# DISCUSSION PAPER SERIES

No. 2855

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***FINANCIAL ECONOMICS***

Centre for Economic Policy Research

www.cepr.org

**Available online at:** **www.cepr.org/pubs/dps/DP2855.asp**

*ISSN 0265-8003*

# IPO ALLOCATIONS: DISCRIMINATORY OR DISCRETIONARY?

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Discussion Paper No. 2855
July 2001

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CEPR Discussion Paper No. 2855

July 2001

# ABSTRACT

## IPO Allocations: Discriminatory or Discretionary?*

We estimate the structural links between IPO allocations, pre-market information production, and initial underpricing returns, within the context of theories of bookbuilding. Using a sample of both US and international IPOs we find evidence of the following:

- IPO allocation policies favour institutional investors, both in the US and worldwide.
- Increasing institutional allocations results in offer prices that deviate more from the indicative price range established prior to bankers' efforts to gauge demand among institutional investors.
- Constraints on the discretion bankers exercise in the allocation of IPO shares reduce institutional allocations.
- Constraints on allocation discretion result in smaller price revisions. We interpret this as indicative of diminished information production.
- Initial returns, which reflect a significant indirect cost of going public, are directly related to our measure of information production and inversely related to the fraction of shares allocated to institutional investors.

Our results indicate that discretionary allocations promote price discovery in the IPO market and reduce issuance costs for firms attempting to go public.

JEL Classification: G32
Keywords: bookbuilding, initial public offerings, intermediation and underpricing

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* We are grateful to William Greene, Michel Habib, Maureen O'Hara, Jay Ritter, and participants at the NYSE 'Global Equity Markets in Transition' conference, Hawaii 2001, the Third Toulouse Finance Workshop, and seminars at Oxford University and the University of Wisconsin-Madison for helpful comments. We wish to thank the many companies, banks, and bourses that made data available. All errors are our own.

Submitted 27 March 2001

# NON-TECHNICAL SUMMARY

IPO allocation policies favour institutional investors. This is well known, although rather less well documented, in the US. In this Paper, we show that the same is true worldwide. Averaging across 36 countries and 1,005 IPOs between 1990 and 2000, we find that share allocations to institutional investors are virtually double those received by retail investors. This is in line with the available evidence from the US.

How should this empirical fact be interpreted? In the US, allocation policies are discretionary – there are no rules to guide or to constrain investment bankers. The academic literature argues that discretion can enable investment bankers to favour some investors over others and thereby improve price discovery and better serve the interests of issuing firms. Outside the US, allocation discretion is frequently constrained and yet the end result, in allocations at least, appears much the same. On net then, is 'discretion' a good thing or should allocation practices more accurately and pejoratively be thought of as 'discriminatory'?

In the near future this question is likely to receive considerable attention from both academics and policy-makers as the recently begun investigations into allocation practices by the Securities and Exchange Commission and the US attorney's office in Manhattan take shape. Outside the US, bookbuilding, with its emphasis on discretionary allocation practices, has virtually supplanted the traditional fixed-price offering, and its *pro rata* allocation policy, in much of continental Europe and increasingly in Asia. Thus the stage is set for serious consideration of the consequences of allocation practices for primary market performance.

In this Paper we attempt to shed light on this rather complex question. We take the maximization of the issuer's proceeds, net of the costs of issuance, as the objective of pricing and allocation policies. This requires careful consideration of the source and magnitude of the indirect costs of issuance. Specifically, IPOs are typically 'underpriced', in the sense of large first-day price increases on average, and institutional investors are the primary beneficiaries.

This underpricing is frequently viewed as a *quid pro quo* arrangement embodied in the optimal mechanism for acquiring private valuation-relevant information from institutional investors. Although discounts diminish the issuer's proceeds from the offering, in this view, *expected* proceeds decline under alternative allocation policies. Constraints on the banker's allocation discretion are therefore likely to diminish the issuer's expected net proceeds.

The limited documentation of allocation policy in the literature appears consistent with this prediction. There are at least two reasons, however, why it is premature to accept discretion as a good thing on the basis of these studies alone. First, it is conceivable that statistical tests of the mechanism design theory have been unable to reject the theory in spite of its weak explanatory power. Second, most studies have focused on relatively narrow, reduced-form tests of the theory, often ignoring serious endogeneity problems, rather than testing the broader structure implied by the mechanism design perspective. In this Paper, we estimate a structural model designed to put the theory to a more severe test. One noteworthy finding is that the theory survives our test.

Moreover, most existing tests of the theory have used data from the US. The problem with US data, apart from the general unwillingness of US banks to share information about their allocation policies, is that it provides no useful alternative for comparison. Banks maintain full allocation discretion in all US firm-commitment IPOs. By contrast, the international data used in our analysis comprises a wide range of allocation policies subject to an equally wide range of regulatory constraints. At one extreme, the German primary markets are increasingly dominated by bookbuilding practices and, like the US, impose few constraints on how shares are allocated. At the other extreme are countries like Australia where fixed price offerings with *pro rata* allocations are the default option given issuing firms. In the middle lie countries like France and the United Kingdom where issuers can select from a range of underwriting practices and banks are subject to a variety of constraints on the discretion they exercise in the allocation of shares.

The sample heterogeneity in allocation policy provides for identification of our structural econometric model. In turn, estimation sheds light on whether discretionary allocation is beneficial and if so, under what circumstances. The following results should be of interest to policy-makers:

- Constraints on bankers' allocation discretion reduce institutional allocations.
- Constraints on allocation discretion result in offer prices that deviate less from the indicative price range established prior to bankers' efforts to gauge demand among institutional investors. We interpret this as indicative of diminished information production.
- Initial returns are directly related to this measure of information production and inversely related to the fraction of shares allocated to institutional investors.

We tentatively conclude that discretionary allocation promotes price discovery in primary markets and diminishes the attendant costs of information acquisition.

*A good catchword can obscure analysis for fifty years.*

Wendell Wilkie, 1938

## 1. Introduction

IPO allocation policies favor institutional investors. This is well known, although rather less well documented, in the U.S. In this paper, we show that the same is true worldwide. Averaging across 36 countries and 1,005 IPOs between 1990 and 2000, we find that share allocations to institutional investors are virtually double those received by retail investors. The available evidence from the U.S. indicates much the same [Hanley and Wilhelm (1995), Aggarwal (2000)].

How should this empirical fact be interpreted? In the U.S., allocation policies are discretionary – there are no rules to guide or constrain investment bankers. Outside the U.S., allocation discretion is frequently constrained and yet the end result, in allocations at least, appears much the same. Benveniste and Wilhelm (1990) suggest that banker discretion can benefit issuers facing asymmetrically informed investors. On the other hand, it is not hard to imagine bankers exercising discretion to favor institutional investors with whom they maintain long-term relationships. The open question is whether, on net, "discretionary" share allocation is beneficial or whether it should more accurately and pejoratively be thought of as a "discriminatory" practice that serves the bankers' interests at the expense of other parties to the transaction.

Until recently, allocation practices were criticized, to little effect, for discriminating against retail investors. But on December 6, 2000 the *Wall Street Journal* alleged that in exchange for IPO allocations, bankers required institutional investors to purchase shares in the secondary market or pay unusually high trading commissions. The Securities and Exchange Commission and the U.S. attorney's office in Manhattan responded by announcing investigations to determine whether these

practices violate regulations barring tie-ins.[1] Credit Suisse First Boston, and its technology banking group headed by Frank Quattrone, have been the focus of the public debate. However, it is widely assumed that CSFB's competitors follow similar allocation practices.

Fundamentally, either of the practices under scrutiny can be thought of as a tool for (implicit) price discrimination because they create the potential for extracting a unique payoff from each investor receiving an initial allocation. In other words, investors can be charged different all-in prices for IPO shares. Explicit price discrimination in the sale of IPOs is prohibited in the U.S. as well as in most other jurisdictions. But under certain circumstances, price and/or allocation discrimination can promote primary market efficiency [Benveniste and Wilhelm (1990)].

In this paper we attempt to shed light on the rather complex question of whether such discriminatory practices undermine primary market efficiency. The complexity begins with identifying an appropriate objective for pricing and allocation policies. The bulk of academic theory treats maximization of proceeds received by the issuer as the appropriate objective. Although there is merit in this assumption in the context of well-developed capital markets, it is less obviously appropriate for privatization IPOs or when it is hoped that broad share ownership will spur the development of secondary markets or serve some other public interest. Some might even argue for non-discriminatory allocations on egalitarian grounds regardless of the consequences for issuing firms.

For the purpose at hand, we implicitly take proceeds maximization net of the direct costs of issuance as the appropriate objective of a pricing and allocation policy. We believe this approach sheds more light on the ongoing debate in the U.S. and increasingly is germane to policymakers worldwide. But it also requires careful consideration of the source and magnitude of the indirect

[1] See Smith and Pulliam ("U.S. Probes Inflated Commissions for Hot IPOs", *Wall Street Journal*, December 7, 2000, p. C1) as well as subsequent articles. Also see the seven-part series beginning May 2, 2001 in *Red Herring*.

costs of issuance. Initial public offerings are typically discounted or "underpriced", in the sense of large first-day price increases, and institutional investors are the primary beneficiaries.

Benveniste and Spindt (1989) establish conditions under which this substantial indirect cost of bookbuilding reflects a *quid pro quo* arrangement with institutional investors whose non-binding bids or "indications of interest" provide the foundation for establishing the issuer's offering price. Absent "compensation" (in the form of large allocations of underpriced shares) for revealing their superior information, institutions would have little incentive to bid aggressively knowing that to do so would only drive up the offering price. But indiscriminate allocation of underpriced shares rewards both informed and uninformed investors. Although discriminatory allocation of underpriced shares diminishes the issuer's proceeds from the offering *ex post*, in this view, *expected* proceeds decline under alternative allocation policies [Benveniste and Wilhelm (1990), Sherman and Titman (2000)]. Constraints on the banker's allocation discretion can therefore diminish the issuer's expected net proceeds.

Benveniste, Busaba, and Wilhelm (1996) extend the analysis by showing that discretionary implementation of "penalty bids" designed to prevent immediate sale of initial share allocations by some investors can increase expected proceeds by providing another instrument for price discrimination. Bankers routinely attempt to prevent secondary market prices from declining below the offering price. In this context, penalty bids buoy secondary market prices by counterbalancing selling pressure. In other words, they are economically equivalent to the alleged demands from bankers that investors purchase shares in the secondary market in exchange for initial share allocations. But allowing some investors to sell at the offer price while preventing others from doing so, is also equivalent to providing some initial investors with put options in

addition to their share allocations but withholding them from others. Thus for the same (offer) price, some investors receive shares and put options while others receive only shares.

Alternatively, allocation discretion might aggravate an agency problem between the issuer and its banker [Baron (1982)] arising from the fact that bankers deal repeatedly with institutional investors but infrequently with issuers. Biais, Bossaerts, and Rochet (1999) examine this possibility by assuming that bankers and institutional investors collude to extract informational rents from issuers. Once again, the optimal price and allocation mechanism (from the issuer's perspective) favors informed investors with discounted share allocations. However, price discrimination is not optimal in this setting whereas both price and allocation discrimination can be optimal in the Benveniste and Wilhelm (1990) setting.[2] Thus mechanism design theory generally predicts favorable treatment of institutional investors when they maintain the informational upper hand but the level of discretion necessary for promoting the interests of the issuer can vary with the circumstances at hand.

