Gross Capital Flows and Asymmetric Information

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Abstract

This paper shows that the behavior of gross capital flows can identify the nature of information asymmetries in international equity markets. Information asymmetry *between* foreign and domestic investors implies a correlation between net flows and returns. Information asymmetry *within* groups of foreign and domestic investors implies that gross flows and absolute returns are correlated. I find that the correlation between gross flows and absolute returns is stronger than the correlation between net flows and returns, suggesting that information asymmetries within countries are more important than those between countries.

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Key words: gross international capital flows, asymmetric information, trading volume

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1 Introduction

Net international capital flows are associated with a tremendous volume of gross cross-border transactions. In fact, net flows account for only a small fraction of total flows. For example, between 1990 and 1998 average net annual flows in bonds and equity between the U.S. and the rest of the world accounted for only about 3% of total flows. [1] This paper presents some basic facts about gross equity flows, and offers a dynamic rational expectations model that can account for their behavior. Furthermore, I show that the relationship between gross flows and returns can help us to identify the nature of information asymmetries in international capital markets.

The fact that gross flows are large was first pointed out by Tesar and Werner (1995). I expand upon their work by emphasizing not only the size of gross flows, but also their variance and their relationship with returns. Two facts emerge from my investigation. First, total gross flows are far more volatile than net flows. Second, gross flows are correlated with absolute returns. I investigate what types of investor heterogeneity are necessary to match these patterns. I contrast three types: random noise in investors' demands, asymmetric information between countries, and asymmetric information within countries.

Random noise in investors' demands can generate gross flows. The size of gross flows in this case depends on the variance of the noise: the greater the variance, the greater the gross flows. However, if the variance is constant over time, so are gross flows constant. Contrary to this, my data shows that gross flows are highly volatile. Random noise would have to be extremely heteroskedastic to generate matching variance of gross flows. Even if this were the case, random noise could not explain why gross flows are associated with absolute returns. Hence, random noise in investors' demands can not explain the patterns found in gross flows data.

To explain the patterns of gross flows I use a well established result that asymmetric information can generate trading among investors (Grossman 1976). Trading occurs because investors assign weights to common and private shocks according to the quality of their private information. In equilibrium, uninformed and informed investors react to common shocks in opposite ways. Wang (1994) uses this idea in a model of competitive trading volume. Brennan and Cao (1997) use a similar mechanism to generate gross and net flows between countries. In their model, foreign investors receive private signals which on average are less precise than the private signals of domestic investors. After a positive common shock such as a public information release, uninformed foreigners tend to buy and informed domestic investors tend to sell. This generates net flows between countries.

Moreover, in this case net flows are correlated with returns.

I show that in order to replicate the high relative variance of total gross flows, there has to be a substantial information asymmetry *within* the group of foreign investors. In this case informed foreigners buy while uninformed foreigners sell. This leads to a high variance of total gross flows relative to net flows. Furthermore, while information asymmetry *between* countries implies that *net* capital flows are correlated with returns, information asymmetry *within* countries implies that *gross* flows are correlated with *absolute* returns. I find that the correlation between gross flows and absolute returns is much stronger than the correlation between net flows and returns. This suggests that information asymmetries are more important within countries than between countries.[2]

The question of information asymmetries in international capital markets has appeared repeatedly in the literature. The debate often centers on the differences between foreign and domestic investors as in Brennan and Cao (1997). Frankel and Schmukler (1996) argue that during the Mexican crisis in 1994, domestic residents were the first to sell Mexican assets, suggesting that domestic residents were better informed than foreigners. Most recently Choe et al(2000) find that Korean individual investors are at informational advantage over foreign investors. Seasholes(2000), on the other hand, finds that that foreign investors act as more informed than domestic. Kaufmann et al (1999) shows additional evidence on asymmetric information between foreign and domestic investors. There are at least two papers that consider information asymmetry within the group of foreign investors. In the first one, Kodres and Pritsker (1998) present a model of contagion with information asymmetry among all investors. The second paper by Calvo and Mendoza (2000) has two types of foreign investors: those who gather the relevant information, and those who just follow the crowd.

Portes and Rey (1999) show how information flows affect the cross-sectional variation in gross equity flows. They have annual data on bilateral flows for 14 countries, and they investigate the geographical pattern of gross flows. In a resulting gravity equation, the variables which come out most strongly are those related to information flows (such as telephone call traffic, multinational bank branches, etc.). Information issues also arise repeatedly in the trading volume literature. In Copeland (1976), information arrives to investors sequentially. Comiskey et al (1987) explore how the dispersion of information affects trading volume. It appears that information frictions may be the key to understanding the behavior of gross flows.

In the next section I review some stylized facts about gross flows. Section 3 presents a dynamic rational expectations model of gross capital flows. The model's empirical implications are tested in section 4. The final section concludes.

2 Facts about Gross Equity Flows

Many of the simple facts about the behavior of gross flows are unknown. This section looks at the size, variance and contemporaneous correlation between gross equity inflows and ouflows. The source of my data is the U.S. Department of Treasury, which collects data on transactions in long term securities with residents of foreign countries. The data is based on compulsory reporting by banks, brokers and dealers. It has been collected on a monthly basis since 1977 and is known as the TIC data. It includes gross purchases and sales of foreign stocks by U.S. investors, and captures gross flows between U.S. and other countries.[3] I define gross inflows(outflows) as gross purchases(sales) of foreign stocks by U.S. investors. I choose a sample of the 5 largest emerging and the 5 largest developed markets as measured by average stock market capitalization. Monthly data for 1990 and 1998 are used throughout the paper. I express flows as percentages of market capitalization. This serves two purposes. First, it deflates the flows because market capitalization moves with the price index. Second, it provides comparability across markets. Gross and net flows are plotted in figure 1.

There are a number of patterns that emerge from gross flows data. First, gross flows are strikingly large relative to net flows. Table 1 shows average annual total gross flows, which are defined as the sum of gross inflows and gross outflows. Annual flows range from 0.7% for Taiwan to 19.8% for the United Kingdom. This means that in one year U.S. investors alone buy and sell almost one fifth of the total market capitalization in the United Kingdom. Tesar and Werner (1995) were first to point out that international capital markets are characterized by large turnovers. They measure the size of total gross flows as a proportion of U.S. investment positions, and note that turnover of foreign equity holdings is roughly twice that of domestic holdings.

Excess flows are defined as the difference between total flows and the absolute value of net flows. The last column in table 1 shows that excess flows are large and differ only slightly from total flows. This indicates that the size of gross outflows and gross inflows is similar. In other words, net flows are very small compared to gross flows. Statistics which report only net capital flows capture a mere fraction of actual capital flows. The size of gross flows indicates that investors operate in constantly changing environments, and suggests that both investors and investment assets are highly heterogeneous.

Second, gross inflows and outflows are positively correlated. Table 2 reports contemporaneous correlations between detrended gross inflows and outflows. The positive correlation between gross inflows and outflows is robust to different de-trending and scaling methods and is apparent even in annual figures. For example, 1993 net flows in Mexico were \$5.7 billion, an increase of 56% from 1992. This indicates very favorable investment conditions. One would expect this large increase in net flows to be associated with an increase in gross inflows and a decrease in gross outflows. However, both gross inflows and gross outflows increased. Similarly, the general retreat from the Mexican market in 1998 was accompanied by a fall in both gross inflows and outflows. This data questions the role of aggregate shocks and indicates that a country with large net inflows does not necessarily experience high gross inflows and low gross outflows.

The correlation between gross inflows and outflows is related to the relative variance of total flows. Specifically, the difference between the variance of total gross flows and the variance of net flows is equal to four times the covariance between gross inflows and outflows. Hence, relative variance of total gross flows and correlation between gross inflows and outflows are one phenomena. Table 3 reports the standard deviation of detrended net and total flows. The variance of gross flows is far greater than that of net flows. This is true even after both series were linearly detrended and have mean zero. To get an idea of the volatility of gross flows, consider again the example of Mexico: in 1994, total gross flows were \$38 billion. They dropped to roughly \$15 billion in 1995 and 1996 only to sharply increase to \$24 billion in 1997. It is interesting to point out that net capital flows are often perceived as highly volatile (e.g. Fischer (1998), or IMF (1999), box 2.2). However, table 3 indicates that gross flows are even more volatile than net flows. Therefore, it is odd that so little is known about the events which drive volatility in gross flows.

The use of monthly aggregate flows raises at least two empirical issues. First, it is possible that monthly flows pick up sales and purchases by the same investor in the same month. Frequent trades by a single investor are aggregated into large monthly gross flows associated with no or small net flows. In this case, gross flows measured at a daily frequency could be close to zero.[4] Another possibility is that an investor sells some assets and buys others. Aggregate monthly data can not distinguish between gross flows which result from the heterogeneity of assets and those that result from the hetereogeneity of investors.

The model of gross flows which is presented in the next section relies on heterogeneity of investors. I argue that investor heterogeneity is a natural starting point for modeling gross flows. A frequent trader has to find others willing to trade. Similarly, if an investor wishes to replace one asset with another, he must find an investor willing to trade. In order for a trade to occur, investors have to be heterogeneous in some way. Therefore, even with heterogeneous assets, some *investor* heterogeneity is necessary to generate gross flows. [5]

3 A Model of Gross Flows

I first present a closed economy noisy rational expectations model with asymmetric information. This type of model originated in Grossman (1976). In my version of the model there are informed and uninformed investors as in Wang(1994) and Brennan and Cao (1997). These investors maximize negative expected utility every period as in Campbell et al (1993). I replicate the result that in an equilibrium, informed and uninformed investors react to common shocks in opposite ways. [6] In the next step, I let investors reside in two different countries and derive gross and net capital flows. Finally, I contrast their behavior under different types of heterogeneity. The main result is that in order to generate volatile gross flows, uninformed investors have to reside in both domestic and foreign countries.

