R_{t+1}^D)$	+	0.16	+	0.17	+	0.20	+	0.24	+	0.25	+	0.19
$\sigma(\text{VOL}), \%$	3.1	12.8	2.7	10.7	13.2	11.4	2.1	2.4	2.7	1.3	35.1	65.1
$\rho(\text{GP}_t^*, \text{GS}_t^*)$	0.63	0.98	0.97	0.97	0.87	0.99	0.95	0.75	0.91	0.32	0.60	0.86

Notes: $\Delta\theta_t^*$ is net purchases by U.S. investors, R_t^D is the local excess stock return, VOL is local trading volume, and GP_t^* and GS_t^* are gross purchases and gross sales of foreign stocks by U.S. investors, respectively. Data for $\rho(\Delta\theta_t^*, E_t^U R_{t+1}^D)$ were taken from Table 2 in Bohn and Tesar (1996). σ stands for S.D. and ρ is the correlation coefficient.

occurs in waves of simultaneous buying and selling. The fact that it overpredicts the correlation in some countries could be due to transitory idiosyncratic shocks that are recorded as gross flows in the data.

Return chasing behaviour is apparent both from Table 5 and from the cross-correlograms in the second column of Figure 2. The model generates positive contemporaneous correlation between returns and net purchases ($\rho(\Delta\theta_t^*, R_t^D) > 0$) for all countries. Moreover, it captures the tent-shaped pattern around the contemporaneous correlation displayed in the data. Qualitatively, it also captures cyclicity in the correlation of lagged returns and flows: low and negative at 2 and 3 lags, and increasing after lags 4 or 5. The model also generates positive correlation between net purchases by U.S. investors and expected returns based on public information: $\rho(\Delta\theta_t^*, E_t^U R_{t+1}^D) > 0$. This is consistent with evidence presented by Bohn and Tesar (1996) for our set of countries. These authors estimate expected returns using a comprehensive set of instruments that proxies the public information set. They then show that U.S. investors move into a market when their fitted expected returns are high.

6.2. Interpreting structural shocks

To provide intuition for our numerical results, we now discuss the role of three structural shocks in generating the stylized facts we are interested in. We consider the business cycle shock ε_t^{FD} , the transitory shock to dividends ε_t^D , and the innovation to the off-market factor ε_t^{FB} . We omit the transitory shock to off-market returns, since its contribution to the moments of interest is negligible. We also focus on one country, France, as a representative example. The construction of variance decompositions and structural impulse response functions is explained in the appendix available at the *Review's* website.

6.2.1. Variance decompositions and impulse responses. Figure 3 provides variance decompositions that quantify the relative importance of the three shocks. Every panel plots the contribution of the three shocks to one key second moment. The top right panel shows the first autocovariance of U-investors' net purchases, a measure of persistence. The other panels illustrate three aspects of return chasing: the covariances of U-investors' net purchases with current, lagged, and expected future returns. As discussed above, U.S. investors' net purchases are proportional to those of U-investors, so that their properties can also be directly read off the figure. From Tables 4 and 5 and Figure 2, we have that all four moments are positive in the data.

Figure 4 provides impulse responses for the three shocks (in columns), where the size of a shock is normalized to one S.D. Every column displays the reaction of the local stock price P_t ; U-investors' forecast error of the business cycle, $F_t^D - E_t^U(F_t^D)$; the local per-dollar stock return,