The limited documentation of allocation policy in the literature appears consistent with this interpretation. However, it may be premature to accept discretion as a good thing on the basis of these studies alone. Most empirical studies have focused on relatively narrow, reduced-form tests of the theory, often ignoring serious endogeneity problems, rather than testing the broader structure implied by the mechanism design perspective.[3] In this paper, we estimate a structural

[2] In a similar vein, Biais and Faugeron-Crouzet (2000) identify a parallel between France's *Mise en vente* auctions and bookbuilding by establishing conditions under which both implement the optimal price and allocation mechanism.

[3] See, for example, Hanley (1993). Hanley and Wilhelm (1995) and Cornelli and Goldreich (1999, 2000) are constrained from estimating a structural model by the fact that they have allocation data only for a single bank. The structural test performed by Biais et al. (1999) suffers from limited data and, for our purposes, the fact that allocation policy in the *Mise en vente*, while discriminatory, provides bankers with limited discretion. Ljungqvist, Jenkinson, and Wilhelm (2000), using data similar to ours, account for the econometric consequences of issuers selecting endogenously from a 'menu' of price and allocations mechanisms when they go public.

model designed to put the mechanism design theory to a more severe test. One noteworthy finding is that the theory survives our test.

Most existing tests of the theory have also been limited to the U.S. The problem with U.S. data, apart from the general unwillingness of U.S. banks to share information about their allocation policies, is that it provides no useful alternative for comparison.[4] Banks maintain full allocation discretion in all U.S. firm-commitment IPOs. Outside the U.S., bookbuilding practices have virtually supplanted the traditional fixed-price offering, and its pro rata allocation policy, in much of Continental Europe and increasingly in Asia [Ljungqvist, Jenkinson, and Wilhelm (2000)]. But these countries have also imposed a wide range of regulatory constraints on allocation policies. At one extreme, the German primary markets are increasingly dominated by bookbuilding practices and, like the U.S., impose few constraints on how shares are allocated. At the other extreme are countries like Australia where fixed price offerings with pro rata allocations are the default option given issuing firms. In the middle lie countries like France and the United Kingdom where issuers can select from a range of underwriting practices and banks are subject to a variety of constraints on the discretion they exercise in the allocation of shares.

This heterogeneity in allocation policy provides for identification of our structural econometric model. In turn, estimation sheds light on whether discretionary allocation is beneficial on net and if so under what circumstances. The following results should be of interest to policy makers:

- Constraints on bankers' allocation discretion reduce institutional allocations.
- Constraints on allocation discretion result in offer prices that deviate less from the indicative price range established prior to bankers' efforts to gauge demand among institutional investors. We interpret this as indicative of diminished information production.

[4] Cornelli and Goldreich (1999, 2000) are the noteworthy exceptions and both support the general theory.

- Initial returns are directly related to this measure of information production and inversely related to the fraction of shares allocated to institutional investors.

We tentatively conclude that discretionary allocation does not pose a net cost to issuers because it promotes price discovery in primary markets and diminishes the attendant costs of information acquisition.

## 2. Sample and Data

Our dataset spans the period January 1990 to May 2000 and covers a large fraction of the IPOs brought to market worldwide during the decade. The 1990s are noteworthy both for the high level of primary market activity and also as a period of unprecedented experimentation in the means by which issuing firms were marketed to investors. The sharp increase in global offerings required banks to develop mechanisms to appeal to a wide range of investor preferences and abide by a similarly wide range of regulatory constraints. Privatization movements in Europe and Asia contributed to the experimentation by introducing a new breed of extremely large, mature firms to the primary markets and by encouraging the pursuit of broader interests like wealth redistribution [Jones, Megginson, Nash, and Netter (1999)] and secondary market development [Pagano (1993)]. By the end of the decade, a large fraction of IPOs were carried out by methods that involved discretionary share allocation for at least part of the offering [Ljungqvist et al. (2000)].

### *Sample construction*

We assemble a large dataset of IPOs from a variety of sources, detailed below. While we do not have allocation data for every IPO in this dataset, we still require as comprehensive a dataset as possible, in order to derive certain measures of aggregate IPO activity for our econometric model.

The econometric model, in turn, focuses on firms floating in four countries – France, Germany, the U.K., and the U.S. – which are subject to a wide range of constraints described later.

Throughout the paper, observations per country refer to the number of firms going public in that country, including foreign issuers. We adopt this convention because rules on allocation discretion are formulated at the level of the country of listing, not the country of origin. Where a company lists in more than one country, we define its main listing as being in its home country, or if it only lists abroad as the country where the bulk of the offering is conducted.

Specifically, the dataset consists of three parts, covering the 15 countries of the European Union, non-EU Europe, and Rest of the World. Throughout, we exclude IPOs by investment trusts, companies previously listed elsewhere, and introductions (listings not accompanied by the sale of securities, common in the U.K.). The EU15 part consists of 2,967 IPOs and captures offerings anywhere in the world by firms based in an EU15 country as well as offerings in an EU15 country by firms based anywhere in the world:

| Issuers **based** in the 15 European Union countries | Issuers **listing** in the 15 European Union countries | Number of IPOs |
|---|---|---|
| √ | √ | 2,861 |
| √ | × | 82 |
| × | √ | 24 |
| | | 2,967 |

These 2,967 offerings were identified from five principal sources:

- the Equityware database (between January 1992 and July 1999) [see Ljungqvist et al. (2000) for further details];
- the SDC Global New Issues database, from which we extract all IPOs not already covered in Equityware (619 cases, of which 324 were conducted before January 1992 or after July 1999);
- information provided by European stock exchanges;

- a search of every article in Reuters' "Share issues" news archive for each EU15 country;
- and Ljungqvist's (1997) database of German IPOs.

Every offering contained in these sources was checked for eligibility as a bona fide IPO against IPO prospectuses and regulatory filings.[5,6]

The EU15 sample is relatively comprehensive. In addition, we have access to a less comprehensive sample of 98 IPOs by issuers in non-EU Europe and 695 IPOs by issuers in the rest of the world (excluding the U.S.), over the period January 1992 to July 1999. These offerings were identified using Equityware.

*Allocation data*

The transparency of the distribution of shares between retail and institutional investors varies substantially across countries. Some countries follow the U.S. in not requiring this information to be made public. Until recently, this was the case in Germany, so to gather allocation data we approached companies directly. There were 470 IPOs in Germany during our sample period. Of these, 377 were bookbuilding exercises, 92 were fixed-price offerings, and one was conducted by auction. [See Appendix A for details of offering mechanisms and allocation rules in Germany.]

Bookbuilding became the dominant offering mechanism in 1995, accounting for 94% of German IPOs in 1995-2000. Our survey was conducted in May and June 2000 and targeted all 351 firms which went public in Germany between January 1996 and March 2000 (we also contacted a sample of pre-1996 issuers in a trial but found that none could provide allocation data). Responses were received from 106 firms (30%). Of these, 93 disclosed their allocations to us, five said they

[5] Checking every IPO listed in SDC but not in Equityware, we found that SDC frequently misclassifies seasoned offerings as IPOs and double-counts IPOs under different names.

[6] We are grateful to Wolfgang Aussenegg, Jan Jakobsen, François Derrien, and Giancarlo Giudici for looking over our Austrian, Danish, French, and Italian samples, respectively.

no longer had the data, five were unwilling to make the data available, and three sent data pertaining to subsequent seasoned equity offerings. In addition, we received detailed allocation data for 36 IPOs from an underwriter (widely regarded as the market leader in IPOs on the *Neuer Markt*, Germany's dominant primary market). Finally, we obtained allocation data for 15 additional firms from press releases. This provides a sample of 144 IPOs in Germany for which allocation data is available, covering 38% of all IPOs since 1996.[7]

By contrast, in France the Bourse generally requires issuers to report allocations, though public availability of the notifications is patchy in the case of flotations on the over-the-counter markets. During the sample period there were 516 IPOs in France: 28 on the Premier Marché, 247 on the Second Marché, 124 on the Nouveau Marché, and 117 on an OTC market (the Paris Marché Libre, its predecessor, the Marché Hors-Cote, or the OTC markets in Lyon and Nantes). Of the 516 offerings, 255 were pure or hybrid bookbuilding exercises, 44 were fixed-price offers, and 185 were conducted via auctions; 32 OTC offerings could not be classified (though they are likely to be auctions). [See Appendix B for details of offering mechanisms and allocation rules in France.] Allocation data for auctions is not publicly available. Among non-auctions, we obtain allocation data from the Bourse for 237 of the 255 pure or hybrid bookbuilding efforts, and 7 of the 44 fixed-price offers. In total, we thus have allocation data for 244 issues.[8] This covers virtually the entire population of bookbuilt IPOs, and about half of all French IPOs during the sample period.

In the U.K., there were 876 IPOs on the three markets of the London Stock Exchange between January 1990 and May 2000: 515 IPOs on the Official List, 19 on the Unlisted Securities Market (USM, from 1990 to 1995), and 342 on the Alternative Investment Market (AIM, from June 1995

[7] Two of these were fixed-price offerings and one was sold by auction. In our econometric analysis, we lose all three due to the lack of indicative price ranges.
[8] In our econometric analysis, we lose seven bookbuilt IPOs due to the lack of indicative price ranges.

to May 2000).[9] As discussed in Appendix C, offerings can be categorized as 'placings' (651 cases), 'public offers' (12 cases), 'hybrids' (which combine a placing with a public offer; 178 cases), or 'global offers' (which combine a listing in London with one abroad, usually in the U.S.; 35 cases). Allocation policies for the first two are virtually binary. Placings are not registered for offering to the public at large and so involve only institutional investors or extremely wealthy individuals. In some instances, placings set aside a proportion of shares for employees. On the other hand, public offers, which are allocated on a pro-rata basis or by ballot, are nearly exclusively a retail phenomenon. We were able to obtain allocation data for 186 of the 213 hybrid or global offers from the London Stock Exchange, which like the Paris Bourse requires publication of the 'basis for allocation'. In addition, we know the allocations for all placings and most public offers, giving a total of 843 IPOs for which allocation data is available.

To provide a link to the published literature on IPO allocations, which uses U.S. data, we include a sample of IPOs in the United States. U.S. banks and issuers are not required to reveal how shares were allocated across various investor clienteles. However, we have access to a small sample of 30 U.S. firms taken public in the U.S. by Goldman Sachs between March 1993 and July 1995,[10] as well as two European firms which went public in the U.S.

For all four countries, our allocation data reflect the aggregate allocations of the entire syndicate, rather than – as in Hanley and Wilhelm (1995) and Aggarwal (2000) – of the lead manager only. Our data thus allows us to more precisely measure allocation policy than is the case in the extant literature.