3.1 A Noisy Rational Expectations Model

Investors allocate their wealth between one risky and one riskless asset. The riskless asset can be interpreted as an investment in U.S. treasury bills which yield constant return R. The risky asset can be interpreted as a developing country stock or bond which yields dividend d_t, where d_t is a random variable distributed $N\left(\overline{d}, \sigma_d^2\right)$. All payoffs accrue in terms of the riskless asset. There is no consumption in this model. In each period, agents maximize expected negative exponential utility of the next period wealth, subject to the following budget constraint:

$$w_{t+1}^i = Rw_t^i + x_{t+1}^i(P_{t+1} + d_{t+1} - RP_t)$$

where $w_t^i = m_t^i + x_t^i P_t$ and m_t^i, x_t^i are the beginning of the period holdings of riskless and risky assets respectively. P_t is the beginning of the period price of the risky asset. In a dynamic framework, agents have to forecast not only the future dividend but also the future price of the asset. The budget constraint includes the capital gains term P_{t+1}. It will be shown later that P_{t+1} is a linear function of normally distributed random variables. Hence, the next period wealth is a linear function of two normally distributed random variables: d_{t+1} and P_{t+1}, and is also normally distributed. Under the assumption of a negative exponential utility function, the investors' problem is equivalent to maximizing the following expression:

$$E[w_{t+1}^i|I_t] - \frac{a}{2}var[w_{t+1}^i|I_t] \tag{1}$$

where I_t is the information set and a is the coefficient of absolute risk aversion, which, in what follows, is assumed to be equal to 1. Maximizing (1) with respect to x_{t+1}^i yields the first order condition:

$$x_{t+1}^i = \frac{E\left[P_{t+1} + d_{t+1} - RP_t|I_t\right]}{var\left[P_{t+1} + d_{t+1} - RP_t|I_t\right]} \tag{2}$$

Note that asset demand is independent of beginning of the period wealth. This is because investors have constant absolute risk aversion and can borrow unlimited amounts. If an investor's demand for the risky assets exceeds his net worth, he can take a negative position in the safe asset.

The investor information set I_t includes three items: a private signal, a common signal and the equilibrium price. The common or aggregate signal, Y_t, is observed by everyone. The private signal S_t^i, is specific to each investor. The signals are determined as follows:

$$\begin{aligned} Y_t &= d_{t+1} + \xi_{t+1} \\ S_t^i &= d_{t+1} + \varepsilon_{t+1}^i \end{aligned} \tag{3}$$

where $\varepsilon_{t+1}^i \sim N(0, \sigma_i^2)$, $\xi_{t+1} \sim N(0, \sigma_\xi^2)$ and d_{t+1}, ξ_{t+1} and ε_{t+1}^i are independent. Thus, investors observe the realization of the dividend up to noise ξ_{t+1} in the common signal and up to noise ε_{t+1}^i in their private signal. Notice that ξ_{t+1} is an aggregate noise that affects all investors, while ε_{t+1}^i is different for each investor. The lower the variance of each of the signals, the more precise information investors have. Half of investors are informed and the other half are uninformed. The informed investors receive a signal with variance σ_I^2. The uninformed receive a signal with variance σ_U^2 and $\sigma_U^2 > \sigma_I^2$. I denote I and U as sets of informed and uninformed investors respectively.

The third piece of information agents use to form expectations is the equilibrium price. Equilibrium price conveys information about the future dividend because it reflects the demand from other investors. By observing the equilibrium price, investors could infer the value of private signals received by other investors. If the noise from private signals cancels out in the aggregate, the price becomes fully revealing. This means that by observing the equilibrium price and common signal Y_t, agents can derive the future dividend with certainty. This insight was first described by Grossman (1976). It is usually resolved by introducing a noise into the system as in Helwig (1980). The noise can be interpreted as a random supply of risky assets. Adhering to this interpretation, the equilibrium condition that sets demand equal to supply, can be written as:

$$\int_{i\epsilon I} x_{t+1}^i + \int_{i\epsilon U} x_{t+1}^i = 1 + Z_t \tag{4}$$

where Z_t is a random variable distributed $N(0, \sigma_z^2)$. The supply of the risky asset is equal to one plus random deviations Z_t. I assume that the noise in the private signal cancels out. Specifically,

$$\int_{i\epsilon I} \varepsilon_t^i = 0 \qquad \int_{i\epsilon U} \varepsilon_t^i = 0$$

The expectation of future price is formed by making a guess about the functional form of the price function. In equilibrium the guess is correct. This is also the way the model is solved. I conjecture that the equilibrium price is a linear function of the future dividend d_{t+1}, common signal ξ_{t+1}, and supply shock Z_t:

$$P_t = a_0 + a_1 d_{t+1} + a_2 \xi_{t+1} + a_3 Z_t \tag{5}$$

where a_1 and a_2 are expected to be positive and a_3 is expected to be negative. Given this conjecture, the four random variables: the dividend d_{t+1}, the equilibrium price P_{t+1}, private signal S_t^i and common signal Y_t, are distributed jointly normal. The derivation of the conditional moments of d_{t+1} is tedious but straightforward and appears in appendix A. Conditional means and variances depend on the precision of the private signal. Plugging them in first order conditions (2), the asset demand functions can be written as:

$$\begin{aligned} x_{t+1}^i &= \alpha_0^U + \alpha_1^U S_t^i + \alpha_2^U Y_t + \alpha_3^U P_t \qquad for \quad i \in U \\ x_{t+1}^i &= \alpha_0^I + \alpha_1^I S_t^i + \alpha_2^I Y_t + \alpha_3^I P_t \qquad for \quad i \in I \end{aligned} \tag{6}$$

where α's are constants that depend on $\sigma_d^2, \sigma_\xi^2, \sigma_Z^2, \sigma_I^2, \sigma_U^2, a_0, a_1, a_2$ and a_3. The α's are derived in appendix A. I show that $\alpha_1^i, \alpha_2^i > 0$ for $i = U, I$ which is intuitive as positive signals increase asset demand. I also show that $\alpha_3^i < 0$ so that the demand curve is downward sloping. The sign of α_3^i depends on two opposite effects. One is related to the budget constraint: a lower price presents an opportunity to buy cheaply. The other effect is related to the revision of conditional expectations. Specifically, a low price indicates a lower future dividend. It turns out that the budget constraint effect is always stronger than the effect of revised conditional expectations.

There are three results regarding α's which help with the intuition of the model. [7] First, informed investors weigh the private signal more than the uninformed do: $\alpha_1^U < \alpha_1^I$. This is natural in light of the fact than informed investors' private signal is less noisy. Second, informed investors weigh the common signal less than the uninformed: $\alpha_2^U > \alpha_2^I$. This is because informed investors regard the common signal as relatively less precise. Finally, the absolute value of price elasticity of demand of informed investors is greater than that of the uninformed, or $|\alpha_3^U| < |\alpha_3^I|$. This means that informed investors' response to price changes is greater that of the uninformed. There are two channels which affect this relationship. Both channels work in the same direction. One is related to the difference in conditional variances of excess returns. The conditional variance of uninformed investors is greater than that of the informed. Since the variance enters the asset demand (2) in the denominator, it makes the price elasticity smaller in absolute value. The intuition is that informed investors know more about the true value of the asset and thus are more responsive to price changes. The second channel is related to the response of the conditional expectation of d_{t+1} to price changes. Conditional expectations respond positively to price because a high price indicates a high future dividend. It can be shown that the conditional expectation of the uninformed investors responds to price more than that of the informed investors. For example, when price increases, the uninformed revise their expectations upward more than do the informed. This further hinders the response of the uninformed investors to price changes. In summary, the demand curve of the uninformed is flatter than that of the informed.

I plug asset demands (6) into equilibrium condition (4). Equating coefficients on the constant, d_{t+1}, ξ_{t+1} and Z_t to coefficients in the conjectured price function (5) yields the following system of four nonlinear equations:

$$
\begin{aligned}
a_0 &= -\frac{\alpha_0^U + \alpha_0^I - 1}{\alpha_3^U + \alpha_3^I} \\
a_1 &= -\frac{\alpha_1^U + \alpha_1^I + \alpha_2^U + \alpha_2^I}{\alpha_3^U + \alpha_3^I} \\
a_2 &= -\frac{\alpha_2^U + \alpha_2^I}{\alpha_3^U + \alpha_3^I} \\
a_3 &= \frac{1}{\alpha_3^U + \alpha_3^I}
\end{aligned}
\tag{7}
$$

where $a_1, a_2 > 0$, $a_3 < 0$ and the sign of a_0 depends on the parameters. As expected, both the dividend realization d_{t+1} and the aggregate noise ξ_{t+1} affect price positively. This is because both variables increase asset demand. The random supply shock Z_t affects price negatively because larger supply means lower price. One immediately see that $a_1 > a_2$. This is because the dividend realization d_{t+1} enters asset demands in both the private and common signals. Price is more tightly correlated with the actual dividend realization d_{t+1} than with the aggregate noise ξ_{t+1}.