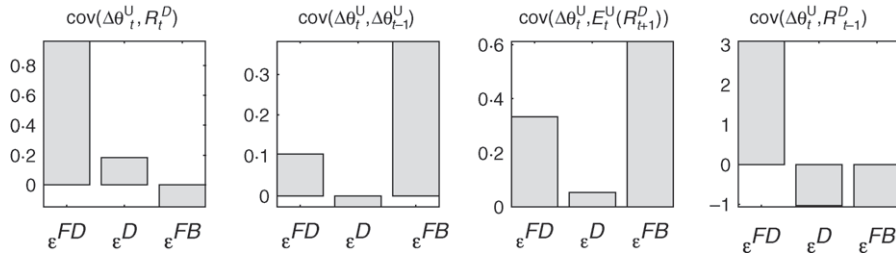


FIGURE 3

Variance decompositions for four key second moments. The contributions of the three shocks ϵ^{FD} , ϵ^D , and ϵ^{FB} are stated as fractions of the total covariance. $\Delta\theta_t^U$ denotes net purchases of local stocks by U-investors; R_t^D is the local excess stock return; $E_t^U R_{t+1}^D$ is U-investors' time t expectation of the time $t+1$ local excess stock return.

R_t^D ; U-investors' net purchases, $\Delta\theta_t^U$; and U-investors' conditional one-quarter-ahead forecast of the local stock return, $E_t^U(R_{t+1}^D)$.

6.2.2. Business cycle shocks, persistence, and return chasing. The business cycle shock, ϵ^{FD} , contributes positively and significantly to all four moments in Figure 3. It is especially important for the return chasing moments as well as for the oscillating correlograms of Figure 2. Figure 4 shows that, on impact, the shock leads U-investors to buy stocks and simultaneously increases the stock price. These price and quantity responses are the net result of two counteracting effects that affect prices and quantities in opposite directions.

On the one hand, a positive realization of ϵ^{FD} increases S-investors' expected off-market returns. Because stocks and off-market opportunities are substitutes, S-investors are led to sell stocks, which tends to lower the stock price. On the other hand, the shock raises both investors' expected pay-off from stocks, since it provides good news about dividends. This induces an increase in the stock price. It also leads S-investors to buy stocks, because S-investors are relatively more optimistic than U-investors. Indeed, both investors "underreact"; since they cannot be sure that the observed movements in dividends and prices have not been caused by other shocks, their forecast moves by less than the true state of the business cycle. However, S-investors receive an additional signal; the off-market return also provides information about the business cycle. As a result, S-investors underreact by less, which makes them more optimistic.

The net result of Figure 4 follows from the general rule announced in Subsection 4.1: a change to the expected pay-off on stocks leads to a strong price response and a weak quantity response, while the opposite is true for a change to the expected off-market return. In the present context, the price response is therefore dominated by the good news about dividends: the price rises even though S-investors are dumping stocks. In contrast, the quantity response is dominated by S-investors' desire to get out of the market and into private opportunities, even though these investors are actually more optimistic about stocks than U-investors. The bottom line is that the business cycle shock thus leads to a high realization of stock returns together with a net purchase by U-investors, and with $\delta > 0$, also by U.S. investors. In fact, Figure 3 shows that this shock is responsible for most of the contemporaneous correlation of flows and returns generated by our model.

This outcome is exactly what is needed for stocks and private opportunities to actually be perceived as substitutes in equilibrium. In Section 4.1, we have shown that asset substitutability obtains if realized stock returns are positively correlated with either expected off-market returns or realized off-market returns. In the present context, both conditions are satisfied. On the one hand, if the price rises with a business cycle shock, realized stock returns are high when