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[9] This excludes companies transferring from one London market tier to another (including from the Rule 535.2 or 4.2 trading facility which replaced the Third Market), companies floating on Ofex (an unregulated trading facility operated by J.P. Jenkins, a firm of stockbrokers), and introductions (listings not accompanied by the sale of securities).

[10] This sample of U.S. offerings does not overlap with those used by Hanley and Wilhelm (1995) and Aggarwal (2000).

Our econometric model focuses on the IPOs in the four countries just described. In addition, we have allocation data for 399 IPOs in other countries which we include for descriptive purposes. For some countries (for instance Finland), the data comes from filings with the local stock exchange. For the remainder, we rely on information about the final tranche structure in hybrid deals to infer retail and institutional allocations. Suppose that the issuer announces tranches of 1 million shares for retail investors and 2 million shares for institutions. This information is typically contained in the preliminary offering prospectus. Depending on local rules, the issuer may or may not reallocate between tranches in the light of relative demands. On the assumption that institutions do not submit bids pretending they are retail investors, and vice versa, we use the final tranche sizes to compute the institutional/retail split (taking into account the overallotment option, which frequently benefits institutions). Information regarding final tranche sizes is obtained from issuer reports to their stock exchange or press announcements by the underwriter or the issuer. Given this procedure, we are unable to infer allocations in non-hybrid offerings in cases where no voluntary or mandatory disclosure takes place.

## 3. A Global Perspective on IPO Allocations

Table 1 summarizes the mean retail and institutional allocations in our sample, broken down by country of listing. With few exceptions among the countries for which we have more than a few observations, institutional allocations outnumber retail allocations by something in the neighborhood of 2 or 3 to 1, on average, when banks have discretion in how shares are allocated. For example, institutions receive 76% of IPO shares in France and 73% in those U.K. IPOs which are open to both institutional and retail investors. In the small sample of Goldman-backed U.S. IPOs, institutions take 66% of the average offer. On the other hand, German IPOs yield less

generous discretionary allocations to institutions of about 58% on average. Across the 1,662 IPOs for which we have allocation data, the average institutional allocation is 80%, though this reflects the large number of U.K. placings. Excluding these, the average drops to 68%.

From here on, we focus on IPOs in France, Germany, the U.K., and the U.S. Because we do not have allocation data for every IPO in these countries, we are concerned about the potential for sample selection bias. As a first cut, Table 2 provides, for each of the four countries, summary statistics regarding offer size, underpricing, allocations to institutions, and the number of privatizations. For each country, we test for differences in means or medians between the full country sample (column [1]) and the sample for which we have allocation data (column [2]). This reveals no significant differences in Germany or the U.K. In France, median gross proceeds is significantly higher amongst firms for which we have allocation data, reflecting the fact that smaller issuers are more likely to use an auction to price their securities. To see how representative our small U.S. sample is, we compare it to an SDC-generated sample of 4,541 IPOs in the U.S. between January 1990 and May 2000, which excludes unit and investment trust offerings. The U.S. offerings for which we have allocation data are significantly larger than the average or median U.S. IPO during the sample period, and were lead-managed by a top-tier bank.

Availability of allocation data is only a necessary condition for inclusion in our econometric model. In addition, we require data on the initial price range in order to measure the degree of price discovery in the pre-market. This requirement reduces the number of available IPOs from 843 to 231 in the U.K. (where indicative price ranges have not traditionally been disclosed publicly), with negligible losses in France (from 244 to 237) and Germany (from 144 to 141). Table 2 also provides tests for differences between the sample for which we have allocation data (column [2]) and the reduced sample for which we have both allocation and price range

information (column [3]). There are some significant differences amongst the U.K. offerings, which treble in terms of average and median offer size. This is largely due to the fact that we lack indicative price ranges for many placings. Before 1996, placings were confined to smaller issues (up to £15 million till December 1993, up to £25 million till December 1995), while larger issuers were compelled to use a hybrid. Due to the attrition amongst placings, average institutional allocations fall from 93% in column [2] to 86.3% in column [3]. We are also more likely to have allocation and price range data for privatizations, not surprisingly given their larger size.

Across the four countries, the average company raises $75 million, the median $28 million, and underpricing averages 26%. Amongst the 641 firms for which we have both allocation and price range information, the average company raises $215 million, the median $31 million, and underpricing averages 22%.

Given these patterns, we need to take sample selectivity bias seriously. We will outline a Heckman (1979) selectivity correction in the next section, after we have set out the theoretical and empirical methodology used to analyze the 641 IPOs in France, Germany, the U.K., and the U.S. described in Table 2.

## 4. The Determinants and Consequences of Allocation Policy

The empirical framework derives from the Benveniste and Spindt (1989) perspective of discretionary allocation as a key element of the investment bank's effort to extract private information from potential investors prior to setting the offer price for an IPO. Allocation policy, in turn, is influenced by these strategic considerations and various constraints imposed by the regulatory regime under which the IPO is conducted. In the remainder of this section we outline the theory underpinning these elements of the econometric model and conclude with a discussion

of the identification and estimation of the implied system of equations describing the market. The precise definitions of all our variables can be found in Table 3.

*Price discovery in primary markets*

By price discovery in primary markets we mean the degree to which prior expectations regarding the value of the offering, reflected in preliminary filings with the issuer's regulator, are revised in response to feedback from investors and the market at large before the offer price is set. Thus we think of the offer price as reflecting a conditional expectation representing the culmination of primary market price discovery. The literature has proposed two main proxies for the learning reflected in the difference between these conditional and unconditional expectations. Cornelli and Goldreich (2000) define the variable *Revision = (Offer Price* $- P_{low}$*) / (*$P_{high} - P_{low}$*)*, where $P_{high}$ and $P_{low}$ are the upper and lower bounds of the indicative price range generally filed with the issuer's regulator prior to seeking feedback from institutional investors in the course of bookbuilding. Hanley (1993) measures learning instead as *Offer Price / [½(*$P_{high} + P_{low}$*)] – 1*. To ensure our results are easily comparable to the related clinical analysis in Cornelli and Goldreich (2000), we follow their approach.[11]

By construction, *Revision* = ½ if the offer price is set at the midpoint of the price range, indicating that no new information has emerged. *Revision* is negative if the offer is priced below the range, 0 if priced at $P_{low}$, 1 if priced at $P_{high}$, and greater than 1 if priced above the range. In our data, *Revision* averages 0.68 in France, 0.84 in Germany, 0.49 in the U.K., and 0.74 in the U.S.

Benveniste, Busaba, and Wilhelm (2001) argue that issuers learn not only through their own marketing efforts but also through those of their rivals. In other words, price discovery is a

[11] Our results are unaffected by the scaling of the information, with slightly smaller standard errors using Hanley's approach.

function of both deal-specific information and information spilling over from contemporaneous transactions and perhaps secondary market activity. [See Lowry and Schwert (2000) and Benveniste, Ljungqvist, Wilhelm, and Yu (2001) for empirical evidence consistent with this prediction.] Spillover effects from contemporaneous transactions are controlled by the mean, $m\_Revision_{BB}$, and standard deviation, $\sigma\_Revision_{BB}$, of price revisions for contemporaneous IPOs in the same local market. The volatility measure, $\sigma\_Revision_{BB}$, is included to control for noise and idiosyncratic information reflected in contemporaneous revisions. In other words, if contemporaneous IPOs are subject to a common information factor, we assume that the influence of this common information on price revisions is comparable in magnitude across IPOs. Deviations from the mean reflect noise or idiosyncratic factors that reduce the precision of learning about the common factor.

IPO *i*'s contemporaries are defined as all local IPOs which were priced between the dates for setting *i*'s indicative price range and finalizing its offer price.[12,13] We refer to the period between these dates as the bookbuilding phase and subscript all variables defined during this period by 'BB'.[14] The bookbuilding phase averages 15 calendar days in France, 11 days in Germany, and 17 days in the U.K. [see Appendix D]. If spillovers from contemporaneous offerings are substantial, we expect a positive relationship between *Revision* and $m\_Revision_{BB}$. However, when the signal-

[12] If there are no contemporaneous IPOs, or none that use bookbuilding, $m\_Revision_{BB}$ and $\sigma\_Revision_{BB}$ are set to ½ and 0 respectively.
[13] These variables are estimated using the *full* country samples described in column [1] of Table 2.
[14] We use the *precise* dates on which the price range and the offer price were set in each case. Note that these generally precede the announcement date by a day or two. Since we are here interested in the information set of the issuer and not of outside investors, we collect the earlier dates. We obtained these as follows: in France, from the market regulator (the Commission des Opérations de Bourse) and the Paris Bourse; in Germany, from the final IPO prospectus (which recapitulates the sequence of events); in the U.K., from the London Stock Exchange's Regulatory News Service and from the 'expected timetable of principal events' in the 'pathfinder' (preliminary) prospectus. In the U.S., we use SEC filing and effective dates from Securities Data Company.

to-noise ratio for information generated by contemporaneous offerings is low, less learning occurs and so *Revision* should be negatively related to $\sigma\_Revision_{BB}$.

In the Benveniste-Spindt framework, discounted share allocations constitute the compensation provided in exchange for investors' private information. Other things equal, large price revisions, reflecting a greater yield of private information, will carry the expectation of a larger discount. This is the well-documented 'partial adjustment' phenomenon observed in both the U.S. [Hanley (1993), Lowry and Schwert (2000), and Loughran and Ritter (2001)] and worldwide [Ljungqvist et al. (2000)]. The partial adjustment phenomenon also suggests that if spillovers are important, contemporaneous revisions tell only part of the story. In isolation, a moderate positive contemporaneous revision might be interpreted as revealing only a moderate amount of information. But if it is coupled with a large initial return, the Benveniste-Spindt framework predicts the combination reflects a strong positive response. We control for this effect by including the mean of the one-day initial return of all local IPOs whose first trading day occurs during IPO *i*'s bookbuilding phase, $m\_IR_{BB}$, in addition to the contemporaneous revision variables.

Secondary market spillovers are measured by the return to a local market index during each IPO's bookbuilding phase ($MktRet_{BB}$) as well as the standard deviation of daily index returns during the same period ($\sigma\_Mkt_{BB}$). The rationale for including $\sigma\_Mkt_{BB}$ mirrors that for $\sigma\_Revision_{BB}$. Although large market movements might be reflective of the arrival of considerable new information bearing on an IPO's offer price, when volatility is high it is difficult to tease out its implications. So again, IPO *i*'s price revision should be directly related to $MktRet_{BB}$ and negatively related to $\sigma\_Mkt_{BB}$.