The four equations (7) are highly nonlinear in a's and can not be solved analytically. Even though a complete analytical solution is not available, I can investigate the effects of the dividend d_{t+1}, the aggregate noise ξ_{t+1} and the random supply Z_t on equilibrium asset holdings. After tedious algebra, I can show that in equilibrium the asset demands have the following form:

$$\begin{aligned} x^i_{t+1} &= \tfrac{\varepsilon^i_{t+1}}{\sigma^2_I} + \phi_0 + \phi_d(\sigma^2_U - \sigma^2_I)d_{t+1} - \phi_\xi(\sigma^2_U - \sigma^2_I)\xi_{t+1} + (1-\phi_z)Z_t \quad \mathit{for}\; i \in I \\ x^i_{t+1} &= \tfrac{\varepsilon^i_{t+1}}{\sigma^2_U} + (1-\phi_0) - \phi_d(\sigma^2_U - \sigma^2_I)d_{t+1} + \phi_\xi(\sigma^2_U - \sigma^2_I)\xi_{t+1} + \phi_z Z_t \quad \mathit{for}\; i \in U \end{aligned} \tag{8}$$

where ϕ's are positive constants which are derived in appendix A. The main result in (8) is that the asymmetric information drives a wedge between the response of informed and uninformed investors. The size of the wedge depends on the extent of information asymmetry. Note that under symmetric information, realizations of the dividend d_{t+1} or common noise ξ_{t+1} are fully reflected in the equilibrium price and do not affect individuals' optimal portfolios. Under asymmetric information, the optimal demand of informed and uninformed investors is affected by common noise ξ_{t+1} and the dividend d_{t+1}. This is because the informed assign different weights to common and private signals than do the uninformed. Consider first the effect of a positive aggregate noise shock ξ_{t+1}. Other things being equal, ξ_{t+1} will induce all investors to hold more of the risky asset. However, given Z_t, the supply of the risky asset is fixed. Price will increase. The effect of ξ_{t+1} on equilibrium asset holdings will depend on two factors: the amounts by which the demand curves shift, and their slopes. The demand curve of the informed will shift less than that of the uninformed because $\alpha^U_2 > \alpha^I_2$. Furthermore, informed investors' demand curve is steeper than the demand curve of uninformed investors. Informed investors are more sensitive to price increases and will reduce their demand more than the uninformed. Hence, a positive ξ_{t+1} shock will lead to a reallocation of the risky asset from the informed to the uninformed. Another way of looking at the process is to say that uninformed investors assign relatively more weight to the common signal than to their private signal. Thus, after a positive ξ_{t+1} shock, uninformed investors should end up with more of the risky asset.

The noise in the common signal ξ_{t+1} can be interpreted as a common misperception about fundamentals. It encompasses noise which is common to all investors. This includes noise from readily available news about a country's prospects, public statements of government officials, news about political instability, exogenous interest rate changes or pending exchange rate realignment. These shocks contain some information about fundamentals. In equilibrium, the informed and uninformed "interpret" the information differently.

The dividend realization is the fundamental component of both signals. It also has an opposite effect on the informed than on the uniformed. After a positive dividend shock, the demand of informed investors shifts out more than that of the uninformed. This is because the informed put greater weight on private signals containing the dividend realization ($\alpha_1^I > \alpha_1^U$). This effect will outweigh the effect of different slopes of the demand curves. The informed end up buying the risky asset from the uninformed. A positive shock to d_{t+1} will lead to the reallocation of the risky asset to informed investors. That informed investors respond to fundamentals in the right direction is quite intuitive in a rational expectations model.

It is easy to show that ϕ_z is less than 1 (see equation (A.6) in appendix A). This means that the realization of Z_t impacts the holdings of both types of investors in the same direction. As supply of the risky asset increases, its price falls. Both types of investors increase their demand and absorb the increase in supply. Moreover, since $|\alpha_3^U| < |\alpha_3^I|$, ϕ_z is less than $\frac{1}{2}$. Therefore, the informed investors absorb a disproportionate amount of random supply shocks. This is because uninformed investors interpret the decrease in price as a decrease in fundamentals and reduce their demand.

3.2 Gross and Net Capital Flows

Two domestic investors willing to trade foreign assets can trade directly between themselves or through a foreign intermediary. Measured international capital flows occur only in the second case. This happens when assets are bought and sold in the country where they were issued. For example, when an American investor goes through a broker in Mexico to purchase or sell a Mexican stock, measured international flows occur. Institutional, legal and liquidity considerations may be reasons why assets are often traded where they are issued. On the other hand, the trading of ADR's on the New York Stock Exchange or in the OTC market are examples of domestic investors trading foreign assets. According to the World Bank (1997, p.101), about three fourths of the equity capital raised by developing countries is through direct purchases and the rest through ADRs and GDRs.

I assume that there are two countries in the world: one foreign and one domestic. In each country there is a continuum of investors normalized to 1. Hence, the total number of investors is 2. I assume that assets are traded in the location where they are issued. This amounts to requiring foreign investors to trade through a local broker. Under this assumption, when a foreign investor changes his or her demand for the risky asset, international capital flows occur. Aggregate net capital flow from the foreign to the domestic country is the sum of asset demand changes of all foreigners. Gross inflow is the sum of all positive changes in asset demands. Gross outflow is the negative of the sum of all negative changes in asset demands. I denote net flows as net, gross inflows as pos, and gross outflows as neg. [8]

$$
\begin{aligned}
net_t &= \int_{-\infty}^{\infty} \triangle x^i_{t+1} \, dF^*(\triangle x^i_{t+1}) \\
pos_t &= \int_{0}^{\infty} \triangle x^i_{t+1} \, dF^*(\triangle x^i_{t+1}) \\
neg_t &= -\int_{-\infty}^{0} \triangle x^i_{t+1} \, dF^*(\triangle x^i_{t+1})
\end{aligned} \tag{9}
$$

Function $F^*()$ is the cross-sectional distribution of asset demand changes of foreign investors. Capital flows are integrals of asset demand changes across investors. To calculate net flows, the integral is taken over all investors. Gross inflow(outflow) is an integral over positive(negative) demand changes. The pattern of gross flows depends on the cross-sectional distribution of asset demands, which in turn depends on the information asymmetry and the location of informed and uninformed investors between domestic and foreign countries. I would like to contrast the pattern of flows in three different cases.

The first case is perfect information symmetry, $\sigma^2 = \sigma_I^2 = \sigma_U^2$. In this situation, terms which depend on d_{t+1} and ξ_{t+1} drop out of asset demands because their effect is fully incorporated in the equilibrium price. Moreover, under information symmetry, the random supply is absorbed equally by all investors ($\phi_z = \frac{1}{2}$). Hence, the equilibrium asset holdings (8) depend only on idiosyncratic shocks ε_t^i and fluctuations in asset supply Z_t:

$$\triangle x_t^i = \frac{\triangle \varepsilon_t^i}{\sigma^2} + \frac{1}{2} \triangle Z_t \tag{10}$$

The first term determines the spread of the cross sectional distribution of changes in asset demands. The spread depends on the variance of the idiosyncratic noise, σ^2. The second term $\frac{1}{2}\triangle Z_t$ shifts the entire distribution to the left or right. I obtain gross inflows and ouflows by plugging the changes in asset demands (10) into formulas for capital flows (9) and integrating over i. Gross and net flows can be written as:

$$
\begin{aligned}
net_t &= \tfrac{1}{2}\triangle Z_t \\
pos_t &= \tfrac{1}{\sigma}f(-\tfrac{1}{2}\triangle Z_t\sigma) + \tfrac{1}{2}\triangle Z_t F(\tfrac{1}{2}\triangle Z_t\sigma) \\
neg_t &= \tfrac{1}{\sigma}f(\tfrac{1}{2}\triangle Z_t\sigma) - \tfrac{1}{2}\triangle Z_t F(-\tfrac{1}{2}\triangle Z_t\sigma)
\end{aligned}
\tag{11}
$$

where $f()$ and $F()$ are standard normal density and distribution functions respectively. The derivations of the above expressions are in appendix B.

Net flows are equal to the half of the change in asset supply. Under symmetric information, fluctuations in asset supply are equally absorbed by domestic and foreign investors. In order to accomodate an increase of $\triangle Z_t$ in asset supply, foreign net purchases are $\frac{1}{2}\triangle Z_t$. Note that unlike gross flows, net flows do not depend on the variance of private/idiosyncratic noise. Thus, investor heterogeneity cancels out in aggregate net flows.

Gross inflows and outflows contain two terms: the first term is the integral over the idiosyncratic component of private signals; the second term represents a shift in the distribution of asset demands by supply shock Z_t. As the supply of the risky asset increases, the entire distribution of asset demands shifts to the right. To accomodate an increase in supply, gross inflows increase, while gross outflows decrease. It is shown analytically in Appendix B that $\triangle Z_t$ affects gross inflows and outflows in opposite ways:

$$
sign\left(\frac{\partial pos_t}{\partial \triangle Z_t}\right) = -sign\left(\frac{\partial neg_t}{\partial \triangle Z_t}\right) \tag{12}
$$

The opposite effect of $\triangle Z_t$ on gross inflows and outflows gives rise to a negative correlation between the two. Since Z_t is the only source of variation in gross flows, the correlation between gross inflows and outflows is -1:

$$
cov(pos_t, neg_t) = -1
$$

As a consequence, the variance of total gross flows is smaller than the variance of net flows.[9] This result indicates that idiosyncratic noise alone is unable to explain the positive correlation between gross inflows and outflows, and the high variance of gross flows. Idiosyncratic shocks undoubtedly play an important role in gross flows. However, the pattern of gross flows indicates something in the behavior of transaction volume above and beyond idiosyncratic shocks.

Next I consider the case where all domestic investors are informed and all foreigners are uninformed. I denote the share of uninformed investors in the domestic country γ. In this case $\gamma = 1$.

Gross flows are integrals over the cross-sectional distribution of the uninformed investors:

$$\begin{aligned} pos_t &= \int_0^{\infty} \triangle x^i_{t+1} dF^*_U(\triangle x^i_{t+1}) \\ neg_t &= -\int_{-\infty}^{0} \triangle x^i_{t+1} dF^*_U(\triangle x^i_{t+1}) \end{aligned}$$

where F^*_U is the cross-sectional distribution of uninformed investors. Their changes in asset demands are:

$$\triangle x^i_t = \tfrac{\triangle \varepsilon^i_t}{\sigma^2_U} + A_t$$

where $A_t = -\phi_d(\sigma^2_U - \sigma^2_I)\triangle d_{t+1} + \phi_\xi(\sigma^2_U - \sigma^2_I)\triangle \xi_{t+1} + \phi_z \triangle Z_t$. Thus, the demand changes are shifted not only by the supply changes Z_t, but also by dividend shocks d_{t+1} and aggregate noise shocks ξ_{t+1}. Integrating over changes in demands gross and net flows can be written as follows:

$$\begin{aligned} & net_t = A_t \\ & pos_t = \tfrac{1}{\sigma_U} f(-A_t\sigma_U) + A_t F(A_t\sigma_U) \\ & neg_t = \tfrac{1}{\sigma_U} f(A_t\sigma_U) - A_t F(-A_t\sigma_U) \end{aligned} \tag{13}$$

The expressions are the same as in (11), the case of information symmetry, except that $\frac{1}{2}\triangle Z_t$ is replaced by A_t. In this case, A_t shifts the entire distribution of asset demands to the right, increasing gross inflows and decreasing gross outflows. This makes the correlation between gross inflows and outflows equal to -1. Consequently, the variance of net flows is higher than the variance of total gross flows. The intuition is that the dividend and aggregate noise shocks cause trading between informed domestic investors and uninformed foreigners generating a lot of net flows and little gross flows. Thus, complete information asymmetry between foreign and domestic investors can not account for the observed patterns of gross flows data.