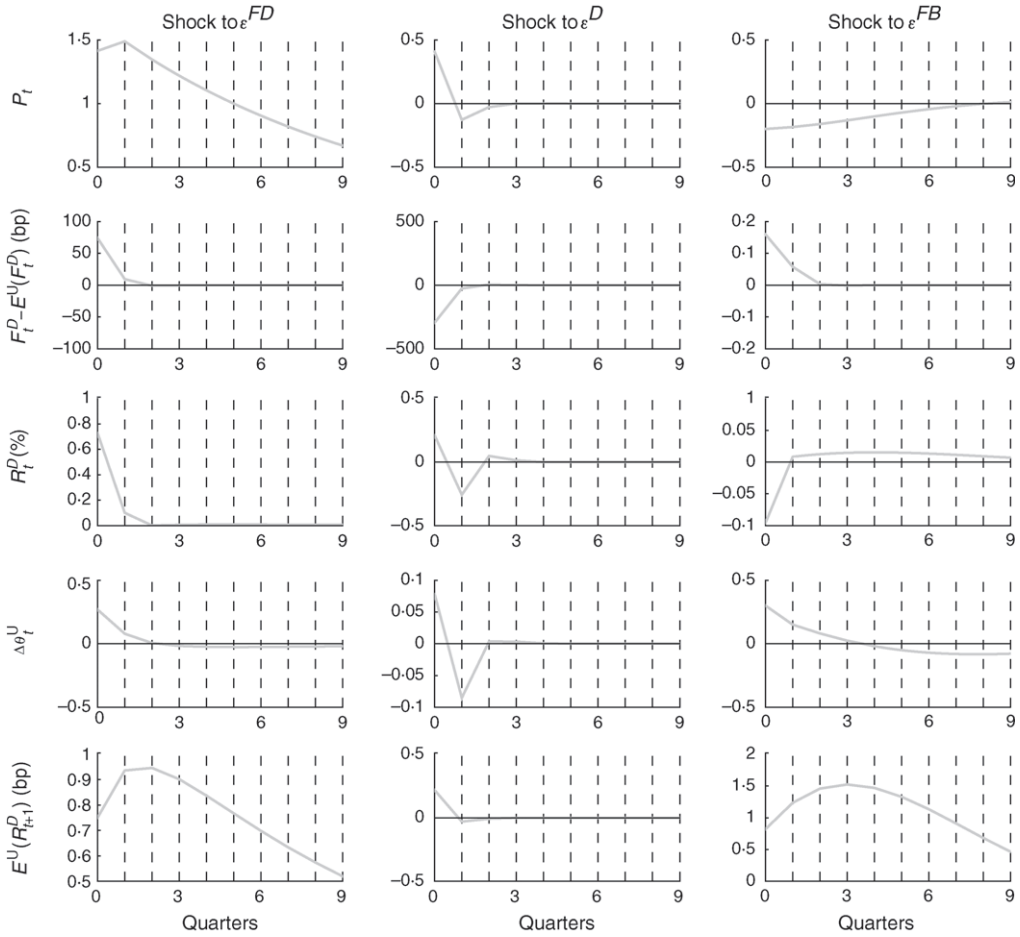


FIGURE 4

Impulse responses to one S.D. shocks in ε^{FD} , ε^D , and ε^{FB} . P_t is the local stock price; $F_t^D - E^U F_t^D$ is U-investors' forecast error on the business cycle factor (in basis points); $\Delta\theta_t^U$ is net purchases of the local stocks by U-investors; R_t^D is the local excess stock return; and $E_t^U R_{t+1}^D$ is U-investors' time t expectation of the time $t + 1$ local excess stock return (in basis points).

off-market opportunities are good. On the other hand, imperfect information about the true state of the business cycle, together with procyclicality of off-market opportunities ($\eta_D > 0$), implies that a high realization of the off-market return R^B signals high F^D . It thus leads to an increase in S-investors' estimate of F^D ; off-market returns are then associated with high realized stock returns.

The high stock return realized on impact is followed by further net purchases by U-investors, before reversal sets in. In fact, for three quarters after the impact effect, disagreement and risk-sharing trades go in the same direction, thus generating pronounced return chasing. While disagreement is reduced as U-investors learn about the nature of the shock and become more inclined to buy, business cycle momentum creates more private opportunities. S-investors' incentive to sell shares thus also increases, at least in the short run. After about three quarters, reversal sets in. Disagreement has become weaker, while the return on private opportunities is now beginning to revert to the mean. As a result, S-investors return to the stock market. Both initial

momentum and eventual reversal of flows are predictable given the high realized return caused by the initial shock. This explains the observed oscillations of the cross-correlogram in Figure 2. We note, however, that disagreement trades represent a minor part of overall trading activity as the calibrations induce significant information revelation.

