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# The determinants of international investment and attention allocation: Using internet search query data

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ABSTRACT

This paper explores the joint determination of home bias and attention allocation. We overcome the typical challenge associated with evaluating attention allocation theories by using a new internet search query dataset to measure how much information investors decide to process. Employing an instrumental variables approach, we find empirical evidence of a two-way causality between home bias and attention. Our estimates suggest that if all countries were to receive the same level of attention as the U.S., then the average home bias by U.S. investors would fall from 85.2% to 57.3%.



## 1. Introduction

The existence of a domestic bias in international equity holdings was first documented by French and Poterba (1991) and Tesar and Werner (1995). One popular justification focuses on the role of informational asymmetries between domestic and foreign investors. Although over the past decade innovations in telecommunication and information technologies have greatly increased investors' access to information around the globe, significant levels of home bias still remain. To explain this persistent bias, information-based models commonly have to assume implausibly large exogenous information asymmetries. Recent work by Van Nieuwerburgh and Veldkamp (2009), however, generated these large information asymmetries by endogenizing the investors' information structure. In their model, the allocation of investors' limited attention leads to information heterogeneity endogenously and thereby a sizeable bias in portfolios. Our paper provides empirical support for attention-based explanations of the home equity bias.

The idea that "most people everyday encounter, or could very easily encounter, much more information that is in principle relevant to their economic behavior than they actually respond to" (Sims, 2006)–known as inattentiveness–has recently been incorporated into finance and economic models.[1] Although attention allocation models are very appealing from a theoretical perspective, empirical evaluation remains a challenge. The main difficulty relies on measuring the pieces of information each agent processes. Our paper overcomes such a challenge by using a new dataset from America Online (henceforth AOL) that includes over 21 million web searches by 657,426 customers. We then combine data on U.S. holdings of foreign securities to analyze the joint determination of home bias and attention allocation by U.S. investors.

Our contributions are three-fold. First, we derive a simple model based on Van Nieuwerburgh and Veldkamp (2009) to study the channels through which attention allocation affects portfolio choice and vice versa. Second, we provide a new measure of the attention allocated across countries by U.S. investors. Measuring attention

[1] In macroeconomics, inattentiveness has been used by Mackowiak and Wiederholt (2009a) and Mankiw and Reis (2002) to explain sticky prices and by Luo (2008), Mackowiak and Wiederholt (2009b) and Tutino (2009) to explain business cycle dynamics. Falkinger (2007) develops a theoretical model in which firms have to compete first for consumers' attention before competing for their budgets. In finance, it has been used to better understand the equity-premium puzzle in Gabaix and Laibson (2002), price comovement in Mondria (forthcoming), portfolio underdiversification in Van Nieuwerburgh and Veldkamp (2010), home equity bias in Van Nieuwerburgh and Veldkamp (2009) and the forward discount bias in Bacchetta and Van Wincoop (forthcoming).

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allocation is a complicated task. Agents process information using different media (i.e., books, magazines, newspapers, radio, TV, the Internet) and, for most of these media, it is virtually impossible to track the amount of effort spent processing information about different topics. On August 3, 2006, AOL released a dataset that includes all web search queries from its users for a three month period (March 1st to May 31st of 2006), as well as whether they clicked on a result and where it appeared on the result page. A web search query is the exact phrase that a user types into the search engine to satisfy his or her information needs. In this paper, we explore the AOL dataset to help us measure the attention allocated to different countries. We believe that a measure based on internet search queries can proxy attention allocation because: (*i*) the World Wide Web is becoming the predominant information medium; (*ii*) search engines are the most popular tool for finding reliable information on the "Web" since they minimize the time required and the amount of information which must be consulted; (*iii*) by having user's exact search query, we know the topic that he or she was interested in. Using this dataset, we construct a click-through series that counts the number of times a user clicked on a search result from a particular country. The idea is to measure the attention allocated to a country by the number of times this country provided the answer to a search query.

Our third contribution is to study the determinants of attention allocation and home equity bias across countries by U.S. investors. We combine the click-through series with home bias data constructed from the 2006 survey of U.S. portfolio holdings of foreign securities (Fig. 1). We recognize that both home bias and attention allocation are endogenous and, using instrumental variables as our estimation methodology, we find empirical evidence of joint causality. First, causality runs from asset holdings to attention allocation. Using instrumental variables that capture implicit financial costs, we find that agents do indeed allocate more attention to countries whose assets make up a greater share of their portfolios. Second, causality also runs from attention allocation to asset holdings. Using instrumental variables that are related to a country's popularity among internet users, we find that international investors favor assets from more familiar countries. Taken together, our results show that the unconditional correlation between measures of information and equity holdings is not just due to agents being more interested in countries whose assets they already hold. Instead, agents endogenously increase their holdings of a particular country's assets in response to an exogenous increase in the information they have about that country. Our results also suggest that if all countries were to receive the same level of attention as the U.S., then the average home bias by U.S. investors would fall from 85.2% to 57.3%.