Finally, consider the case of information asymmetry *within* the groups of foreign and domestic investors. In this case some foreigners are informed and some are uninformed. Gross inflows and gross ouflows now consist of the sum of gross purchases of informed and uninformed foreigners:

$$pos_t = \int_0^{\infty} \triangle x^i_{t+1} dF^*_I(\triangle x^i_{t+1}) + \int_0^{\infty} \triangle x^i_{t+1} dF^*_U(\triangle x^i_{t+1}) \tag{14}$$

$$neg_t = -\int_{-\infty}^{0} \triangle x^i_{t+1} dF^*_I(\triangle x^i_{t+1}) - \int_{-\infty}^{0} \triangle x^i_{t+1} dF^*_U(\triangle x^i_{t+1}) \tag{15}$$

where F^*_U and F^*_I are the cross-sectional distributions of informed and uninformed investors respectively. I focus on an extreme situation where $\gamma = \frac{1}{2}$. This means that half of the foreign investors are informed and half are uninformed; the same holds in the domestic country. Integrating (14) gross and net flows can be written as:

$$\begin{aligned} net_t &= \tfrac{\triangle Z_t}{2} \\ pos_t &= \tfrac{1}{2}\left[\tfrac{1}{\sigma_U} f(-A_t\sigma_U) + A_t F(A_t\sigma_U) + \tfrac{1}{\sigma_I} f(-B_t\sigma_I) + B_t F(B_t\sigma_I)\right] \\ neg_t &= \tfrac{1}{2}\left[\tfrac{1}{\sigma_U} f(A_t\sigma_U) - A_t F(-A_t\sigma_U) + \tfrac{1}{\sigma_I} f(B_t\sigma_I) - B_t F(-B_t\sigma_I)\right] \end{aligned} \tag{16}$$

where $B_t = \phi_d(\sigma_U^2 - \sigma_I^2)\triangle d_{t+1} - \phi_\xi(\sigma_U^2 - \sigma_I^2)\triangle\xi_{t+1} + (1-\phi_z)\triangle Z_t$. In this case, net flows depend only on random supply shock $\triangle Z_t$. This is because all flows due to d_{t+1} and ξ_{t+1} occur between informed and uninformed foreigners and do not affect net flows. Total gross flows will depend on all three shocks d_{t+1}, ξ_{t+1} and Z_t. This suggests that if the variance of $\triangle Z_t$ is relatively small, the variance of total gross flows could be greater than the variance of net flows.

Information asymmetry within countries can potentially make gross inflows and outflows positively correlated. Consider the effect of the three random variables that affect gross flows: the dividend shock d_{t+1}, aggregate noise shock ξ_{t+1}, and supply shock Z_t. Other things being equal, after a positive dividend shock d_{t+1}, the informed foreigners tend to buy, increasing gross inflows, while uninformed foreigners tend to sell, increasing gross outflows. Appendix B shows that the effect of $\triangle d_{t+1}$ on gross inflows and outflows is exactly the same:

$$\frac{\partial pos_t}{\partial \triangle d_{t+1}} = \frac{\partial neg_t}{\partial \triangle d_{t+1}} > 0 \tag{17}$$

This is dramatically different from the previous case where d_{t+1} shocks affected gross inflows and outflows in opposite directions. The intuition is that informed foreigners tend to sell while uninformed foreigners tend to buy, hence both gross inflows and outflows increase. It is easy to see that $\triangle\xi_{t+1}$ also affects gross inflows and outflows in the same direction. This increases the correlation between gross inflows and outflows. Finally, Appendix B shows that the asset supply $\triangle Z_t$ still affects gross inflows and ouflows in the opposite direction as in (12), which decreases the correlation. This means that the correlation between gross inflows and outflows will depend on whether the variance of Z_t is sufficiently small. However, it is clear that under information asymmetry within countries, the correlation can be positive:

$$cov(pos_t\, neg_t) \lesseqqgtr 0$$

In order to generate volatile gross flows and a positive correlation between gross inflows and outflows, one needs to assume that there is information asymmetry *within* the group of foreign investors. Foreign investors need to be heterogeneous not only in their idiosyncratic shocks, but also in the precision of private signals. This section examined three extreme cases. The patterns of flows in intermediate cases and the quantitative properties of my model are the subjects of the next section.

3.3 Simulation of the Model

In this section I simulate the dynamic model and investigate how idiosyncratic shocks and information asymmetry affect patterns of gross flows. Given the parameter values for σ_I^2, σ_U^2, σ_d^2, σ_ξ^2, and σ_Z^2, I use a computer to solve equations (7). This yields the coefficients a_0, a_1, a_2 and a_3 in price function (5), and coefficients α's in asset demands (6). I make no attempt to calibrate the parameters to their real world counterparts. Instead, I explore the properties of the model for different parameter values. Specifically, I investigate the effects of two factors: the difference between the variances of informed and uninformed signals, $\sigma_U^2 - \sigma_I^2$; and the number of informed investors residing in the foreign country γ. This exercise shows that the model can indeed generate volatile gross flows and a positive correlation between gross inflows and outflows. I set $\sigma_d^2 = \sigma_\xi^2 = 5$, $\sigma_Z^2 = 0.025$, $R = 1$, $\overline{d} = 0$ and generate a random series for d_t, ξ_t and Z_t accordingly.[10] As a benchmark I set the number of informed and uninformed investors in both countries to be the same so that $\gamma = \frac{1}{2}$. I first consider the effects of the difference between the variances of the informed and uninformed signals.

Figure 2 shows the correlation between gross inflows and outflows. The horizontal axis is the wedge between the variance of the private signal of informed investors σ_I^2, and that of the uninformed σ_U^2, where $\sigma_I^2 = 0.01$ and σ_U^2 runs from 0.01 to 1. At the far left end of the figure the variances of private signals are the same and there is information symmetry. At this point the correlation equals -1, this is because the only source of variation in gross inflows and outflows are asset supply shocks. As described in section 3.1, asset supply shocks cause a negative correlation between gross inflows and outflows. As information asymmetry increases, this correlation turns positive. The effects of dividend shocks d_t and common noise shocks ξ_t outweigh the effect of supply shocks.

Figure 3 shows the relative variance of total gross flows. It corresponds to the correlation between gross inflows and outflows. As information asymmetry increases, the volatility of gross flows also increases. At the far left end of the axis the variance of gross flows is close to zero. This is because at that point the size of gross flows depends on the variance of idiosyncratic shocks. Gross flows are relatively constant because the variance of idiosyncratic shocks is constant. The volatility increases rapidly as asymmetric information kicks in. With asymmetric information, common shocks affect gross flows which increases their variance.

Next I consider the effects of the number of informed investors in domestic and foreign countries. I set the variance of the informed signal σ_I^2 to be 100 times lower than the variance of the uninformed signal. If investors within each country are homogeneous, dividend and common noise shocks will not affect gross flows. Gross flows will be generated only by idiosyncratic shocks and asset supply shifts. In order to match the data there must be information asymmetry within each country. This is shown in figure 4 which plots the correlation between gross inflows and outflows against the share of informed investors residing in the foreign country. The correlation is negative when investors are homogenous within each country. It reaches a peak when half of the investors in each country are uninformed. This is the point at which the heterogeneity within each country is at a maximum. The model matches the observed correlation when the number of informed and uninformed in each country is approximately the same. The plot of the relative variance of gross flows has a similar shape because correlation between gross inflows and outflows is equivalent to the relative variance of total gross and net flows.

4 Relationship with Returns

Information asymmetries between and within countries have different implications for the relationship of gross and net flows with returns. Information asymmetry between countries implies that net flows are correlated with returns, while information asymmetry within countries implies that gross flows are correlated with absolute returns. The relationship of gross flows with returns can uncover the nature of information asymmetries in international capital markets. We have seen that asymmetry within countries is necessary to replicate the patterns of gross flows. This section shows that the interaction of flows and returns is again consistent with asymmetry within countries.

The relationship between flows and returns is engendered by the fact that shocks affect flows as well as prices. Informed investors respond positively to dividend shock d_t and negatively to aggregate noise shock ξ_t. Uninformed investors respond in exactly the opposite way. The random supply shock Z_t affects informed and uniformed in the same direction. From the price function (5) we see that equilibrium price depends on dividend d_t, aggregate noise ξ_t, and random supply Z_t. Since the coefficient on the dividend a_1 is greater than the coefficient on the aggregate noise a_2, the realization of the dividend has a stronger impact on the equilibrium price than the aggregate noise. Equilibrium price is more strongly correlated with the fundamental dividend process d_t than with aggregate noise ξ_t. Since informed investors respond positively to the dividend shock, their purchases are positively correlated with returns. On the other hand, purchases of uninformed investors are associated with negative returns.[11]

If uninformed investors live in the foreign country, net capital flows should be negatively correlated with returns. This is demonstrated in figure 6 which shows the correlation between net flows and price changes against the share of informed investors residing in the foreign country. The correlation is negative if investors in the foreign country are uninformed. The correlation is positive if they are informed. If the average investor in each country is equally informed, $\gamma = \frac{1}{2}$, the correlation between net flows and price changes is zero.

