Information-Processing Costs and Breadth of Ownership*

JEONG-BON KIM, *City University of Hong Kong and University of Waterloo*†

BING LI, *City University of Hong Kong*

ZHENBIN LIU, *Hong Kong Baptist University*

ABSTRACT

Using the U.S. Securities and Exchange Commission's mandate of eXtensible Business Reporting Language (XBRL) as a natural experiment, this study investigates whether and how the decreased information-processing costs brought about by XBRL influence firms' breadth of share ownership. We find that the XBRL mandate is associated with an increase in the total number of a firm's shareholders. This finding is consistent with the notion that XBRL facilitates a more transparent environment and decreases information-processing costs, thereby attracting more shareholders in general. More interestingly, we find that while XBRL adoption is associated with an increase in share ownership of individual and non-U.S. foreign institutional investors, it is associated with a decrease in share ownership of U.S. domestic institutional investors. Further evidence shows that this asymmetric shift in share ownership is more pronounced for more complex firms. Our findings, taken together, suggest that the decreased information-processing costs brought about by XBRL help firms establish a level playing field by reducing the information disadvantages of individual and foreign institutional investors over domestic institutional investors. Our results are robust to potential endogeneity concerns and alternative research designs.

Coûts du traitement de l'information et étendue de l'actionnariat

RÉSUMÉ

Utilisant à titre d'expérience naturelle l'imposition par la Securities and Exchange Commission des États-Unis de l'eXtensible Business Reporting Language (XBRL), les auteurs se demandent si la diminution des coûts du traitement de l'information engendrée par le XBRL influe sur l'étendue de l'actionnariat des sociétés et, le cas échéant, de quelle façon. Ils constatent que l'imposition du XBRL est associée à une hausse du nombre total d'actionnaires des sociétés. Cette observation est

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† Corresponding author.

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conforme à la notion selon laquelle le XBRL favorise un environnement plus transparent et réduit les coûts du traitement de l'information, attirant ainsi de manière générale davantage d'actionnaires. Fait plus intéressant encore, les auteurs constatent qu'alors que l'adoption du XBRL est associée à une hausse de l'actionnariat chez les particuliers investisseurs et les investisseurs institutionnels étrangers de l'extérieur des États-Unis, elle est associée à une diminution de l'actionnariat chez les investisseurs institutionnels nationaux des États-Unis. Des données complémentaires révèlent que cette asymétrie dans la transformation de l'actionnariat est plus marquée lorsque les sociétés sont plus complexes. Les constatations des auteurs, prises dans leur ensemble, laissent croire que la réduction des coûts du traitement de l'information engendrée par le XBRL aide les sociétés à créer une situation équitable en réduisant les désavantages liés à l'information auxquels sont exposés les particuliers investisseurs et les investisseurs institutionnels étrangers par rapport aux investisseurs institutionnels nationaux. Les résultats de l'étude ne sont pas sensibles aux problèmes d'endogénéité et à la permutation des plans de recherche.

1. Introduction

A recent strand of research focuses on security market consequences of a firm's ownership structure in general, and on breadth of ownership in particular. Brennan and Tamarowski (2000) and Bushee and Miller (2012) argue that one major task of the investor relations department is to obtain a broader investor base.[1] Merton (1987), Barber and Odean (2008), and Hirshleifer et al. (2009) suggest that ownership breadth has important stock return implications. Firms frequently work to increase their investor base by enhancing investor recognition in the market. However, Sims (2003, 2006) models a setting in which investors have limited information-processing capacity and high information-processing costs, so that they fail to fully process and utilize even public information and their investment decisions are constrained.

Yet, there is limited empirical research that examines how information-processing costs affect investors' investment decisions. This is due, in part, to the difficulty of capturing unobservable information-processing costs. Taking advantage of a recent regulation—the U.S. Securities and Exchange Commission (SEC) requirement that firms report their financial statements using eXtensible Business Reporting Language (XBRL)—that exogenously reduces the costs to investors for processing information contained in published financial statements, this article investigates whether and how information-processing costs affect investor decisions to include a particular firm's stock in investment portfolios, thereby impacting the breadth of ownership at the individual-firm level.

Several XBRL studies focus on the equity market consequences of XBRL-induced changes in the information environment (e.g., Yoon et al. 2011; Kim et al. 2012; Li et al. 2013; Blankespoor 2014; Liu et al. 2014; Dong et al. 2016; Efendi et al. 2016). Fewer studies, however, consider whether reduced information-processing costs induced by XBRL affect a firm's ownership structure. We utilize changes around the XBRL mandate to provide evidence about whether and how information-processing costs influence investor decisions to invest in a firm's equity shares. Additionally, we examine whether different types of investors (i.e., individual versus institutional; U.S. institutional versus non-U.S. institutional) obtain differential benefits from the XBRL-induced reduction in information-processing costs.