Controlling for these potential spillover effects, Benveniste and Wilhelm (1990) predict that banker discretion promotes price discovery. The banker's level of discretion differs across the four

countries and, in the case of France and the U.K., within countries. The various options facing issuers in France, Germany and the U.K. are outlined in Appendices A-C. Since it is impossible to quantify the relative discretion granted to bankers across deals we define two categories of constraints on banker discretion and outline these in Table 4.[15]

Our first category of constraints includes deals subject to a variety of constraints limiting banker discretion in offerings open to both retail and institutional investors. For example, fixed-tranche deals in France and the U.K., where allocations for different classes of investors are fixed in advance of the bookbuilding effort, clearly remove a degree of freedom that might prove valuable in the mechanism-design framework. Similarly, some hybrid transactions, particularly in the U.K., include an automatic clawback provision triggered by retail demand. In essence, such provisions enable retail investors to condition their demand for an offering on feedback received from institutional investors. When institutional demand is strong, retail investors can follow suit and the clawback provision calls for the banker to reassign shares to retail investors that otherwise would have been assigned to institutional investors. But institutional investors, recognizing that strong indications of interest will only cause them to be crowded out by retail investors, will have weaker incentives to step forward with strong indications in the first place. Finally, the sample includes 7 French fixed-price offerings, which (perhaps surprisingly) post an indicative price range enabling their inclusion in the analysis. These fixed-price offerings provide underwriters with no discretion because shares are simply allocated on a pro rata basis. In total, 18 French and 87 UK offerings fall within our first category, of constraints which we designate with the dummy variable *BB_constraints*.

[15] Our classification is based on the rules operating in each case, as announced in the preliminary prospectus or regulatory filings.

The estimation sample also includes 126 U.K. placings that can only be sold to institutional investors (ignoring the fact that ten of these set aside between ½% and 20% of the offer for their employees). These offerings are designated with the dummy variable *BB_placings*. In this setting, retail investors no longer provide the fallback in bargaining with institutional investors envisioned by Benveniste and Wilhelm (1990). For example, suppose the underwriter had reason to believe that investors were deliberately understating their demand in hopes of forcing a lower price. The optimal response in the Benveniste-Spindt framework is to reduce institutional allocations by allocating more to retail investors. However, deliberately misrepresenting positive views is not an optimal response to the underwriter's optimal response, and so this is not a Nash equilibrium – *unless* there are constraints on the underwriter's ability to switch allocations to retail investors. In the presence of constraints, misrepresenting positive views may be a Nash strategy, to the extent that the institutions' profits on their reduced (but non-zero) allocations are greater than the profits from truthful revelation of their information. One plausible constraint is that there aren't enough retail investors and so *some* institutions receive non-zero allocations. In U.K. placings the offering is not registered for sale to retail investors and so we have the worst-case scenario. Although this is a constraint on the banker's capacity for eliciting information from institutional investors neither its absolute magnitude nor its magnitude relative to that of the constraints captured by *BB_constraints* are clear a priori.[16]

The remaining offerings are classified as unconstrained bookbuilding efforts. In addition to U.S. and German IPOs, this category also includes dual-tranche deals which do not pre-commit the underwriter to particular tranche sizes, as in U.K. 'global offers' which typically state that the

[16] If this argument is correct and it is more difficult to induce truthful revelation in placings, the problem should be attenuated if there exist other sources of leverage over the participating institutional investors. For instance, if the underwriter deals repeatedly with the same institutions, it may credibly threaten to cease future dealings with an

final tranche structure is to be decided after the offer closes, or French hybrid bookbuilding efforts which provide for the possibility of clawback (usually but not exclusively in favor of retail investors) but leave the decision whether to exercise the clawback option with the underwriter.

Finally, note that the banker in the Benveniste-Spindt framework simultaneously determines how much to allocate to investors who relinquish private information and how much to revise the offer price in response, so what we observe is the equilibrium combination of quantity (allocations) and price (*Revision*). We therefore let *Revision* depend on allocations to institutional investors. Even after controlling for the level of explicit constraints on discretion, local custom or other circumstances might influence banker expectations regarding their capacity to favor certain investors in exchange for information. We therefore normalize ex post institutional allocations by the average institutional allocation in contemporaneous offerings (local offerings during the three months preceding firm *i*'s IPO). This variable, which we call *Inst_Alloc*, will be greater than 1 if institutions are allocated more than is 'normal' in that market at that time.[17] For U.K. placings, the normal assumed allocation is 1. Clearly, *Inst_Alloc* is endogenous according to the Benveniste-Spindt framework, and our estimation will control for this.

In summary, the model of primary market price discovery to be estimated is:

$$Revision = f_1(Inst\_Alloc, m\_Revision_{BB}, \sigma\_Revision_{BB}, MktRet_{BB}, \sigma\_Mkt_{BB}, m\_IR_{BB}, BB\_constraints, BB\_placings) \quad (1)$$

institution perceived as deliberately misrepresenting its demand. Consistent with this argument, we find that placings are associated with smaller revisions but that the effect is mitigated, the greater the lead manager's market share.

[17] This normalization enables us to pool data from across countries but assumes that allocation practices are comparable across countries once we have controlled for regulatory and other differences. Later we test this assumption and discuss the implications of the test results.

*Allocation policy*

We assume that institutions are the primary source of any information extracted in the course of a bookbuilding effort and take *Inst_Alloc* as a reflection of the banker's allocation strategy.[18] Thus large price revisions, if they derive from such information, should be associated with large institutional allocations, other things equal. Moreover, there is likely to be a non-linearity in this relationship: particularly valuable information requires particularly favorable allocations to induce investors to truthfully reveal their information. We therefore include both *Revision* and *Revision+*, the latter being equal to *Revision* whenever the offering is priced above the range, and zero otherwise. As argued earlier, price revisions should be viewed as being chosen simultaneously with allocations, so both *Revision* and *Revision+* will be treated as endogenous.

Large IPOs provide more currency for compensating informed investors and so may diminish the fraction of the offering they will expect. We control for this effect by including the variable *Proceeds*, defined as the natural log of gross proceeds raised in the offering (converted into U.S. dollars using exchange rates on the pricing day). This variable too is endogenous if issuers aim to minimize wealth losses associated with their offerings [Habib and Ljungqvist (2001)], and will therefore be treated as endogenous in the estimation.

We do not control separately for the regulatory constraints *BB_constraints* and *BB_placings* on allocations because our dependent variable *Inst_Alloc* measures institutional allocations relative to what is 'normal' in the local market, and so already takes into account the presence of constraints.[19] We do, however, include a dummy variable indicating whether the offering was the result of a privatization of a state-owned firm. This reflects the fact that privatizations were quite

[18] See Cornelli and Goldreich (1999) for evidence.
[19] Our results are not significantly changed when we include the two constraints dummies in the allocation equation ($\chi^2$ test of equal coefficients across the two specifications: 8.56 with *p*-value 0.99).

commonly used as instruments of public policy aimed at broadening domestic share ownership or employee ownership [Jenkinson and Ljungqvist (2001)]. Either would tend to favor retail investors. Thus the model specification for the banker's allocation policy is:

$$Inst\_Alloc = f_2(Revision, Revision+, Proceeds, Privatization) \quad (2)$$

*Initial Returns*

In the Benveniste-Spindt framework, discounted share allocations constitute the compensation provided in exchange for investors' private information. Other things equal, large price revisions, reflecting a greater yield of private information, will carry the expectation of a larger discount. Again, there is likely to be a non-linearity in this relationship: particularly valuable information requires some combination of favorable allocations and initial return to induce information revelation. We therefore include both *Revision* and *Revision+* in the initial return model.

Holding the quantity of information revealed constant and assuming institutional investors are the source of this information, the *percentage* discount should be negatively related to the fraction of shares allocated to institutional investors. In other words, investors' incentive compatibility constraint for sharing their information demands a minimum dollar compensation that can be satisfied by infinitely many combinations of share price and quantity. Again, we do not control separately for the regulatory constraints *BB_constraints* and *BB_placings* which we let affect underpricing only indirectly, through their effect on *Revision* and *Inst_Alloc*. Unreported tests indicate that the regulatory constraints do not have an independent, direct effect on underpricing.

Benveniste and Spindt argue that underwriters can reduce underpricing by 'bundling' deals.[20] Essentially, a higher deal flow affords underwriters the opportunity to cut off informed investors from other, lucrative deals as punishment for misrepresenting their private information. Higher (expected) deal flow should therefore lead to a lower marginal cost of acquiring information. Similarly, Booth and Chua (1996) and Benveniste, Busaba, and Wilhelm (2001) argue that during periods of high IPO volume, there is greater potential for issuers sharing the costs of information production, again leading to lower required underpricing returns.

We control for this effect with two variables.[21] *IPOVol*, which captures aggregate deal flow, is defined as the number of local IPOs in the six weeks before to two weeks after the present IPO's pricing date. We include volume after the pricing date to allow for expectations regarding bundling with deals that are already in the pipeline. Clearly the eight-week window is arbitrary; experimenting with different window sizes, we find that the results become progressively weaker the longer the window, but are not qualitatively altered with shorter windows. Our second variable is *IBmktshare*, which is defined as the lead manager's (or if more than one, the average of the lead managers') market share in the local market. *IBmktshare* may capture either bank-specific deal flow or the lead manager's reputation and thus certification ability. In either case, we expect it to be negatively related to initial returns. We will treat *IBmktshare* as potentially endogenous, for it is possible that issuers choose their underwriters endogenously. Indeed, Habib and Ljungqvist (2001) show that treating underwriter choice as *exo*genous leads to the erroneous inference that more prestigious underwriters are associated with *higher* underpricing in the U.S. in the 1990s.

Unlike in the U.S., where deals are typically priced only a few hours before trading begins, there is a substantial lag between pricing and trading in the three European countries [see

[20] See Sherman (2000), especially proposition 2, for an elaboration of this point.
[21] Again, we use the full country samples to derive these variables.

Appendix D for details]. During this post-pricing phase, further information could arrive from the secondary market, in the form of general market movements and spillovers from other IPOs which have begun trading in the meantime. We attempt to capture such information using $MktRet_{post\text{-}pricing}$, the market return between IPO *i*'s pricing date and its fifth trading day (to coincide with our measurement of *Initial Returns*, see below), the post-pricing market volatility $\sigma\_Mkt_{post\text{-}pricing}$, and $m\_IR_{post\text{-}pricing}$, the average first-day return of all local offerings which open during this period.

Finally, we aim to control for firm-specific valuation uncertainty in three ways. Privatization IPOs generally involve more mature firms for which, presumably, more information is in the public domain, so their discounts may be smaller if discounts are at least in part compensation for private information. By the same reasoning, younger firms and firms in high-technology industries may be harder to value and thus carry higher initial returns. We therefore include a dummy for privatization IPOs, the natural log of one plus firm age at the time of the IPO, and a dummy which equals one for firms whose principal activities are in a high-tech industry.[22,23,24] This yields the following model for initial returns:

$$\begin{aligned} \textit{Initial Return} = f_3(&\textit{Revision}, \textit{Revision+}, \textit{Inst\_Alloc}, \textit{IPOVol}, \textit{IBmktshare}, \\ &MktRet_{post\text{-}pricing}, \sigma\_Mkt_{post\text{-}pricing}, m\_IR_{post\text{-}pricing}, \\ &\textit{Privatization}, \textit{Age}, \textit{Hightech}) \end{aligned} \qquad (3)$$

[22] Since our sample firms come from different countries, there is no consistent SIC code that we can use to assign firms to the high-tech category. Instead, we base our assignments on a reading of each firm's business description as published in its prospectus. On this basis, 232 of the 641 firms are classified as high-tech. These operate in the following range of industries: biotech, pharmaceuticals, medical instruments, software and hardware development, communications technology, advanced electronics, and specialty chemicals. In addition, we classify internet-related businesses as high-tech.