If both informed *and* uninformed investors live in the foreign country, gross flows should be correlated with absolute returns. This is because shocks lead to a reallocation of the risky asset between informed and uninformed investors. This reallocation leads to gross flows and occurs after both positive and negative shocks. Gross flows are associated with any price change and should be positively correlated with absolute returns. [12]

To see that this is true in my model, consider figure 5 where the correlation between total gross flows and absolute returns is plotted against the share of informed investors living in the foreign country. The plot is hump shaped, and the correlation is the highest where the foreign country is half informed and half uninformed. This is the point where information asymmetry *within* both countries is at its maximum. In summary, information asymmetry between countries implies a correlation between net flows and returns, while information asymmetry within countries implies a correlation between gross flows and absolute returns.

Which of these predictions can be sustained in the data? First consider the graphical representations of these relationships. Figure 7 scatter plots net monthly flows against monthly returns for the 10 countries which were included in section 2. For all countries except Japan and Germany, there appears to be no relationship between net flows and returns. [13] Figure 8 plots monthly gross flows against absolute returns. The figure indicates that large absolute returns are associated with large gross flows. Table 4 reports the correlations of the data depicted in figures 7 and 8, and confirms what is seen in the figures. The correlations between net flows and returns, reported in the first column, are mostly insignificant. The correlations between gross flows and absolute returns are positive and statistically significant. The results indicate that the relationship between gross flows and absolute returns is stronger than the relationship between net flows and returns. This suggests that information asymmetries within countries are more important than information asymmetries between countries.

5 Conclusion

Capital flows are at the center of current macroeconomic policy concerns. I study the behavior of gross capital flows and try to explain it. Gross flows are large, volatile, and account for nearly all international capital movement. I show that random noise in asset demands alone can not explain observed patterns of gross flows. In particular, it can not explain the large variance of gross flows and the positive correlation between gross inflows and outflows. This suggests a particular type of investor heterogeneity. I present a model with asymmetric information in which the key element is information asymmetry *within* the group of foreign investors. In equilibrium, informed and uninformed foreigners react to common shocks in opposite ways, causing these shocks to affect gross flows. Common shocks increase the variance of gross flows and generate a positive correlation between gross inflows and outflows.

I explore quantitative properties of the model in a number of simulation exercises and show that it can account for several features of gross flows data. Two assumptions are necessary for the model to match the data well. First, the variance of the informed signal needs to be substantially lower than the variance of the uninformed signal. Second, the heterogeneity within each country needs to be substantial. When the number of informed and uninformed investors in both countries is approximately the same, the model matches the data.

The model's empirical implications complement those already found in the literature. When information asymmetry occurs between countries, net flows are correlated with returns. If the asymmetry is within countries, however, gross flows are correlated with absolute returns. I find that the correlation between gross flows and absolute returns is stronger than the correlation between net flows and returns. This supports my model and sheds light on the nature of information asymmetries in international capital markets. Furthermore, the positive correlation between total gross flows and absolute returns challenges alternative explanations of gross flows. For example, it is unclear how the heterogeneity of assets could generate a correlation between gross flows and absolute returns of a composite price index. Similarly, it is hard to see how a heteroskedastic noise in asset demands could produce this implication.

This paper suggests that asymmetric information within countries is an important phenomenon in international capital markets. Information about foreign markets can be difficult and costly to obtain. My model and the empirical evidence suggest that there are investors who acquire this information and those who do not. This finding is relevant to the current debate on volatility in international capital markets. In particular, asymmetric information is a key transmission mechanism in a number of theoretical models of financial crises and contagion. In Calvo and Mendoza (2000), information asymmetry within the group of foreign investors, in conjunction with margin requirements, creates contagion and market volatility.[14] In Kodres and Pritsker (1998), a high amount of information asymmetry increases a market's susceptibility to contagion. In the domestic context, Gennotte and Leland (1990) present a model where asymmetric information plays an important role in generating price volatility and market crashes.

A Derivation of Results in Section 3.1

In this appendix I derive the results which were used in section 3.1. First, given the signals (3) and equilibrium price function (5), the conditional moments of the excess returns, $P_{t+1} + d_{t+1} - RP_t$, can be written as:

$$E(d_{t+1}|S_t^i, Y_t, P_t) = constant + \frac{\sigma_d^2}{\det_i}(a_3^2\sigma_z^2\sigma_\xi^2 S_t^i + ...$$
$$+(a_2^2\sigma_\xi^2\sigma_i^2 + a_3^2\sigma_\xi^2\sigma_z^2 - a_1a_2\sigma_\xi^2\sigma_i^2)Y_t + (a_1 - a_2)\sigma_\xi^2\sigma_i^2 P_t)$$
$$var(P_{t+1} + d_{t+1} - RP_t|S_t^i, Y_t, P_t) = \frac{a_3^2\sigma_d^2\sigma_z^2\sigma_\xi^2\sigma_i^2}{\det_i} + a_1^2\sigma_d^2 + a_2^2\sigma_\xi^2 + a_3^2\sigma_z^2$$
$$\det_i = a_3^2\sigma_d^2\sigma_z^2\sigma_\xi^2 + (a_1 - a_2)^2\sigma_d^2\sigma_\xi^2\sigma_i^2 + a_3^2\sigma_d^2\sigma_z\sigma_i^2 + a_3^2\sigma_z^2\sigma_\xi^2\sigma_i^2 > 0$$

Plugging the conditional moments to the first order conditions (2) and mapping to asset demand functions (6) yields the coefficients αs:

$$\alpha_1^i = \frac{a_3^2\sigma_z^2\sigma_\xi^2\sigma_d^2}{denom_i} \tag{A.1}$$
$$\alpha_2^i = \frac{(a_2^2\sigma_i^2 + a_3^2\sigma_z^2 - a_1a_2\sigma_i^2)\sigma_\xi^2\sigma_d^2}{denom_i} \tag{A.2}$$
$$\alpha_3^i = \frac{(a_1 - a_2)\sigma_d^2\sigma_\xi^2\sigma_i^2 - \det_i}{denom_i} \tag{A.3}$$
$$denom_i = \sigma_d^2\sigma_\xi^2\sigma_z^2\sigma_i^2 a_3^2 + (a_1^2\sigma_d^2 + a_2^2\sigma_\xi^2 + a_3^2\sigma_z^2)\det_i > 0$$

It can be seen immediately from (A.1) that $\alpha_1^i > 0$. That $\alpha_3 < 0$ can be proven by contradiction. Subtracting the second and third line in (7) we get

$$(a_1 - a_2) = -\frac{\alpha_1^U + \alpha_1^I}{\alpha_3^U + \alpha_3^I}$$

Suppose that $\alpha_3^i > 0$, then it must be that $(a_1 - a_2) < 0$. However, from (A.3) we see that if $(a_1 - a_2) < 0$, α_3 must be less than zero, which is a contradiction. That $\alpha_2^i > 0$ can also be proven by contradiction. If $\alpha_2^i < 0$ then $a_2 < 0$ from (7). If $a_2 < 0$, it must be that $a_1 > 0$ because $(a_1 - a_2) > 0$. But from (A.2) we see that if $a_2 < 0$ and $a_1 > 0$ it must be that $\alpha_2^i > 0$, which is a contradiction.

The results that $\alpha_1^U < \alpha_1^I$, $\alpha_2^U > \alpha_2^I$ and $\alpha_3^U > \alpha_3^I$ are tedious but straightforward to show by subtracting $\alpha_1^I - \alpha_1^U$, $\alpha_2^U - \alpha_2^I$ and $\alpha_3^U - \alpha_3^I$ and showing that each difference is greater than zero.

The coefficients in the equilibrium asset holdings (8) can be written as:

$$
\begin{aligned}
\phi_d(\sigma_U^2-\sigma_I^2) &= \frac{\alpha_1^U\alpha_3^I-\alpha_1^I\alpha_3^U}{\alpha_3^U+\alpha_3^I}+\frac{\alpha_2^U\alpha_3^I-\alpha_2^I\alpha_3^U}{\alpha_3^U+\alpha_3^I} && \text{(A.4)}\\
\phi_d &= \frac{a_3^2\sigma_z^2\sigma_\xi^2\sigma_d^2(-2\sigma_d^2\sigma_\xi^2(a_1-a_2+a_1^2+a_3^2)+a_2^2\sigma_d^2\sigma_\xi^2+2a_3^2\sigma_z^2\sigma_\xi)}{(a_1-a_2)\sigma_d^2\sigma_\xi^2(\sigma_U^2+\sigma_I^2)-(\det_U+\det_I)}\\
\phi_\xi(\sigma_U^2-\sigma_I^2) &= \frac{\alpha_2^U\alpha_3^I-\alpha_2^I\alpha_3^U}{\alpha_3^U+\alpha_3^I} && \text{(A.5)}\\
\phi_\xi &= \frac{a_3^2\sigma_z^2\sigma_\xi^2\sigma_d^2(-\sigma_d^2\sigma_\xi^2(a_1-a_2+a_1^2+a_3^2)+a_2^2\sigma_d^2\sigma_\xi^2+a_3^2\sigma_z^2\sigma_\xi^2)}{(a_1-a_2)\sigma_d^2\sigma_\xi^2(\sigma_U^2+\sigma_I^2)-(\det_U+\det_I)}\\
\phi_z &= \frac{\alpha_3^U}{\alpha_3^U+\alpha_3^I} && \text{(A.6)}
\end{aligned}
$$

It is clear from (A.6) that $\phi_z > 0$ and $\phi_z < 1$. That ϕ_ξ is positive can be seen by dividing the nominator and denominator of (A.5) by α_3^I and noting that $\alpha_2^U > \alpha_2^I$ and $\alpha_3^U/\alpha_3^I < 1$. To see that $\phi_d > 0$ is only a little more cumbersome. Note that (A.4) can be written as:

$$\phi_d(\sigma_U^2-\sigma_I^2)=\frac{\frac{a_3^2\sigma_z^2\sigma_\xi^2\sigma_d^2\left(\frac{denom_I}{denom_U}\alpha_3^I-\alpha_3^U\right)}{denom_I}}{\alpha_3^U+\alpha_3^I}+\phi_\xi(\sigma_U^2-\sigma_I^2)$$

The second term is positive since ϕ_ξ is positive. The first term is positive as well, because $\frac{denom_I}{denom_U} < 1$ and $\alpha_3^U > \alpha_3^I$, yielding both the nominator and the denominator in the first term negative. Hence, the entire expression is positive.