6.2.3. Off-market shocks and persistence. Figure 3 shows that the off-market shock, ε^{FB} , contributes significantly to the persistence of net purchases. However, it also makes it more difficult for the model to account for return chasing (it generates a negative correlation between net purchases and current and lagged returns) and for the observed trading volume (it generates more asymmetric information and adverse selection trades). Consider a positive realization of ε^{FB} . S-investors' expected off-market returns increase and, with asset substitutability, S-investors sell the local stock, depressing its price. There is another induced effect. Indeed, as U-investors see the price fall, they believe that F^D may have moved and end up underestimating the state of the business cycle. A lower expectation of dividends induces them to sell and puts further downward pressure on the price.

The price response to an off-market shock is thus clearly negative. For quantities, the risk-sharing trades generated by the asset substitutability override the disagreement trades. The latter are smaller since the shock does not generate a lot of disagreement, but contribute to lower volume nonetheless: Figure 4 shows that U-investors' forecast error is small, while S-investors' forecast error is equal to zero since they observe the shock. Overall, the off-market shock leads S-investors to sell as stock prices fall, thus working against return chasing. As the shock persists and F_t^B increases, investors learn the nature of the shock and the forecast error is reduced. However, S-investors keep leaving the stock market to pursue private opportunities, thus generating persistent flows. As U-investors buy following low returns, the shock also generates negative covariance of lagged returns and flows.

Momentum in the expected off-market return is necessary in order to quantitatively match flow persistence in most of the countries. To explore this issue, we have re-calibrated France with an AR(1) process for the off-market factor, with the same first order serial correlation as in the original calibration (*i.e.* $\rho(F_t^B, F_{t-1}^B) = 0.96$). The resulting first autocorrelation of net purchases (0.044) is still positive, but significantly below the estimate from the data. At the same time, the model can qualitatively generate flow momentum even when the off-market factor is not present at all. This is illustrated by the case of Japan, where $\eta^B = 0.001\%$.

For the case of Italy, the model matches persistence quantitatively even though η^B is small. The variance decomposition of $\text{cov}(\Delta\theta_t^U, \Delta\theta_{t-1}^U)$ (not reported) confirms that the off-market factor contributes almost nothing towards persistence in Italy. The reason is that dividend shocks are particularly volatile in Italy (Table 2 shows that $\sigma(\varepsilon^{FD}) \approx \sigma(\varepsilon^D)$). An increase in dividends is thus as likely to have come from a persistent business cycle shock as from a transitory dividend shock. As a result, there is a lot of imperfect information in the Italian market that entails persistent forecast errors (with a hump-shaped response to ε^{FD} shocks as F_t^D unfolds) and highly persistent risk-sharing trades. Imperfect information thus replaces momentum in the off-market expected return as an alternative mechanism driving flow momentum.

6.2.4. Dividend shocks, public signals, and overreaction. Transitory shock to dividends, ε^D , contribute positively only to the contemporaneous correlation of flows and returns. They work against both persistence and positive correlation of flows and lagged returns. In response to a positive realization of ε^D , both investors see dividends increase. However, they cannot exclude the possibility that the business cycle factor F^D has moved and therefore increase their forecast of F^D . Since the shock increases the expected pay-off from stocks, there is a strong positive price response. The quantity response is due to the combination of two effects. First,

the increase in expected F^D is stronger for U-investors, who have access to fewer signals and therefore update their belief more in response to the dividend signal. As a result, disagreement increases and induces U-investors to buy. Second, when S-investors believe that F^D is higher, they also believe that there are better off-market opportunities, which leads them to sell stocks.