[23] Another popular proxy for uncertainty is offer size. This is a curious proxy, for it is clearly endogenous to the offer price. Moreover, Habib and Ljungqvist (1998) prove that as a matter of identities, underpricing is strictly decreasing in offer size *even when holding uncertainty constant*. We thus refrain from using it.

[24] Hanley (1993) used the width of the price range as a proxy for valuation uncertainty. In our data, this variable had no significant effect and we therefore refrain from using it.

where *Initial Return* is defined as the percentage return from the offer price to the closing price on the fifth trading day following listing. This is the same convention used by Ljungqvist, Jenkinson, and Wilhelm (2000) to obviate problems arising when daily price changes are subject to regulatory limits, as for instance in France. After-market prices were obtained from Datastream and Equityware for non-U.S. offerings and from CRSP for U.S. offerings.

As an alternative to equation (3), we estimate the impact of allocation policy on *dollar* underpricing, that is the total amount of money 'left on the table':

$$\begin{aligned} \textit{Dollar Underpricing} = f_3(&\textit{Revision}, \textit{Revision+}, \textit{Inst\_Alloc}, \textit{IPOVol}, \textit{IBmktshare}, \\ &\textit{MktRet}_{\textit{post-pricing}}, \sigma\textit{\_Mkt}_{\textit{post-pricing}}, \textit{m\_IR}_{\textit{post-pricing}}, \\ &\textit{Privatization}, \textit{Age}, \textit{Hightech}) \end{aligned} \qquad (3')$$

where *Dollar Underpricing* equals *Initial Return* times the dollar gross proceeds. To a first approximation, maximizing the net proceeds of the offer (and thus the issuer's wealth) is equivalent to minimizing *Dollar Underpricing*.[25] Following the argument in Habib and Ljungqvist (2001), the optimum is characterized by the issuer and his banker having chosen their allocation policy such that informed investors are just compensated for the value of disclosing their private information. A test for the optimality of allocation policies in our data can be based on the coefficient for *Inst_Alloc* in equation (3'), which captures the partial derivative of *Dollar Underpricing* with respect to institutional allocations. At the optimum, the partial derivative must be zero and so a zero coefficient for *Inst_Alloc* in equation (3') is consistent with issuers having

[25] It is an approximation, for it ignores the dilution effect of selling new (primary) shares at a discount. For further details, see Habib and Ljungqvist (2001).

chosen the allocation policy which minimizes *Dollar Underpricing*.[26] A non-zero coefficient can be interpreted as follows. If informed investors expect too little compensation relative to the value of their private information, less information discovery will ensue in the pre-market, leading to a negative relationship between *Dollar Underpricing* and *Inst_Alloc*: more money is left on the table, the less is allocated to institutions. If, on the other hand, underwriters favor institutions with large allocations beyond the point where the issuer benefits from information production, perhaps in the expectation of kickbacks, *Dollar Underpricing* would increase in *Inst_Alloc*.

*Estimation*

The two models defined by the three structural equations (1)-(3) and (1)-(3') cannot be estimated using ordinary least squares, for each equation includes amongst its explanatory variables the dependent variable of one or both of the other equations. Specifically, the *Initial Return* is endogenous to both *Revision* and *Inst_Alloc*, which in turn are endogenous to each other and to *Proceeds*, which is endogenous to the offer price and thus related to both *Initial Return* and *Revision*. This has two consequences. First, it causes the endogenous variables to be correlated with the disturbances, leading to biased coefficients when estimated using OLS. Second, since some of the explanatory variables are the dependent variables of other equations in the system, the error terms are expected to be correlated across equations, leading OLS standard errors to be biased upwards.

Three-stage least squares (3SLS) provides consistent estimates of the coefficients and standard errors. The former is achieved by means of instrumental variables (as in 2SLS), the latter by

[26] This test for optimality was first proposed by Demsetz and Lehn (1985) in the context of executive ownership. Note that it does *not* follow that the coefficient on *Inst_Alloc* in equation (3), which has percent underpricing on the left-hand side, should also be zero, for issuers are minimizing dollar rather than percent underpricing.

means of generalized least squares [see Greene (2000), pp. 692–693]. Briefly, 3SLS generates instrumental variables for all endogenous variables, in the form of predicted values from a regression of each endogenous variable on all exogenous variables in the system; obtains a consistent covariance matrix based on the residuals from a 2SLS estimation of each equation; and then using the consistent covariance matrix and instrumental variables in place of the endogenous variables, concludes with generalized least squares estimation. 3SLS estimates are consistent if the model is identified, that is, if there is sufficient information to estimate the parameters of the structural model. A necessary condition for identification is that the number of exogenous variables excluded from an equation is at least as large as the number of endogenous variables included in that equation. This 'order condition' is satisfied in our model.

*Selectivity bias*

Earlier, we discussed the potential for selectivity bias: unless data is simply missing randomly, the results we estimate for the sample for which data is available may be biased. For instance, if the willingness of issuers or banks to share data with us is in some way systematically related to their bookbuilding behavior or some other characteristics, estimates based on the sample for which data is available may be misleading. To explore whether selectivity bias is a concern, we use a Heckman (1979) correction. The procedure is as follows. In the first step, we estimate a selection equation of the probability of an observation being included in our final sample, using a probit on the full country samples of Table 2, column [1]. The explanatory variables we use are the log of offer size and dummies for the country of listing and the IPO year. This equation has very good fit, with a pseudo-$R^2$ of 47.4%, and confirms that we are more likely to have complete information for larger offerings outside the U.S. and especially in France.

From this selection equation, we generate the inverse of the Mills' ratio which we use as an exogenous variable in the second step to estimate the structural model. The estimation is based on 2SLS rather than 3SLS, since the inclusion of the inverse Mills' ratio causes the disturbances to be heteroskedastic, and so the GLS weights are no longer correct. There is no known correction for this. [For further details regarding selectivity corrections in structural estimation, see Maddala (1983), pp. 234–235.] The coefficient estimate for the inverse Mills' ratio is very small in magnitude and insignificant in each of the three equations, and a Wald test of the joint hypothesis that all three coefficients are zero cannot be rejected (*p*-value=0.68). Moreover, only one coefficient estimate (discussed below) changes by more than two standard errors following the Heckman correction. Thus, although our final sample is not as comprehensive as we would like, this does not appear to lead to selectivity bias.

**5. Results**

Table 5 summarizes the three-stage least squares estimates of the model's structural parameters. We first focus on the system defined by equations (1)-(3). The *Revision* equation (1) yields several insights. *Other things equal, constraints on allocation discretion result in smaller revisions relative to the indicative price range.* Relative to unconstrained offerings, constraints on the split between retail and institutions reduce average revisions by 0.21 (*p*-value=3.8%) while shutting out retail investors ex ante reduces average revisions by 0.29 ($p<1\%$). These are large effects, bearing in mind that the mean of *Revisions* is 0.65.

Arguably, issuers have some ability to choose the mechanism through which they offer shares to the public, and so the constraints they are subject to.[27] For instance, French and British firms

[27] We are grateful to the referee for alerting us to this possibility.

could list in a less constrained country, assuming the additional cost of issuing abroad does not outweigh the benefit derived from escaping local constraints. We test this hypothesis using a variant of the Durbin-Wu-Hausman test of the null hypothesis that *BB_constraints* is exogenous. The test is based on the difference in coefficients estimated under the null of exogeneity (Table 5) and the alternative of endogeneity. In our data, the test does not reject the null that *BB_constraints* is exogenous ($\chi^2$=0.06, *p*=81.1%). The same holds for *BB_placings* ($\chi^2$=0.11, *p*=73.7%).

Institutional allocations (relative to expectation) have a positive and significant (*p*=4.7%) effect on price revisions after allowing for the simultaneity between the two and controlling for regulatory constraints. This is consistent with the idea that, relative to retail investors, institutional investors are a valuable source of information. To illustrate the economic magnitude of the effect, consider a one standard deviation increase in institutional allocations from the mean. This will increase *Revisions* from 0.65 to 0.87, holding all other covariates at their sample means. This effect is stronger than that measured by Hanley (1993) and Hanley and Wilhelm (1995). However, if we follow their lead by treating allocation policy as exogenous, the coefficient switches sign. This illustrates the extent of the simultaneity bias in treating allocations as exogenous.

As we noted earlier, the normalization of institutional allocations essentially imposes a constraint on the estimation. Specifically, it is equivalent to the following procedure:

1. instead of a single variable *Inst_Alloc*, use four interaction variables which equal *non*-normalized institutional allocations times a dummy equaling 1 for country *i*, *i* = 1…4;
2. constrain the coefficients on the four interaction variables to equal $\beta$ / [in-country average institutional allocation for country *i*];
3. estimate $\beta$.

Step 2 assumes that our normalization makes allocations comparable across countries so that there is a single $\beta$. We can test this assumption by allowing the four interaction coefficients to vary by country (results not reported). In the *Revision* equation we cannot reject the hypothesis that the four interaction coefficients are equal.

The positive and significant coefficient ($p$=2.4%) estimated for $m\_Revision_{BB}$ is consistent with information revealed in contemporaneous offerings spilling over into the price discovery process. However, the economic magnitude of the effect is smaller than that of allocation policy: a one standard deviation increase in $m\_Revision_{BB}$ from the mean increases *Revisions* from 0.65 to only 0.71. At the same time, the negative coefficient estimated for $\sigma\_Revision_{BB}$ ($p$<0.1%) is consistent with our prediction that the noisier is the information coming from other offerings, the less the offer price is increased relative to the indicative range. Underpricing of other deals during the bookbuilding phase, as measured by $m\_IR_{BB}$, also appears to spill over. The coefficient is positive and significant ($p$<0.1%), but its economic magnitude is again relatively small. A two-quartile increase in contemporaneous underpricing, from the 1st quartile of 3.9% to the 3rd quartile of 24%, increases average *Revisions* from 0.6 to 0.64.

The coefficient estimated for $MktRet_{BB}$ is positive, as predicted, but not significant at conventional levels ($p$=13.8%), while that for $\sigma\_Mkt_{BB}$ is significantly negative ($p$<0.1%). The former suggests that secondary market information, which is of course public, has only a weak influence when setting the offer price. The latter suggests that volatility in secondary markets – like volatility in the primary market – affects price discovery negatively, and its economic effect is quite large: a one standard deviation increase in volatility reduces *Revisions* from 0.65 to 0.57.

Taken together, the signs of our conditioning variables are strongly consistent with the Benveniste-Spindt framework and the notion of information spillovers. The coefficients are jointly

highly significant, indicating good fit. Of course, other specifications are plausible. For example, Ljungqvist et al. (2000) find that pricing is influenced by both the presence of a U.S. bank as a senior member of the syndicate and the marketing of shares to U.S. investors. Accounting for this leaves all our results unchanged without generating significant insights. This is not surprising in view of the fact that France, Germany and the U.K. are the European markets which involve U.S. investors and U.S. banks the least [Ljungqvist et al. (2000)].