B Derivation of Results in Section 3.2

Gross inflows in (11) are derived by taking an integral over the cross-sectional distribution of asset demands which, given $\frac{1}{2}\triangle Z_t$, is distributed normal with mean $\frac{1}{2}\triangle Z_t$ and variance $\frac{1}{\sigma^2}$.

$$
\begin{aligned}
pos_t &= \int_0^\infty \triangle x_t^i \, dF_{(\frac{1}{2}\triangle Z_t,\frac{1}{\sigma^2})}(\triangle x_t^i)\\
&= \int_{-\frac{1}{2}\triangle Z_t\sigma^2}^\infty \frac{\triangle\varepsilon_t^i}{\sigma^4}\frac{1}{\sqrt{2\pi}\frac{1}{\sigma}}e^{-\frac{1}{2}\left(\frac{\triangle\varepsilon_t^i}{\sigma}\right)^2}d\triangle\varepsilon_t^i+\tfrac{1}{2}\triangle Z_t\int_{-\frac{1}{2}\triangle Z_t\sigma^2}^\infty \frac{1}{\sigma^2}\frac{1}{\sqrt{2\pi}\frac{1}{\sigma}}e^{-\frac{1}{2}\left(\frac{\triangle\varepsilon_t^i}{\sigma}\right)^2}d\triangle\varepsilon_t^i\\
&= \frac{1}{\sigma}f_{(0,1)}(-\tfrac{1}{2}\triangle Z_t\sigma)+\tfrac{1}{2}\triangle Z_t F_{(0,1)}(\tfrac{1}{2}\triangle Z_t\sigma)
\end{aligned}
$$

Gross outflows are derived analogously and net flows are the difference between the two.

The derivative of gross inflows and ouflows with respect to $\triangle Z_t$ in (12) is derived using the fact that standard normal density is symmetric,$f(x) = f(-x)$, and $f'(x) = f(x)(-x)$. It is straightforward to show that the derivatives are:

$$\begin{aligned}
\frac{\partial pos_t}{\partial \triangle Z_t} &= \tfrac{1}{2}F(\tfrac{1}{2}\triangle Z_t\sigma) > 0 \\
\frac{\partial neg_t}{\partial \triangle Z_t} &= -\tfrac{1}{2}F(-\tfrac{1}{2}\triangle Z_t\sigma) < 0
\end{aligned}$$

Equation (17) says that under information asymmetry within countries, the effect of the dividend shock on gross inflows and ouflows is identical. Taking derivative of (16) yields:

$$\begin{aligned}
\frac{\partial pos_t}{\partial \triangle d_{t+1}} &= \frac{\partial pos_t}{\partial A_t}\frac{\partial A_t}{\partial \triangle d_{t+1}} + \frac{\partial pos_t}{\partial B_t}\frac{\partial B_t}{\partial \triangle d_{t+1}} \\
&= \tfrac{1}{2}\xi_d(\sigma_U^2 - \sigma_I^2)[F(B_t\sigma_I) - F(A_t\sigma_U)]
\end{aligned}$$

The derivative of neg_t with respect to $\triangle d_{t+1}$ is derived analogously and (17) is shown using the fact that $F(x) = 1 - F(-x)$.

Finally, the effect of Z_t on gross inflows can be written as:

$$\frac{\partial pos_t}{\partial \triangle Z_t} = \tfrac{1}{2}[F(A_t\sigma_U)\phi_z + F(B_t\sigma_I)(1-\phi_z)]$$

which is less than one half, since the term in square brackets is a weighted average of two numbers each of which is less then one. It is easy to show that $\frac{\partial neg_t}{\partial \triangle Z_t} = \frac{\partial pos_t}{\partial \triangle Z_t} - \frac{1}{2}$ and hence,

$$sign\left(\frac{\partial pos_t}{\partial \triangle Z_t}\right) = -sign\left(\frac{\partial neg_t}{\partial \triangle Z_t}\right).$$

References

[1] Brennan, Michael J., and Henry H. Cao, 1997, International Portfolio Investment Flows, *Journal of Finance* 52(5), 1851-80.

[2] Calvo, Guillermo A., and Enrique Mendoza, 2000, Capital Market Crises and Economic Collapse in Emerging Markets: An Information Friction Approach, *American Economic Review: Papers and Proceedings*, 59-64.

[3] Calvo, Guillermo A., and Enrique Mendoza, 2000, Rational Contagion and Globalization of Securities Markets, *Journal of International Economics* 51(1), 79-113.

[4] Campbell, John Y.; Grossman, Sanford J.; Wang, Jiang, 1993, Trading Volume and Serial Correlation in Stock Returns, *Quarterly-Journal-of-Economics* 108(4), 905-39.

[5] Choe, Hyuk, Kho, Chan Bong, and Rene M. Stulz, 2000, Do Domestic Investors Have More Valuable Information about Individual Stocks than Foreign Investors?, mimeo.

[6] Comiskey Eugene E, Ralph A Walkling, and Michael A. Weeks, 1987, Dispersion of Expectations and Trading Volume, *Journal of Business Finance and Accounting* 14(2), 229-239.

[7] Copeland, Thomas E., 1976, A Model of Asset Trading under the Assumption of Sequential Information Arrival, *Journal-of-Finance* 31(4), 1149-68.

[8] Fischer, Stanley, 1998, Reforming the International Monetary System, David Finch Lecture in Melbourne.

[9] Frankel, Jeffrey A, and Sergio Schmukler, 1996, Country Fund Discounts, Asymmetric Information and the Mexican Crisis of 1994: Did Local Residents Turn Pessimistic Before International Investors?, NBER Working Paper # 5714.

[10] Froot, Kenneth A., Paul G.J. O'Connell, and Mark S. Seasholes, 1998, The Portfolio Flows of International Investors, NBER Working Paper #6687.

[11] Gennotte, Gerard, and Hayne Leland. Market Liquidity, Hedging, and Crashes, 1990, *American Economic Review* 80(5), 999-1021.

[12] Grossman, Sanford J., 1976, On the Efficiency of Competitive Stock Markets Where Trades Have Diverse Information, *Journal-of-Finance* 31(2), 573-85.

[13] Grossman, Sanford J. and Joseph E. Stiglitz, 1980, On the Impossibility of Informationally Efficient Markets, *American Economic Review* 70(3), 393-408.

[14] Hellwig, Martin F., 1980, On the Aggregation of Information in Competitive Markets, *Journal-of-Economic-Theory* 22(3), 477-98.

[15] *International Capital Markets*, 1998, International Monetary Fund.

[16] Kaufmann, Daniel, Gil Mehrez, and Sergio Schmukler, 1999, Predicting Currency Fluctuations and Crises: Do Resident Firms Have an Informational Advantage?, mimeo.

[17] Kodres, Laura, and Matt Prisker, 1998, A Rational Expectations Model of Financial Contagion, mimeo.

[18] Portes, Richard, and Helene Rey, 1999, The Determinants of Cross-border Equity Flows, NBER Working Paper #7736.

[19] Seasholes, Mark S., 2000, Smart Foreign Traders in Emerging Markets, mimeo.

[20] Tesar, Linda L., and Ingrid M. Werner, 1994, International Equity Transactions and U.S. Portfolio Choice, in J. Frankel ed. *The Internationalization of Equity Markets*, NBER University of Chicago Press.

[21] Tesar, Linda L., and Ingrid M. Werner, 1995, Home Bias and High Turnover, *Journal of International Money and Finance* 14(4), 467-92.

[22] Wang, Jiang, 1994, A Model of Competitive Stock Trading Volume, *Journal of Political Economy* 102(1), 127-68.

[23] *World Development Finance (Volume 1)*, 1997, World Bank.

[24] *World Economic Outlook*, 1999, International Monetary Fund.

Notes

[1]Calculated as average ratio of net annual sales of foreign stocks and bonds divided by the sum of gross sales and purchases of foreign stocks and bonds using the "grand total" in the TIC data collected by the U.S. Treasury department.

[2]I must note that the assumption in Brennan and Cao (1997) is that foreign investors are *on average* less informed than domestic ones. This allows for some asymmetry within the groups of foreign and domestic investors and hence for some gross flows. This paper argues that asymmetries *within* countries appear to be more important than those *between* countries.

[3]The well-known shortcoming of this data is that the country breakdown does not necessarily indicate the country of beneficial owner. For example, a purchase of Malaysian stock through an intermediary in London will be interpreted as purchase of U.K. stock. For more details on the TIC data see http://www.treas.gov/tic/ticd.htm or appendix A in Tesar and Werner (1994)

[4]In the limit, as frequency goes to an instant, any flow variable will be equal to zero.

[5]In addition, my empirical findings later in the paper pose a challenge to asset heterogeneity as an explanation of gross flows.

[6]The closed economy version of the model is not aimed at making a contribution to the class of noisy rational expectations models. It is the simplest model of this class which shows how different information asymmetries influence the behavior of gross flows and their relationship with returns.

[7]Proofs of these results are in appendix A.

[8]There are corresponding flows in the riskless asset which depend on asset payoffs in each period. In my model, flows in the riskless and risky assets are negatively correlated. I interpret the riskless asset as the U.S. treasury bond. Under this interpretation, the negative correlation is observed in the data. Net U.S. purchases of foreign stocks and bonds are negatively correlated with net U.S. purchases of U.S. treasury bonds. The correlations range from 0 to -0.3.

[9]Recall that $4cov(pos, neg) = var(sum) - var(net)$.

[10]In principle, I do not need to generate an artificial series to find the properties of the model. Given the equations (7), the correlations and variances can in principle be found analytically. How-

ever, the analytical formulas involve a number of complicated integrals. Therefore, I resort to finding correlations and variances using simulations.

[11] Brennan and Cao show that an average "cumulative" information advantage of domestic over foreign investors implies a positive correlation between net flows and returns. The effect of "marginal" information is just the opposite. In my model all information is "marginal" and hence, if foreign investors are less informed than domestic investors, net flows are negatively correlated with returns.