The first effect driving the quantity response is an overreaction to a public signal, here, dividends, that induces positive correlation between U-investors' flows and local stock returns, as in Brennan and Cao (1997). However, trades driven by a transitory shock are quickly reversed as investors correct their forecast errors. Since transitory shocks generate negative serial correlation in flows, too large a contribution from these shocks would prevent the model from matching persistence. This is why our calibration procedure finds the other two shocks to be relatively more important. Reversal of trades also generates positive correlation of net purchases with lagged returns. While we do not target this moment directly in the calibration, the limited role of transitory shocks is important for the success of our model along this dimension.

6.3. *Transitory links*

In the baseline model discussed so far, we have maintained the assumption that transitory shocks to off-market returns and dividends are uncorrelated, that is, there are no "transitory links". The results show that dependence of expected off-market returns on the business cycle, or $\eta_D > 0$, is sufficient for generating the stylized facts. However, the baseline model generates "too much" return chasing for France: the contemporaneous correlation is too high. In this section we show that the model performance can be improved further with transitory links, in particular, $\rho(\varepsilon^B, \varepsilon^D) > 0$. However, we also show that correlation of persistent shocks is necessary: a model with only transitory links cannot generate the stylized facts.

To assess the contribution of transitory links, we recalibrate the model for France using the contemporaneous correlation of returns and net purchases as an additional target. We obtain population parameters $v_U = 0.44$, $v_U^* = 0.47$, and $v^* = 0.124$, and the return parameters satisfy $\eta_D \sigma_{\varepsilon^{FD}} = 0.85\%$, $\eta_B \sigma_{\varepsilon^{FB}} = 1\%$, and $\rho(\varepsilon^B, \varepsilon^D) = 0.675$. At these parameter values, the model replicates the results in Table 4, but also yields $\rho(\Delta\theta_t^*, R_t^D) = 0.32$, a significant improvement.

The main qualitative difference to the baseline model is that transitory links induce more disagreement. This is because correlated noise makes it harder for U-investors to quickly infer the nature of shocks. The response to any shock thus becomes more persistent, since learning only gradually resolves disagreement. This is the key to improved quantitative performance. Indeed, in the baseline calibration, persistence must be explained to a much greater extent by risk-sharing trades following a business cycle shock. But such trades are accompanied by pay-off effects that generate a lot of return chasing. With transitory links, the implied dependence of off-market expected returns on the business cycle is weaker, $\eta_D \sigma_{\varepsilon^{FD}}$ drops to 0.85% (from 0.92%) in the new calibration. Disagreement trades ensure that the model can still account for persistence, but return chasing is now much lower.

6.3.1. Are transitory links enough? To check whether transitory links are sufficient for generating the stylized facts, we again recalibrate the model for France. In addition to allowing $\rho(\varepsilon^B, \varepsilon^D) \neq 0$, we also shut down dependence of expected off-market returns on the business cycle: $\eta_D = 0$. We also assume that S-investors observe the local business cycle factor F^D . In terms of information and correlation of shocks, the set-up now mimics that in Wang (1994). However, in contrast to Wang's model, we retain the distribution of fundamentals from our

baseline model so that the transitory links model can match observed persistence.¹⁷ The calibration procedure targets the same moments as in the baseline case. However, we no longer need to find η_D , but instead seek to determine the new free parameter $\rho(\varepsilon^B, \varepsilon^D)$.

The transitory links model can account for U.S. holdings in France, the volatility of U.S. investors' net purchases and flow persistence. However, it cannot match observed trading volume jointly with those three moments at any parameter values. We focus on the parameter vector that generates the highest mean volume, which is still only $\mu(\text{VOL}) = 12\%$; mean gross purchases are then $\mu(\text{GP}) = 1.47\%$. The population parameters are $v_U = 0.5$, $v^* = 0.119$, and $v_U^* = 0.538$, whereas the parameters of the off-market return process are $\eta_B \sigma_{\varepsilon^{FB}} = 0.33\%$ and $\rho(\varepsilon^B, \varepsilon^D) = 0.97$.