The allocation equation yields one key insight: *institutions are rewarded with above-normal allocations in return for revealing valuable information, the more so, the more positive the information*. This is evidenced by the positive and significant coefficients for *Revision* ($p$<1%) and *Revision+* ($p$=1%). To illustrate, increasing *Revision* from the mean of 0.65 to 1 (corresponding to pricing at the top of the range) is associated with a 3.2% increase in institutional allocations, while increasing *Revision* further, by one standard deviation to 1.5, is associated with a 35.6% increase in relative institutional allocations.

This result is consistent with efficiency in the mechanism design framework if institutional investors are the primary source of private information. Other things equal, the expected cost of eliciting private information from investors is minimized when discounts are concentrated in states characterized by uniformly strong interest among investors which, presumably, are associated with the largest positive price revisions. This strategy minimizes leakage of surplus to investors providing weak indications of interest and therefore avoids undermining incentives for optimistic investors to be forthright with their opinions.

Consistent with our prediction that large IPOs provide more currency for compensating informed investors and so may diminish the fraction of the offering they will expect, we find that

*Proceeds* is negatively and significantly related to institutional allocations ($p$<1%). Of course, this coefficient also reflects placings in the U.K., which tend to be smaller and exclude retail investors, but the coefficient on *Proceeds* continues to be negative and significant if we control separately for placings.

Finally, we find no evidence of differences in allocations between privatizations and private-sector IPOs. Since privatizations tend to be large IPOs, it is conceivable that their effect on allocations is being subsumed in *Proceeds*. To check whether this is the case, we interacted *Proceeds* with the privatization dummy but found no differential effect of offer size on allocations between private-sector IPOs and privatizations.[28]

The underpricing equation provides strong evidence consistent with the notion of discounted share allocations being used strategically to encourage information production. First, we see strong confirmation of the partial adjustment phenomenon identified by Hanley (1993) in the positive and statistically significant coefficient estimated for *Revision* ($p$<0.1%). Controlling for this effect, large institutional allocations are then associated with significantly smaller initial returns ($p$=3.9%). Other things equal, it suggests that *constraints on banker discretion, which translate into smaller institutional allocations, increase the indirect costs of going public*.

This result contrasts with Hanley and Wilhelm's (1995) finding that institutional allocations had little explanatory power for the cross-sectional variation in initial returns and on the surface may appear contradictory to the Benveniste-Spindt hypothesis. With regard to the former, we note that the results are quite sensitive to our treatment of allocation policy as an endogenous variable.

[28] As mentioned in Section 4, there is one coefficient which changes by more than two standard errors under the Heckman correction: the coefficient on *Proceeds* switches sign to become 0.009, while the privatization dummy becomes negative and significant. However, since the inverse Mills' ratio is invariably insignificant, this is more likely the effect of collinearity between *Proceeds* and the inverse Mills' ratio than evidence of selectivity bias.

If we follow Hanley and Wilhelm and treat institutional allocations as an exogenous explanatory variable in an OLS estimation of the underpricing equation, we find a positive and insignificant relation between underpricing and institutional allocations. We interpret this as evidence of bias associated with failure to treat allocation policy as an endogenous variable. With regard to the latter, it might appear that underpricing should be directly related to institutional allocations in the Benveniste-Spindt framework. After all, efficiency is served by concentrating discounts in the hands of institutional investors if they are the primary source of information. However, as we noted earlier, bankers face a price/allocation tradeoff in satisfying the absolute compensation level required by investors' incentive-compatibility constraint. Holding the level of information revealed and other factors constant, a larger institutional allocation implies that a smaller percentage discount is necessary for eliciting accurate indications of interest.

Finally, there is evidence that the effect on underpricing varies across countries when we allow allocations to have a country-specific effect via the procedure outlined on page 28. Specifically, the effect is significantly stronger in the U.K than in Germany, where in turn it is significantly stronger than in France.

Interestingly, the coefficient on *Revision+* is not significant. This implies that particularly positive information does not result in greater underpricing and thus more money being left on the table overall. Instead, as we saw in the allocations equation, informed investors are rewarded for disclosing such information with particularly favorable allocations.

The coefficient estimated for *IPOVol* is negative as predicted but not significant, while the coefficient estimated for *IBmktshare* is negative and highly significant ($p$=1.3%). The former suggests that the indirect costs associated with underpricing are unaffected by the *general* level of primary market activity. The latter suggests that issuers which chose to employ underwriters with

larger market shares experience lower underpricing. These results are consistent both with the notion of underwriter certification and with Benveniste, Busaba, and Wilhelm's (2001) prediction that certain banks have sufficient market power to spread the costs of information production more uniformly across deals. The effect of *IBmktshare* is large in economic magnitude: a one standard deviation increase in market share reduces underpricing from 22% to 9.2%. Interestingly, *IBmktshare* is significant only if we treat it as endogenous: otherwise, its coefficient estimate decreases by 90%, from –0.019 to –0.002. This mirrors the finding of Habib and Ljungqvist (2001) that the effect of underwriter reputation on underpricing in the U.S. changes dramatically when issuers are assumed to choose their underwriters endogenously.

The post-pricing spillover variables have the expected signs and are mostly significant. In particular, higher initial returns elsewhere in the primary market tend to increase underpricing, which indicates the presence of 'hot issue' markets. Finally, other things equal, we find that companies in high-tech industries are more underpriced ($p$=2.1%), consistent with differences in ex ante uncertainty. Firm age, while negatively related to underpricing as expected, is not significant, nor are privatizations associated with significantly different *Initial Returns*.

When dollar initial returns are introduced as the dependent variable, results are similar with the main exception that now the coefficient estimated for relative institutional allocations is not statistically significant. Recall that the sign of this coefficient can be interpreted as an indicator of the efficiency, to the issuer, of the pricing and allocation policy. A (statistically) zero coefficient is consistent with Habib and Ljungqvist's (2001) argument that issuing firms (and their banks on their behalf) optimize over a variety of deal characteristics to maximize net proceeds (or minimize wealth losses): on average, allocation policy appears to be chosen such that informed investors are

just compensated for the value of disclosing their private information, rather than in the expectation of monetary kickbacks from favored investors.

## 6. Conclusion

If our empirical model, structured around the mechanism-design framework introduced by Benveniste and Spindt (1989), is an accurate representation of the incentive structure of primary equity markets, there appears to be evidence of a strategic link between allocations and measures of price discovery and cost. On net, discretion appears a good thing: it allows issuers to set more informed prices and thus minimize the wealth loss of going public.

Having said this, it is not hard to imagine that discretion could be used to undermine the interests of issuing firms. For example, it has been suggested that underpricing coupled with favoring institutional investors in the U.S. reflects bankers serving their own interests and those of repeat investors. The alleged kickbacks discussed in the context of the SEC's current investigation represent an extreme manifestation of this conjecture. Loughran and Ritter (2001) suggest that issuing firms might willingly put up with this kind of behavior even if it has no apparent benefit for them. Although our findings are not consistent with this hypothesis, direct investigations of proprietary records, such as those currently underway in the U.S., might very well reveal evidence of unsavory behavior. But at a minimum, our results do provide tentative evidence that even if banks are self-serving in their exercise of discretion over the allocation of IPO shares, there appear to be benefits for issuing firms as well.

We qualify our conclusions because of the political nature of the question at hand and the fact that our sample period does not include the dot.com boom that appears the primary focus of investigations. But we also recognize that failure to reject the theoretical structure used in the

analysis obviously does not imply that it accurately describes reality. On the other hand, the mechanism design framework provides an attractive null hypothesis if for no other reason than that it implies a good deal more structure than alternative theoretical perspectives. The framework is not a theory of underpricing. Rather it is a theory of the intermediary function given a particular incentive structure in the primary market and the early stages of the secondary market. In this sense, the theoretical framework subsumes Rock's (1986) winner's curse model [Benveniste and Wilhelm (1990)] and by way of the extension in Biais et al. (1999), subsumes the agency concerns raised by Baron (1982). In contrast to the estimation of reduced-form models more typical of the literature, we have tested a structural model built on this theory. We have not attempted to address the relative explanatory power of competing theories. However, the fact that our estimation of the structural model is so fully consistent with the theory leads us to believe that our conclusions are less likely spurious inferences regarding the linkage between allocation discretion and market efficiency.

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## Appendix A. Offer rules and mechanisms in Germany

***Offer mechanisms***
Issuers can choose freely between fixed-price offerings, auctions, and bookbuilding.

***Allocation rules***
Fixed-price offerings can be allocated in a discretionary fashion. Unless chosen by the issuer, there are no pro rata requirements etc.

In auctions, orders are filled in descending order. The limit set for the last order met determines the single strike price of the auction.

Individual exchanges can, in principle, impose restrictions on IPO allocations as part of their listing requirements. The *Neuer Markt* in Frankfurt, by far the most important exchange for IPOs in Germany, requires issuers to adhere to the allocation guidelines of the Exchange Expert Commission at the Federal Ministry of Finance.

The guidelines were issued on June 7, 2000 (that is, after our sample period). They are largely aimed at increasing the transparency of the allocation process. For instance, they require that the percentage allocated to retail investors be published after the conclusion of the offer. Article 12 deals with allocations to retail investors in the case of oversubscription after a bookbuilding exercise. The article is aimed at ruling out 'subjective' criteria for determining allocations. It recommends issuers draw lots, allocate pro rata (within certain order sizes or across the offer as a whole), allocate according to time priority, or some other 'objective criteria'. The article applies only to 'fair' treatment within the retail allocation, not to allocations to institutions or the relative split between institutional and retail allocations.

Prior to the issuance of these guidelines, IPO allocations were absolutely at the issuer's/syndicate's discretion.