[12]This is similar to the result in Wang (1994) which shows that trading volume is positively correlated with absolute returns.

[13]Brennan and Cao find a positive association between net flows and returns. However, their results are sensitive to their particular scaling scheme. Futhermore, Froot et al(1998) find no contemporaneous correlation between net flows and returns.

[14]It is worth stressing that in my model investors can borrow unlimited amounts. Informed investors stand ready to absorb selling pressure from uninformed investors. However, if informed investors face binding credit constraints, they may not be able to purchase the shares which are being sold. The price needs to drop to induce the uninformed to hold more of the risky asset. This will have implications for the size of gross flows. Trading will be affected by the shape of the margin requirement.

Table 1: Annual Total and Excess Gross Flows

Total flows are the sum of gross inflows and outflows; excess flows are total flows minus the absolute value of net flows. Both series are expressed as a percentage of average market capitalization in a given year. Averages from 1990 to 1998 are reported.

Country	Total Gross Flows	Excess Flows
Brazil	8.1	7.1
Korea	2.9	1.9
Malaysia	2.5	2.3
Mexico	15.4	13.7
Taiwan	0.7	0.6
France	4.6	4.3
Germany	4.9	4.5
Japan	3.6	3.3
Switzerland	5.8	5.4
United Kingdom	19.8	19.1

Table 2: Monthly Correlation Between Gross Inflows and Outflows

Sample correlations of monthly data from January, 1990 to December, 1998. Gross inflows and outflows are expressed as a percentage of market capitalization and are linearly detrended. A ** indicates significance at the 1% level.

Country	Correlation Between Gross Inflows and Outflows
Brazil	0.75**
Korea	0.43**
Malaysia	0.78**
Mexico	0.50**
Taiwan	0.42**
France	0.51**
Germany	0.74**
Japan	0.58**
Switzerland	0.61**
United Kingdom	0.88**

Table 3: Standard Deviation of Detrended Total Gross and Net Flows

A sample standard deviation of monthly data from January, 1990 to December, 1998. Total gross and net flows are expressed as a percentage of market capitalization and are linearly detrended.

Country	Total Gross Flows	Net Flows
Brazil	0.39	0.15
Korea	0.20	0.14
Malaysia	0.14	0.04
Mexico	0.58	0.34
Taiwan	0.03	0.02
France	0.10	0.06
Germany	0.14	0.05
Japan	0.11	0.04
Switzerland	0.17	0.08
United Kingdom	0.30	0.07

Table 4: Correlations Between Gross and Net Flows and Returns

Sample correlations of monthly data from January, 1990 to December 1998. Both total flows(sum) and net flows(net) are expressed as a percentage of market capitalization and are linearly detrended. Returns are log differences in the local stock market index. The data comes from the Emerging Markets Database of IFC for the 5 developing countries and International Financial Statistics for the 5 developed countries. One and two stars indicate significance at the 5% and 1% levels respectively.

Country	corr($net, \triangle P$)	corr($sum, \|\triangle P\|$)
Brazil	0.13	0.22*
Korea	-0.01	0.26**
Malaysia	0.17	0.19*
Mexico	0.26**	0.27**
Taiwan	0.05	0.37**
France	0.05	0.23*
Germany	0.25*	0.20*
Japan	0.50**	0.26**
Switzerland	0.09	0.04
United Kingdom	0.11	0.20*

Figure 1: Gross and Net Flows

Monthly gross and net equity flows expressed as a percentage of market capitalization. The solid line indicates gross inflows, the dashed gross outflows, and the dotted net flows.

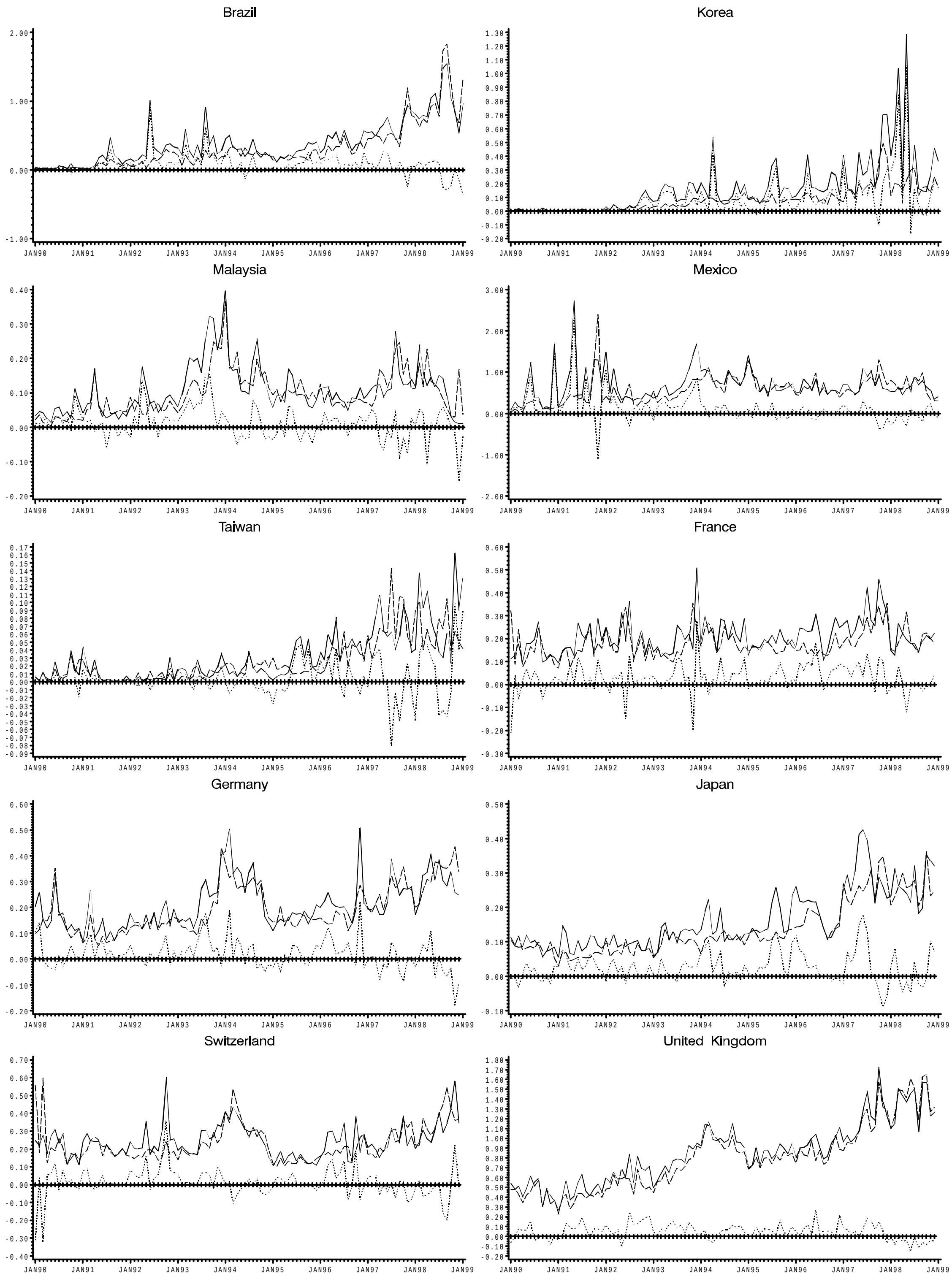

Figure 2: Correlation Between Gross Inflows and Outflows

Information asymmetry is measured as the difference between the variance of informed signal σ_I^2 and the variance of uninformed signal σ_U^2. $\sigma_I^2 = 0.01$ and σ_U^2 runs from 0.01 to 1. The number of informed and uninformed investors in each country is the same so that $\gamma = 0.5$. I set $\sigma_Z^2 = 0.025, \sigma_d^2 = \sigma_\xi^2 = 5, R = 1$.

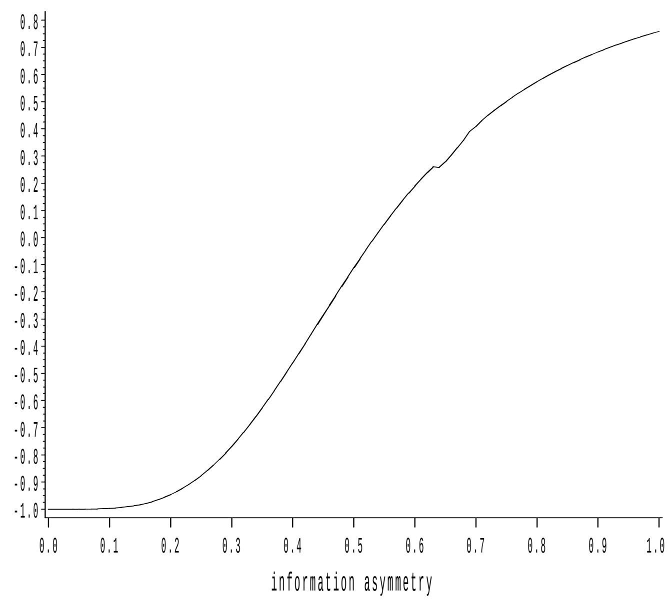

Figure 3: Relative Variance of Total Gross Flows

Variance of total gross flows divided by the variance of net flows. Information asymmetry is measured as the difference between the variance of informed signal σ_I^2 and the variance of uninformed signal σ_I^2. $\sigma_I^2 = 0.01$ and σ_U^2 runs from 0.01 to 1. The number of informed and uninformed investors in each country is the same so that $\gamma = 0.5$. I set $\sigma_Z^2 = 0.025, \sigma_d^2 = \sigma_\xi^2 = 5, R = 1$.