For the non-calibrated moments, we have $\rho(\Delta\theta_t^*, R_t^D) = 0.24$, $\rho(R_{t-1}^D, \Delta\theta_t^*) = -0.6$, and $\rho(\text{GP}_t^*, \text{GS}_t^*) = 0.97$. The transitory links model thus generates less contemporaneous correlation than the baseline model. However, it fails dramatically to generate the fact that high returns forecast high U.S. investors' net purchases. Finally, even though unexpected returns are highly correlated ($\rho(\varepsilon^B, \varepsilon^D) = 0.97$), the equilibrium correlation of *expected* returns as seen by an econometrician with the same information as U-investors is close to 0 and negative ($\rho(E_t^U R_{t+1}^D, E_t^U R_{t+1}^B) = -0.02$).

As discussed above, transitory links induce disagreement and thereby persistence. However, with only transitory links, extremely high correlation of the shocks ε^B and ε^D is required. The model with only transitory links fails to generate sufficient volume for two reasons. One is the large amount of asymmetric information: given high uncertainty, U-investors are more reluctant to buy or sell in the absence of large price changes. In addition, S-investors now use stocks much less to hedge shocks to future expected off-market returns: with $\eta^D = 0$ the strong positive correlation between realized stock returns and expected future off-market returns has disappeared.

To see why the model with only transitory links cannot explain why high realized returns forecast U.S. investor net purchases, consider a shock to the business cycle factor F^D . On impact, S-investors sell stocks. This effect is as in the baseline model and implies that the transitory links model also explains positive *contemporaneous* correlation of U.S. net purchases and returns. However, S-investors reverse their trades and start returning to the stock market immediately after the impact period. Indeed, it is profitable to buy for four quarters as long as U-investors' forecasts worsen. This sell-out by U-investors after a period of large positive returns is inconsistent with the data. In contrast, the baseline model does not generate immediate reversal. If $\eta_D > 0$, business cycle momentum keeps off-market opportunities plentiful after an F^D shock and encourages further selling as S-investors shed risk.

7. CONCLUSIONS

This paper has shown that a calibrated dynamic model of asset trading can capture key stylized facts on the role of U.S. investors in foreign equity markets. In such a model, within-country heterogeneity between sophisticated and other investors turns out to be much more important for explaining cross-border trade than cross-country heterogeneity between investor populations. The latter conclusion follows from the small ratio of the volatility of net flows to mean trading volume and mean gross purchases. It is thus independent of the particular nature of heterogeneity

17. Wang's model assumes AR(1) fundamentals, which imply AR(1) terms in equity holdings and hence negative serial correlation in trades. While it can generate persistence in trading volume, an absolute value, it cannot accommodate persistence in net purchases of a known investor class, a sequence of "signed trades" that can be positive or negative. Explaining persistent volume is easier, since taking the absolute value of the first difference of a stationary process is itself a way of inducing persistence. This is seen most easily when the process itself is i.i.d. The first difference of an i.i.d. process is an MA(1) process with negative serial correlation. Taking the absolute value makes the correlation positive and thus induces persistence.

that generates trade in our model. We expect it to be a robust fact that will resurface in any model that aims to match key moments of trading in international portfolio equity.

There are a number of directions for future research. The present paper takes a parsimonious approach to modelling heterogeneity. While our set-up does a reasonable job at capturing properties of aggregate flow data, it would be interesting to examine a richer structure with more types and assets. Such an exercise could be guided by more micro-level data on both equity flows as well as flows in and out of private opportunities. We have also retained the standard assumption that investors trade broad stock indices. An extension to multiple stocks would introduce portfolio rebalancing within a country portfolio as a separate source of gross flow correlation.

Finally, it would be interesting to apply our set-up to emerging markets. The motives for trade we emphasize, risk sharing and disagreement, are often mentioned in policy discussions on the merits of financial liberalization or capital controls. A quantitative model that captures both motives could be useful in examining the welfare consequences of such policies.

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