## Appendix B. Offer rules and mechanisms in France

Table B1: French methods of bringing securities to listing.

| Method | Description |
|---|---|
| **Offre à prix minimal** (previously known as *Mise en vente*) | Invitation to the public to bid for securities of the issuer at or above a pre-specified minimum price. Bids must be limit orders; market orders are automatically deleted. Once bids are received, 'excessively high' bids are discarded. The Paris Bourse sets the single strike price at which orders are filled using the limit set on the last order met. If demand is excessive, the OPM can be repeated at a higher minimum price, or it can be converted into an *offre à prix ferme* (see below) at a (higher) fixed price. |
| **Offre à prix ferme** (previously known as *Offre publique de vente*) | Invitation to the public to subscribe for securities of the issuer at a fixed price (set in advance unless accompanied by a *placement garanti*, see below). Allocations are non-discretionary (pro-rated) except that issuers may invite subscriptions in Category A (usually up to 100 shares) and Category B (more than 100 shares) with preferential treatment (more favorable allocation/bid ratios) in Category A. In case of excessive demand (allocation/bid ratios below 0.8%), the OPF may be repeated at a higher fixed price. If combined with a *placement garanti*, the price set in the OPF cannot exceed the price set in the *placement*. |
| **Placement garanti** | Invitation to investors to participate in bookbuilding. Issuers may reserve the right to alter the price range. Allocations are at the bookrunner's discretion. In principle open to both retail and institutional investors. |
| **Offre à prix ouvert** | Invitation to (usually) retail investors to submit price/quantity bids within the indicative price range (limits included). Issuers may reserve the right to alter the price range. Always accompanied by a *placement garanti* aimed at institutional investors. Allocations are non-discretionary conditional on the price bid, though as in an OPF, issuers can invite bids in Category A and B with preference shown to smaller orders. Introduced July 24, 1998. |

## Appendix C. Offer rules and mechanisms in the United Kingdom

Table C1: U.K. methods of bringing securities to listing (Yellow Book, chapter 4).

| Method | Description |
|---|---|
| **Placings** | The marketing of securities in issue but not listed or not yet in issue to specified persons or clients of the sponsor or any securities house assisting in the placing, which does not involve an offer to the public or to existing holders of the issuer's securities generally. |
| **Public offers** | |
| Offer for sale | Invitation to the public by, or on behalf of, a *third party* to purchase securities of the issuer *already in issue* (and may be in the form of an invitation to tender at or above a stated minimum price). Thus typically applies to secondary sales of existing shares. |
| Offer for subscription | Invitation to the public by, or on behalf of, an *issuer* to subscribe for securities of the issuer *not yet in issue* (and may be in the form of an invitation to tender at or above a stated minimum price). Thus applies to new shares. |
| Open offer | Invitation to existing holders of securities to subscribe or purchase securities in proportion to their holdings. Used in IPOs where existing shareholders are given the right to purchase shares pro-rata (e.g. spin-offs, demergers or listings by means of a reverse takeover). |
| **Hybrids:** Placing combined with... | |
| Intermediaries offer | The marketing of securities already or not yet in issue, by means of an offer by, or on behalf of, the issuer to intermediaries (i.e. Stock Exchange member firms) for them to allocate to their own clients. |
| Public offer | Defined as above. |
| **Global offers** | The marketing of securities in issue but not listed or not yet in issue to investors at large, registered for sale to the public, within and outside the United Kingdom. Allocation is at the issuer's discretion. |
| **Introduction** | A method of bringing securities to listing not involving an issue of new securities or any marketing of existing securities because the securities are already widely held by the public. |

In addition, issuers can use "such other method as may be accepted by the London Stock Exchange (LSE) either generally or in a particular case".

The terminology 'public offer', as short-hand for a combined offer for sale and offer for subscription, is used where the offer includes both existing and new shares, though we shall use

it as a collective noun for fixed-price offers. Public offers must be advertised in at least one national newspaper and are open to all.

In placings, shares are offered selectively, usually to City institutions. Private investors cannot normally apply. Shares may be set aside for employees.

**Rules regarding choice of offer method**

Until 1991, placings were allowed for offers raising up to £15 million, with public offers being mandatory for larger issues. Following the Initial Public Offers Review, chaired by Graham Ross Russell and which reported in July 1990, the LSE expanded the use of placings subject to making retail participation in IPOs mandatory for issues exceeding certain monetary thresholds. The new rules came into effect in January 1991. Companies offering between £15 million and £30 million were allowed to place their shares subject to the requirement that 75% or £15 million of the offer, whichever was the lesser, had to be offered to the public. The offer element could be satisfied via a traditional public offer or via the newly introduced ‘intermediaries offer’. Issues raising more than £30 million should still come as public offers but the sponsor was free to place up to 50%. Issues raising less than £15 million should be conducted as placings. On 1 December 1993, the thresholds were raised. Below £25 million: placing. Between £25 million and £50 million: mandatory public offer component. Above £50 million: mandatory public offer.

From January 1995, the LSE allowed scientific research based companies to choose freely between placings, public offers and hybrids without regard to offer size (Amendment 4). In January 1996, the LSE abolished restrictions on retail participation for all types of issuers.

## Appendix D. Typical pricing sequences

*Calendar days relative to first trading day (t=0), averages based on our samples.*

**France**
**(pure and hybrid bookbuilding)**

| | |
|---|---|
| *t-20* | preliminary prospectus, containing non-binding indicative price range, filed with and approved by the market regulator (COB – Commission des Opérations de Bourse) |
| | pre-marketing to institutions |
| *t-10* | bookbuilding (*placement garanti* with or without *offre à prix ouvert*) opens: investors can submit their bids |
| *t-5* | the issue is priced; if hybrid offering, *offre à prix ferme* opens |
| *t=0* | trading begins |

**Germany**
**(bookbuilding)**

| | |
|---|---|
| *t-14* | preliminary prospectus released to public |
| | pre-marketing to institutions |
| *t-10* | non-binding indicative price range set |
| *t-9* | price range published as amendment to preliminary prospectus |
| *t-8* | bookbuilding opens: institutions and retail investors can submit their bids |
| *t-3* | the issue is priced |
| *t=0* | trading begins |

**United Kingdom**
**(placing and hybrids)**

| | |
|---|---|
| *t-27* | 'pathfinder prospectus' released to selected institutions. (This is similar to a 'red herring' in the U.S. though it does not (usually) contain a price range. Instead, the institutions are given a price indication that is not otherwise widely disseminated.) |
| | pre-marketing to institutions |
| *t-10* | 'impact day': the issue is priced and the final prospectus is made available to all interested investors. Investors can now apply for shares. |
| *t=0* | trading begins |

**Table 1. IPO allocations by country of listing.**

| Country | N | Mean institutional allocation | Mean retail allocation |
|---|---|---|---|
| United Kingdom | 834 | 0.930 | 0.070 |
| *Placings* | *651* | *0.996* | *0.004* |
| *Public offers* | *6* | *0.000* | *1.000* |
| *Hybrids and global* | *186* | *0.725* | *0.275* |
| France | 244 | 0.763 | 0.237 |
| Germany | 144 | 0.577 | 0.422 |
| Italy | 52 | 0.637 | 0.363 |
| Sweden | 44 | 0.700 | 0.300 |
| Belgium | 40 | 0.622 | 0.378 |
| Finland | 40 | 0.764 | 0.236 |
| Netherlands | 30 | 0.677 | 0.323 |
| Spain | 26 | 0.727 | 0.273 |
| Portugal | 17 | 0.597 | 0.403 |
| Denmark | 9 | 0.680 | 0.320 |
| Greece | 3 | 0.131 | 0.869 |
| Austria | 1 | 0.725 | 0.275 |
| Luxembourg | 1 | 0.974 | 0.026 |
| **EU15** | **1,494** | **0.823** | **0.177** |
| Poland | 9 | 0.785 | 0.215 |
| Hungary | 8 | 0.716 | 0.284 |
| Norway | 7 | 0.624 | 0.376 |
| Croatia | 1 | 0.629 | 0.371 |
| Iceland | 1 | 0.000 | 1.000 |
| Switzerland | 1 | 0.800 | 0.200 |
| **non-EU15 Europe** | **27** | **0.688** | **0.312** |
| Singapore | 60 | 0.590 | 0.410 |
| Hong Kong | 19 | 0.650 | 0.350 |
| South Africa | 8 | 0.379 | 0.621 |
| Turkey | 7 | 0.730 | 0.270 |
| Australia | 4 | 0.571 | 0.429 |
| Thailand | 4 | 0.676 | 0.324 |
| Bahrain | 1 | 0.528 | 0.472 |
| China | 1 | 0.800 | 0.200 |
| Israel | 1 | 0.932 | 0.068 |
| Japan | 1 | 0.500 | 0.500 |
| Lebanon | 1 | 1.000 | 0.000 |
| Malaysia | 1 | 0.674 | 0.326 |
| Philippines | 1 | 0.833 | 0.167 |
| **Rest of World** | **109** | **0.607** | **0.393** |
| **United States** | **32** | **0.663** | **0.337** |
| **Total** | **1,662** | **0.804** | **0.196** |
| **Total w/o U.K. placings and public offers** | **1,005** | **0.684** | **0.316** |

*Notes:*

1. Rules on allocation discretion are formulated at the level of the country of listing, not the country of origin, so we focus on the country of listing. Where a company lists in more than one country, we define its main listing as being in its home country, or if it only lists abroad as the country where the bulk of the offering is conducted. For instance, the Spanish company Terra Networks SA, which obtained listings on the stock exchanges of Madrid, Bilbao, Barcelona and Valencia as well as on Nasdaq, is classified as listing in Spain. Listings on EASDAQ are classified as Belgian (since Belgian law and regulations apply).
2. Institutional and retail allocations sum to 100% of the shares sold. In most countries (including France, Germany, the U.K., and the U.S.), shares sold include overallotment shares where the overallotment option is exercised. Shares allocated to employees or to 'friends and family' are counted as retail allocations.
3. We have no allocation data for IPOs in Ireland, the 15$^{th}$ EU country. (But we do have allocation data for Irish companies going public abroad, in particular in the U.K.)
4. Data for U.K. placings take into account shares aside for employees, which are counted as retail allocations.

**Table 2. Sample characteristics.**

| | Whole sample [1] | w/ allocation data [2] | w/ allocation, price range data [3] | *t*-test (*z*-test for medians): [1]=[2] | *t*-test (*z*-test for medians): [2]=[3] |
|---|---|---|---|---|---|
| **France** | | | | | |
| Number of observations | 516 | 244 | 237 | | |
| *Pure bookbuilding* | *43* | *26* | *26* | | |
| *Hybrid bookbuilding* | *212* | *211* | *204* | | |
| *Fixed-price offering* | *44* | *7* | *7* | | |
| *Auction* | *185* | *0* | *0* | | |
| Gross proceeds ($m): mean | 74.125 | 143.805 | 146.500 | 1.741 | 0.046 |
| Gross proceeds ($m): median | 7.129 | 13.740 | 14.387 | 7.979*** | 0.394 |
| Underpricing (%) | 16.5 | 17.1 | 17.4 | 0.205 | 0.089 |
| Institutional allocations (%) | n.a. | 76.3 | 76.2 | – | 0.056 |
| Fraction privatizations (%) | 3.1 | 4.9 | 4.6 | 1.181 | 0.142 |
| **Germany** | | | | | |
| Number of observations | 470 | 144 | 141 | | |
| *Bookbuilding* | *377* | *141* | *141* | | |
| *Fixed-price offering* | *92* | *2* | *0* | | |
| *Auction* | *1* | *1* | *0* | | |
| Gross proceeds ($m): mean | 131.371 | 236.875 | 241.492 | 1.312 | – |
| Gross proceeds ($m): median | 39.738 | 35.648 | 37.526 | 0.136 | – |
| Underpricing (%) | 40.2 | 49.0 | 49.4 | 1.264 | – |
| Institutional allocations (%) | n.a. | 57.7 | 58.4 | – | – |
| Fraction privatizations (%) | 1.1 | 1.4 | 1.4 | 0.321 | – |
| **United Kingdom** | | | | | |
| Number of observations | 876 | 843 | 231 | | |
| *Placing* | *651* | *651* | *126* | | |
| *Public offer* | *12* | *6* | *0* | | |
| *Hybrid* | *178* | *168* | *87* | | |
| *Global offer* | *35* | *18* | *18* | | |
| Gross proceeds ($m): mean | 92.534 | 87.446 | 261.614 | 0.344 | 6.200*** |
| Gross proceeds ($m): median | 15.485 | 15.164 | 51.687 | 0.318 | 10.504*** |
| Underpricing (%) | 39.6 | 32.0 | 11.9 | 0.915 | 2.398** |
| Institutional allocations (%) | n.a. | 93.0 | 86.3 | – | 5.286*** |
| Fraction privatizations (%) | 3.1 | 3.2 | 11.3 | 0.144 | 5.050*** |
| **United States** | | | | | |
| Number of observations | 4,541 | 32 | 32 | | |
| Gross proceeds ($m): mean | 63.487 | 315.984 | 315.984 | 9.116*** | – |
| Gross proceeds ($m): median | 30.8 | 172.250 | 172.250 | 7.201*** | – |
| Underpricing (%) | 22.0 | 8.9 | 8.9 | 1.560 | – |
| Institutional allocations (%) | n.a. | 66.3 | 66.3 | – | – |
| Fraction privatizations (%) | n.a. | 0.0 | 0.0 | – | – |
| **All four** | | | | | |
| Number of observations | 6,403 | 1,263 | 641 | | |
| Gross proceeds ($m): mean | 75.387 | 121.744 | 215.292 | 4.214*** | 3.067*** |
| Gross proceeds ($m): median | 27.788 | 18.570 | 31.434 | 7.887*** | 8.721*** |
| Underpricing (%) | 25.8 | 30.6 | 22.0 | 1.661* | 1.925* |
| Institutional allocations (%) | n.a. | 85.4 | 75.4 | – | 9.833*** |
| Fraction privatizations (%) | n.a. | 3.3 | 6.1 | – | 2.895*** |