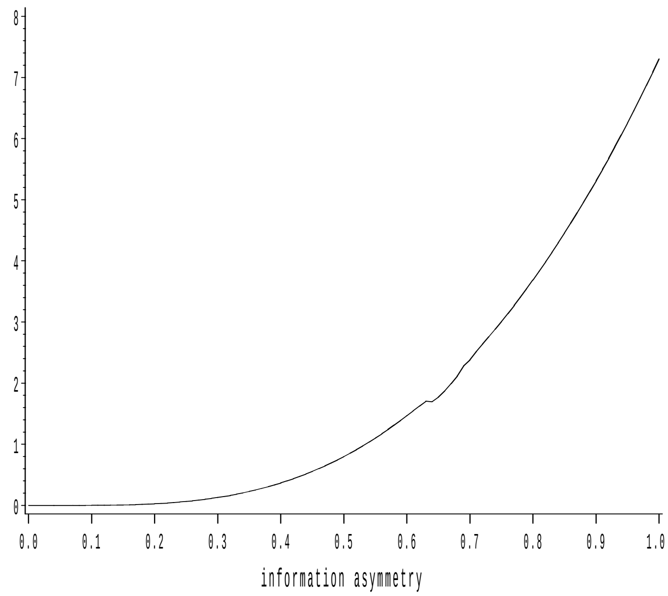

Figure 4: Correlation Between Gross Inflows and Outflows

Information asymmetry is measured as the difference between the variance of informed signal σ_I and the variance of uninformed signal σ_U^2, $\sigma_I^2 = 0.01$ and σ_U^2 runs from 0.01 to 1. The number of informed and uninformed investors in each country is the same so that $\gamma = 0.5$. I set $\sigma_Z^2 = 0.025, \sigma_d^2 = \sigma_\xi^2 = 5, R = 1$.

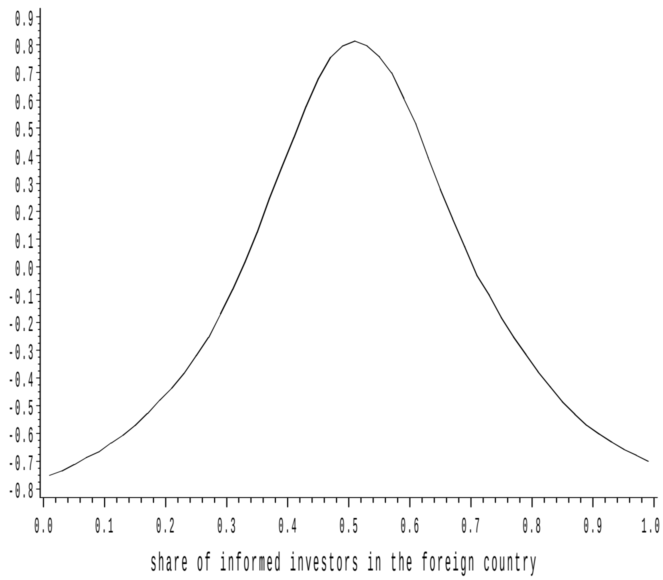

Figure 5: Correlation Between Total Gross Flows and Absolute Returns

Share of informed investors in the foreign country varies from 0 to 1. The variance of informed signal $\sigma_I^2 = 0.01$ and the variance of the uninformed signal $\sigma_U^2 = 1$. I set $\sigma_Z^2 = 0.025, \sigma_d^2 = \sigma_\xi^2 = 5, R = 1$.

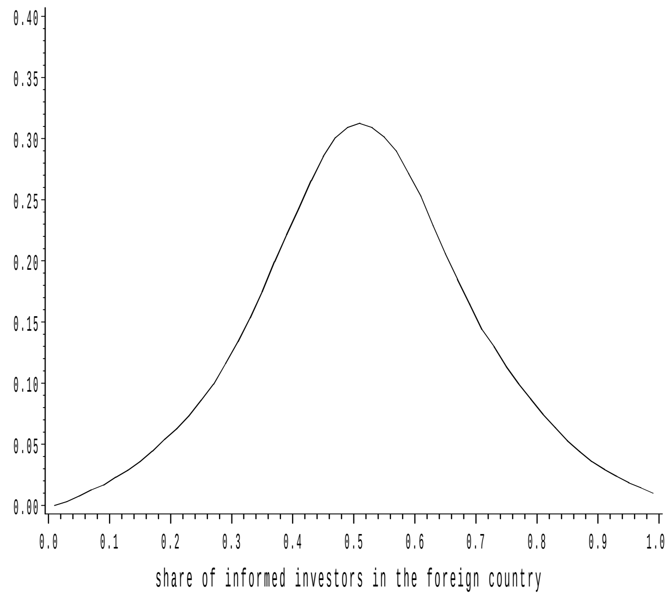

Figure 6: Correlation Between Net Flows and Returns

Share of informed investors in the foreign country varies from 0 to 1. The variance of informed signal $\sigma_I^2 = 0.01$ and the variance of uninformed signal $\sigma_U^2 = 1$. I set $\sigma_Z^2 = 0.025, \sigma_d^2 = \sigma_\xi^2 = 5, R = 1$.

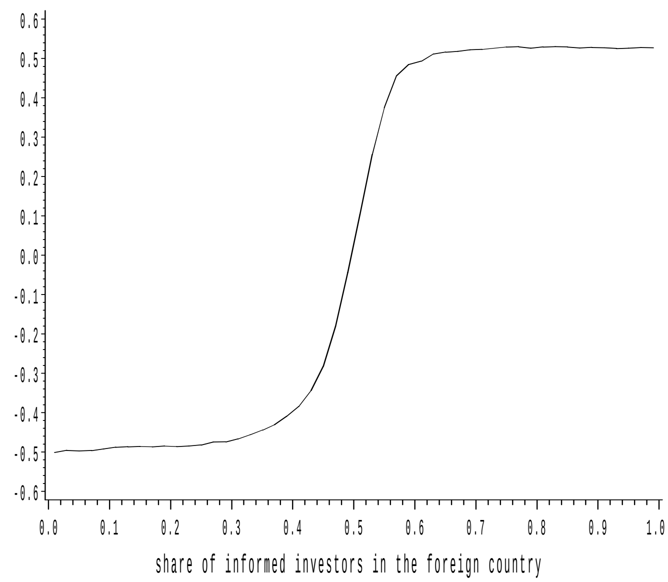

Figure 7: Net Flows and Returns

Net flows are expressed as a percentage of market capitalization and are linearly detrended. The returns are log differences of the local stock market index.

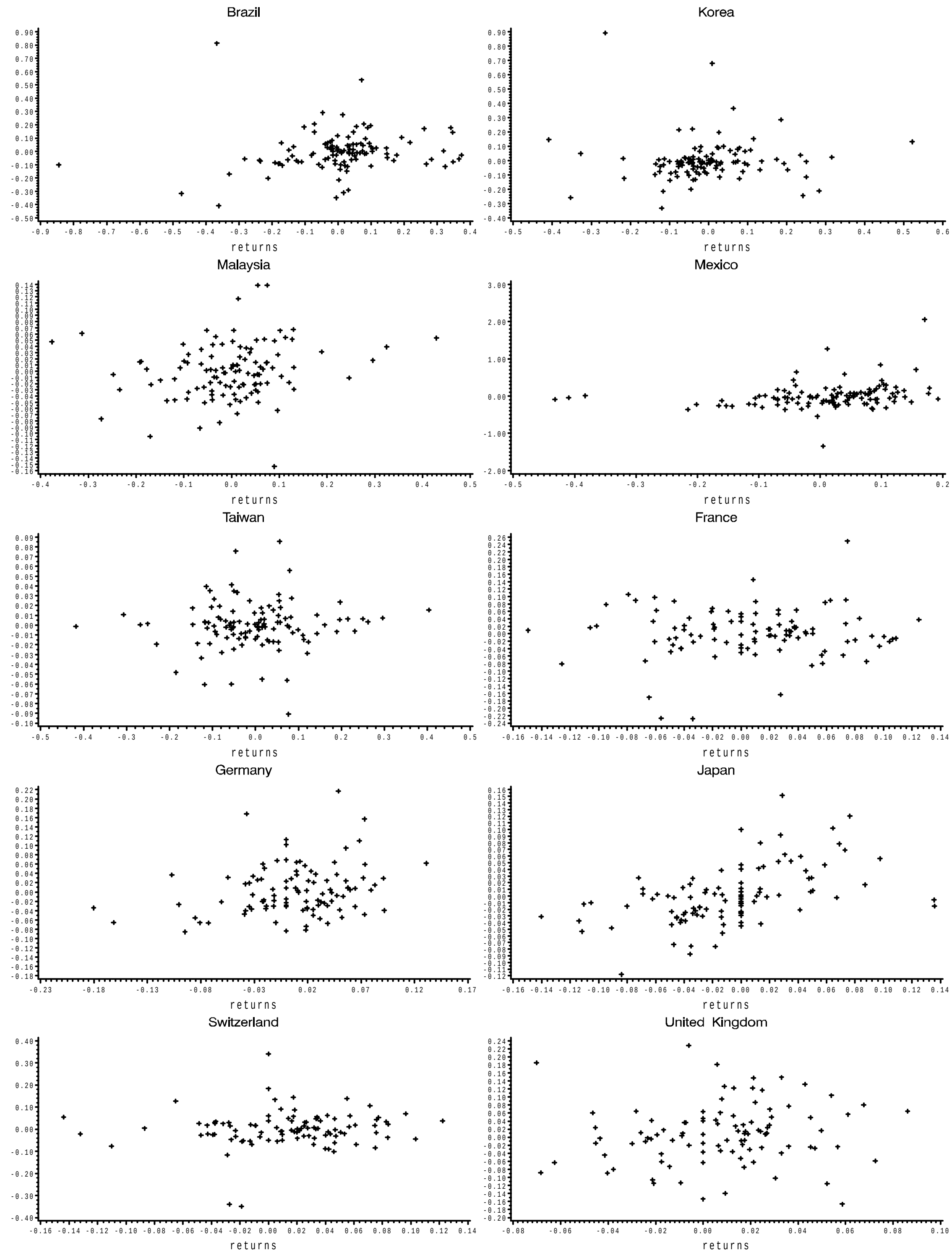

Figure 8: Total Gross Flows and Absolute Returns

Total flows are expressed as a percentage of market capitalization and are linearly detrended. The absolute returns are the absolute value of log differences in the local stock market index.