First, we predict that companies that file financial statements using XBRL attract a larger number of shareholders, thereby increasing the breadth of ownership for such companies. XBRL adoption reduces information-processing costs to investors without imposing many additional costs.[2] Investor information-processing ability is constrained by limited time, resources, and cognitive capacity. Average retail (individual) investors cannot fully process and analyze public information (e.g., Hirshleifer and Teoh 2003; DellaVigna and Pollet 2009). When investors are less informed about or have incomplete information on a particular stock, they tend not to include that stock in their

1. In this study, we use "breadth of ownership" and "investor base" interchangeably.
2. As discussed in detail in section 2, the easily accessible, user-friendly XBRL tools/information intermediaries decrease additional costs for investors using XBRL data, especially for those with fewer resources and less expertise (e.g., retail investors).

portfolios (Merton 1987; Easley and O'Hara 2004). XBRL adoption for SEC filings provides investors easier access to financial data, so that they can extract relevant information in a timelier manner and at virtually no additional cost. As a result, investors are more likely to "research" firm fundamentals and thus become more familiar with a greater number of firms. Increased investor attention and enhanced familiarity associated with decreased information-processing costs are likely to shift the demand curve upward, leading to increased investment in firms that have adopted XBRL (Merton 1987; Huberman 2001; Easley and O'Hara 2004). In addition, reduced information-processing costs facilitate coverage of firms by third parties, including sell-side analysts, news media, ratings agencies, and regulatory bodies (Bhushan 1989; Barth et al. 2001; Li et al. 2013; Liu et al. 2014), as well as other XBRL information intermediaries (e.g., Oxide Solutions, 9Wsearch, Prime Aim, etc.). Moreover, as the reduced information-processing costs increase the benefits from firm disclosure, XBRL adoption may incentivize firms to disclose more information (Diamond and Verrecchia 1991; Zhang 2001; Blankespoor 2014). Investors, therefore, can obtain more and improved information in the post-XBRL period than in the pre-XBRL period. Accordingly, the level of investors' perceived information uncertainty (information risk) decreases for XBRL firms, and more investors will thus be attracted to XBRL firms with lower information-processing costs.

Next, we predict that XBRL-reporting firms attract additional investment from less-endowed investors (e.g., individual and non-U.S. foreign institutional investors), but not from well-endowed investors (e.g., U.S. domestic institutional investors). We argue that the benefits of the XBRL mandate vary across different types of investors who have differing levels of resources and information-processing skills. Prior studies suggest that individual investors benefit more from easily accessible and less-complex 10-Ks (Asthana et al. 2004; Miller 2010; Lawrence 2013), and so they should benefit more from the reduced information-processing costs than institutional investors. Similarly, foreign institutional investors, who possess fewer financial resources and skills relative to domestic institutional investors (Brennan and Cao 1997; Baik et al. 2010; Maffett 2012), should benefit from the reduced information-processing costs. Compared with domestic institutional investors, foreign institutional investors have fewer alternative information sources (e.g., social networks, local contacts) and are more likely to use public financial reports as primary resources for making investment decisions. Because foreign institutional investors suffer from financial reports with high information-processing costs to a greater extent than domestic institutional investors, we predict that the former would benefit more from the reduced information-processing costs than the latter.

Even before the XBRL mandate lowers information-processing costs, well-endowed investors tend to have more alternative information sources and better processing capabilities, which suggests that the incremental benefits of the reduced information-processing costs should be relatively smaller for them. XBRL adoption can potentially decrease the relative information disadvantages that less-endowed investors have over better-endowed investors. We therefore predict an increase in share ownership of less-endowed investors (e.g., individual and foreign institutional investors) after XBRL adoption. Moreover, an increase in ownership of less-endowed investors may squeeze out some of the well-endowed investors (e.g., domestic institutional investors) who are unlikely to retain substantial information advantages.

Using a sample of 30,890 firm-year observations (5,190 unique firms for the period 2005–2014), we show that reduced information-processing costs are associated with an increase in the breadth of ownership. Specifically, firms that provide interactive SEC filings have a larger total number of common shareholders in the subsequent year. We examine individual, foreign, and domestic institutional investors in the U.S. stock markets and show that XBRL adoption is associated with an increase (decrease) in ownership breadth by individual investors and foreign institutional investors (domestic institutional investors). These findings are consistent with the conjecture that decreased information-processing costs reduce the information disadvantages that individual and foreign institutional investors have over domestic institutional investors.

Using a series of cross-sectional settings, we provide evidence suggesting that the asymmetric shift in the breadth of ownership takes place due to reduced information-processing costs around

the XBRL mandate. Specifically, we find that (i) firms with higher information-processing costs have a greater shift in ownership in the post-adoption period, (ii) XBRL filers adopting more standardized XBRL tags experience greater changes in share ownership after the XBRL mandate, and (iii) XBRL adoption reduces the information asymmetry between well-endowed and less-endowed investors, captured by the bid-ask spread. Further, we find that the impact of reduced information-processing costs on ownership breadth represents more of a change in the size of portfolio for each type of investor, rather than a rebalancing between XBRL adopters and non-adopters.[3]