***, **, * = significant at 1%, 5%, 10% (two-tailed tests).

**Table 3. Definition of variables.**

| Variable name | Definition |
|---|---|
| **Endogenous variables** | |
| *Revision* | equals (*Offer price* – $P_{low}$) / ($P_{high}$ – $P_{low}$), where $P_{high}$ and $P_{low}$ are the high and low end of the indicative price range, respectively |
| *Revision+* | equals *Revision* if *Revision* >1 (offer price set above the indicative range), and 0 otherwise |
| *Inst_Alloc* | equals the fraction of shares allocated to institutions in IPO *i* divided by the average fraction of shares allocated to institutions in all local offerings $i \neq j$ in the 90 calendar days preceding *i*'s first day of trading |
| *Initial Return* | equals $P_5$ / *Offer price* – 1, where $P_5$ is the firm's share price on its fifth day of trading |
| *Proceeds* | equals the natural logarithm of dollar gross proceeds (in million), which is the offer price times the number of shares sold (including overalloted shares) converted into US dollars using exchange rates on the pricing day |
| *Dollar Underpricing* | equals *Initial Return* times the dollar gross proceeds, in million |
| *IBmktshare* | equals the lead manager's (or if more than one, the average of the lead managers') market share in the local market, in %. Market share is the sum of gross proceeds in all local offerings lead managed by bank *j* divided by total proceeds raised in all offerings in that local market over the sample period (offerings lead managed by more than one bank are allocated equally to the lead managers). For offerings in the U.S., market shares are computed over the five calendar years preceding firm *i*'s IPO. |

**Table 3. Definition of variables (cont'd).**

| Variable name | Definition |
|---|---|
| **Exogenous variables** | |
| $m\_Revision_{BB}$ | average *Revision* of all local offerings $i \neq j$ between the setting of *i*'s price range and its final pricing, weighted by the number of such offerings |
| $\sigma\_Revision_{BB}$ | standard deviation of *Revision* of all local offerings $i \neq j$ between the setting of *i*'s price range and its final pricing |
| $MktRet_{BB}$ | return on the local market index between the setting of *i*'s price range and its final pricing. Indices used: Germany – Datastream Germany index prior to January 1994 and the DAX200 thereafter; France – Datastream France index prior to January 1991 and the SBF250 thereafter; U.K. – FT-SE All Share index; U.S. – S&P 500 index. |
| $\sigma\_Mkt_{BB}$ | standard deviation of local daily market index returns between the setting of *i*'s price range and its final pricing |
| $m\_IR_{BB}$ | average one-day *Initial Return* of all local offerings $i \neq j$ between the setting of *i*'s price range and its final pricing |
| *IPOVol* | the number of IPOs in the same local market as issue *i*, during the six weeks before to two weeks after *i*'s pricing date |
| $MktRet_{post\text{-}pricing}$ | return on the local market index between *i*'s final pricing and the fifth day of trading (to coincide with the period over which *Initial Returns* are computed) |
| $\sigma\_Mkt_{post\text{-}pricing}$ | standard deviation of daily local market index returns between *i*'s final pricing and the fifth day of trading |
| $m\_IR_{post\text{-}pricing}$ | average one-day *Initial Return* of all local offerings $i \neq j$ between *i*'s final pricing and its fifth day of trading |
| *BB_constraints* | dummy=1 for deals subject to constraints on allocation discretion, as defined in Table 4 |
| *BB_placings* | dummy=1 for U.K. placings, as defined in Table 4 |
| *Privatization* | dummy=1 if issue *i* is a privatization |
| *Hightech* | dummy=1 if issue *i* operates in a 'high-tech' industry; see footnote 22 for industry classifications |
| *Age* | equals one plus the natural logarithm of firm age, where firm age is the IPO year minus the year of foundation as disclosed in IPO prospectuses |

**Table 4. Categorization of sample by restriction imposed on price discovery.**

| Category | Offer mechanisms | Number of cases (with allocation and price range information) |
|---|---|---|
| Unrestricted bookbuilding (*BB_free*) | • Companies listing in the U.S.<br>• Dual-tranche IPOs where tranche allocations are to be determined after orders have been received<br>• Dual-tranche IPOs with clawback provision in favor of one investor class, where the clawback exercise is *discretionary* | France: 245 (219)<br>Germany: 469 (141)<br>U.K.: 41 (18)<br>U.S.: 4,541 (32)<br>All: 5,296 (410) |
| Deals subject to constraints on allocation discretion (*BB_constraints*) | • Dual-tranche IPOs with fixed tranches (i.e. no possibility of clawback or reallocation)<br>• Dual-tranche IPOs with clawback provision in favor of one investor class, where the clawback exercise is *non-discretionary*<br>• Fixed-price offerings with pro-rata allocation<br>• Auctions | France: 239 (18)<br>Germany: 1 (0)<br>U.K.: 184 (87)<br>U.S.: 0 (0)<br>All: 424 (105) |
| Deals subject to constraints on retail participation (*BB_placings*) | • U.K. placings | France: 0 (0)<br>Germany: 0 (0)<br>U.K.: 651 (126)<br>U.S.: 0 (0)<br>All: 651 (126) |
| Unclassified | | France: 32 (0)<br>Germany: 0 (0)<br>U.K.: 0 (0)<br>U.S.: 0 (0)<br>All: 32 (0) |
| All | | France: 516 (237)<br>Germany: 470 (141)<br>U.K.: 876 (231)<br>U.S.: 4,541 (32)<br>All: 6,403 (641) |

*Notes:*

1. The *BB_free* category includes the 92 fixed-price offerings in Germany, on the grounds that underwriters retain allocation discretion in such deals (in contrast to, for instance, France and the U.K. where allocations in fixed-price deals are pro rata or balloted).
2. The *BB_constraints* category includes the 185 fixed-price and 44 auction offerings in France, as well as one auction in Germany.

**Table 5. Regression results.**

| Equation | (1) | (2) | (3) | (1) | (2) | (3') |
|---|---|---|---|---|---|---|
| Dependent var. | *Revision* | *Inst_Alloc* | *Initial Return* | *Revision* | *Inst_Alloc* | *Dollar Underpricing* |
| *Inst_Alloc* | 0.682** | | –0.420** | 0.858** | | –135.189 |
| | *0.343* | | *0.203* | *0.360* | | *119.016* |
| *Revision* | | 0.163*** | 0.527*** | | 0.176*** | 85.611* |
| | | *0.056* | *0.083* | | *0.056* | *48.161* |
| *Revision+* | | 0.216** | 0.030 | | 0.214** | –2.756 |
| | | *0.084* | *0.113* | | *0.085* | *64.939* |
| *Proceeds* | | –0.078*** | | | –0.071*** | |
| | | *0.023* | | | *0.023* | |
| $m\_Revision_{BB}$ | 0.004** | | | 0.004** | | |
| | *0.002* | | | *0.002* | | |
| $\sigma\_Revision_{BB}$ | –0.191*** | | | –0.215*** | | |
| | *0.046* | | | *0.049* | | |
| $m\_IR_{BB}$ | 0.214*** | | | 0.140*** | | |
| | *0.046* | | | *0.049* | | |
| $MktRet_{BB}$ | 0.890 | | | 0.907 | | |
| | *0.600* | | | *0.660* | | |
| $\sigma\_Mkt_{BB}$ | –15.661*** | | | –13.911*** | | |
| | *4.483* | | | *4.872* | | |
| *BB_constraints* | –0.211** | | | –0.149 | | |
| | *0.101* | | | *0.109* | | |
| *BB_placings* | –0.286*** | | | –0.257*** | | |
| | *0.066* | | | *0.069* | | |
| *IPOVol* | | | –0.0002 | | | 0.550 |
| | | | *0.001* | | | *0.849* |
| *IBmktshare* | | | –0.019** | | | –1.592 |
| | | | *0.007* | | | *4.613* |
| $MktRet_{post\text{-}pricing}$ | | | 0.785 | | | –116.136 |
| | | | *0.592* | | | *380.462* |
| $\sigma\_Mkt_{post\text{-}pricing}$ | | | –11.164*** | | | –2809.968 |
| | | | *3.488* | | | *2208.104* |
| $m\_IR_{post\text{-}pricing}$ | | | 0.095*** | | | 34.937 |
| | | | *0.035* | | | *22.780* |
| *Privatization* | | 0.076 | 0.041 | | 0.056 | 195.706*** |
| | | *0.095* | *0.104* | | *0.096* | *65.094* |
| *Hightech* | | | 0.082** | | | 42.356* |
| | | | *0.036* | | | *22.944* |
| *Age* | | | –0.019 | | | –9.390 |
| | | | *0.015* | | | *9.535* |
| *Constant* | 0.143 | 1.154*** | 0.446** | –0.035 | 1.122*** | 121.932 |
| | *0.364* | *0.090* | *0.203* | *0.382* | *0.091* | *120.300* |
| all coeff=0? ($\chi^2$) | 101.8*** | 35.3*** | 114.0*** | 85.9*** | 34.8*** | 40.6*** |

*Notes:*

1. The two systems described by equations (1)-(3) and (1)-(3') are estimated separately using three-stage least squares.
2. Year dummies were included in the first-stage regressions.
3. All variables are defined in Table 3.
4. *Revision*, *Revision+*, *Inst_Alloc*, *Initial Return*, *Proceeds*, *Dollar Underpricing*, and *IBmktshare*, are treated as endogenous. All other regressors are treated as exogenous.
5. Standard errors are given in italics below the coefficient estimates.
6. Number of observations: 641 (237 in France, 141 in Germany, 231 in the U.K., and 32 in the U.S.).
7. $^{***}$, $^{**}$, $^{*}$ = significant at 1%, 5%, 10% (two-tailed Z test).