Many studies have emphasized the importance of asymmetric information in determining home bias.[2] Ahearne et al. (2004), for example, provide evidence that information regarding accounting standards and practices is an important determinant of the distribution of home bias across countries. Dahlquist et al. (2003) discuss the importance of information about cross-country differences in corporate governance while Kraay et al. (2005) suggest that information regarding sovereign risks and political events helps explain differences in country portfolios. Bekaert (1995) presents evidence that information about macroeconomic conditions, market structure and institutions are important drivers of equity flows into emerging markets and Portes and Rey (2005) and Chan et al. (2005) find that the geography of information is relevant for explaining cross-border equity flows and mutual fund equity holdings respectively. Moreover, Coval and Moskowitz (2001) and Malloy (2005) show that fund managers are able to predict abnormal returns in local investments. Because these results are stronger for investments in small firms and firms located in remote areas, the authors argue that local investments allow fund managers to assess and survey the firm's operations and have regular meetings with CEOs. This evidence indicates that information about firm operations and close contact with CEOs generates local bias at home.[3]

The rest of the paper is organized as follows. Section 2 develops the model. Section 3 describes the new measure of attention allocation. Section 4 presents the dataset. Section 5 describes the empirical methodology. Section 6 shows the empirical results. Section 7 concludes.

## 2. Model

The objective of the model is to understand how attention allocation affects asset holdings and how asset holdings affect attention allocation.

### 2.1. Model description

We formulate a partial equilibrium model based on Van Nieuwerburgh and Veldkamp (2009, 2010) with a continuum of investors and two countries. [4] The economy consists of a risk free asset, which pays $R$ units of the consumption good, and two independent risky assets. Even though this is a static model, four discrete events occur during the operation of the market. First, traders are endowed with an initial wealth $W_{i0}$ and limited information processing resources $\kappa$. Second, investors allocate their limited information processing resources to analyze both stock markets and, based on this allocation, obtain private information about each market, $\tilde{Y}_i=(\tilde{y}_{i,1},\tilde{y}_{i,2})'$. Third, each investor chooses optimal asset holdings $X_i=(x_{i,1},x_{i,2})'$ given $\tilde{Y}_i$. Fourth, trading ceases and investors consume the payoffs realized by their portfolios.

Investors have an absolute risk tolerance parameter $\rho$ and maximize a mean-variance objective function

$$U_i = E\left(E\left[W_i^{'}|\tilde{Y}_i\right]-\frac{1}{2\rho}\mathrm{Var}\left[W_i^{'}|\tilde{Y}_i\right]\right)$$

subject to the following budget constraint

$$W_{i1} = W_{i0} + X_i^{'}\left(\tilde{R}-RP\right)$$

where $W_{i0}$ is the initial wealth of agent $i$, $X_i=(x_{i,1},x_{i,2})'$ is the asset holdings vector of agent $i$ , $\tilde{R}=(\tilde{r}_1,\tilde{r}_2)'$ with $\tilde{r}_j\sim N(\bar{r}_j,\sigma^2_{r,j})$ for $j=1,2$ is the vector of risky asset payoffs, $\tilde{Y}_i=(\tilde{y}_{i,1},\tilde{y}_{i,2})'$ is agent $i$'s private information about each market and $P$ is the price vector of the risky assets.

Investors devote information capacity to process information about the vector of unknown and independent asset payoffs $\tilde{R}$. Agent $i$ receives a private signal about each risky asset $j=1,2$ given by

$$\tilde{y}_{i,j} = \tilde{r}_j + \tilde{\varepsilon}_{i,j} \text{ where } \varepsilon_{i,j}\sim N(0,\sigma^2_{i,j})$$

Investors want to obtain information about the risky assets in order to reduce the uncertainty of their optimal portfolio. They face

[2] For theoretical work on the home equity bias puzzle and asymmetric information, see Gehrig (1993), Brennan and Cao (1997), Zhou (1998), Barron and Ni (2008), Hatchondo (2008) and Van Nieuwerburgh and Veldkamp (2009).

[3] However, the evidence provided by Kang and Stulz (1997) and Dahlquist and Robertsson (2001), who show that foreign investors hold stock of firms that are large and have low leverage, suggests that the effect of this information on investments across the border might be rather small.

[4] For a full general equilibrium model, where attention allocation and asset holdings are jointly determined, see Van Nieuwerburgh and Veldkamp (2009) and Mondria and Wu (2010).