This study makes several contributions. First, it contributes to both information-processing cost literature and share ownership literature by showing that information-processing costs influence investors' decisions to include a firm's stock in their investment portfolio (Hirst and Hopkins 1998; Grullon et al. 2004; DellaVigna and Pollet 2009; Hirshleifer et al. 2009; Miller 2010; De Franco et al. 2011; Choi et al. 2013). We use the XBRL mandate to capture unobservable changes in information-processing costs and to investigate its impact on firms' breadth of ownership. We provide evidence that XBRL adoption is associated with lower information-processing costs in the U.S. stock market and that it enlarges ownership breadth, especially in periods after the initial adoption year. Second, we provide evidence of an asymmetric shift in share ownership, which supports the argument that lower information-processing costs mitigate the relative information disadvantages of less-endowed investors, thereby "leveling" the playing field. This is consistent with the SEC argument that lower information-processing costs improve informational equality in the capital markets.[4] Finally, prior literature suggests that increased breadth of ownership leads to lower cost of capital (Merton 1987) and higher stock liquidity (Amihud et al. 1999; Grullon et al. 2004). Our study provides evidence for a channel through which decreased information-processing costs produce the market effects found in earlier studies (e.g., Li et al. 2013): the XBRL mandate contributes to lowering information-processing costs and thereby expanding the breadth of ownership, which in turn increases liquidity and/or decreases the cost of capital.

This article proceeds as follows. Section 2 introduces the institutional background of XBRL, reviews related literature, and develops our hypotheses. Section 3 discusses our sample selection procedures and the regression variables. In section 4, we specify the regression models and present our empirical findings. Section 5 presents results on several additional tests. Finally, section 6 sets forth our conclusions.

2. Literature review and hypothesis development

Breadth of ownership literature

Barber and Odean (2008) and Hirshleifer et al. (2009) argue that a stock market investor with scarce resources must search through thousands of stocks when making investment decisions. Similarly, Merton (1987) argues that investors do not have complete information for all stocks, and therefore do not include certain (unfamiliar) stocks in their portfolios if they lack information. Under this assumption, Merton (1987) models that, if a security is less well known (and breadth of ownership is lower), investors should be compensated with higher expected returns (or lower current market valuation) for the increased idiosyncratic risk they bear. Lehavy and Sloan (2008) and Bodnaruk and Östberg (2009) provide empirical evidence that supports Merton's (1987) theoretical predictions.

Grullon et al. (2004) find that firms with more product market advertising expenditures have a larger number of both individual and institutional investors. Kim et al. (2016) show that firms

3. For example, U.S. domestic institutional investors may shift their investments to non-XBRL adoption countries or alternative non-stock products. Detailed explorations on the possible alternative investments are out of the scope of this study, and we leave them for future research.

4. A concurrent study by Bhattacharya et al. (2018) examines the impact of XBRL adoption on small institutions' responsiveness to 10-K filings relative to large institutions. Our study differs from Bhattacharya et al. (2018) by examining the impact of XBRL mandate on different types of investors' share ownership structures and by including individual investors in the empirical analysis.

with better corporate social responsibility performance are associated with a broader investor base. Choi et al. (2013) suggest that retail ownership breadth is correlated with overpricing, while institutional investor breadth is associated with short-sale constraints. Additionally, the literature indicates that higher breadth of ownership is associated with higher stock liquidity (Amihud et al. 1999; Grullon et al. 2004).

XBRL background and related studies

The SEC began a voluntary interactive data program in April 2005 and mandated that firms provide financial statement information using XBRL over three phase-in periods (2009 for firms with a public common equity float over $5 billion; 2010 for firms with a public float over $700 million; 2011 for all remaining companies). The interactive data requirements apply to periodic reports, current reports, registration statements, and transition reports, as well as to reports on Forms 8-K and 6-K that contain specified financial statements.

One prerequisite for XBRL to impact investors' investment decisions is that investors should be able to access XBRL data while incurring minimal additional costs. This prerequisite appears to be satisfied in practice. First, open-source XBRL intermediaries are available that provide professional yet user-friendly financial analysis services using XBRL data, and that work on all major device types (smartphones, tablets, PCs, etc.). These include Calcbench, 9Wsearch, and SQL Power XBRL Analytics, among others. The prices of these XBRL tools range from several dollars to hundreds of dollars per month. Second, an increasing variety of free XBRL tools has emerged since the XBRL mandate (e.g., XBRL Data in Use, Oxide Solutions, Prime Aim, XBRL Cloud, and Reporting Standard Query). These free tools provide basic financial analysis that caters to the needs of a majority of investors. It is worth noting that, although some of the XBRL tools were available on or before the first XBRL mandate year of 2009 (e.g., Prime Aim in 2008 and 9Wsearch in 2009), the majority of XBRL tools have become available only since 2009 (e.g., XBRL Data in Use in 2010, Calcbench in 2011, SQL Power XBRL Analytics in 2011, Oxide Solutions in 2012). This fact is consistent with the findings of Blankespoor, B.P. Miller et al. (2014) and Harris and Morsfield (2012), in that far fewer XBRL tools were available in the initial XBRL adoption year.[5]

Most existing XBRL studies focus on the market impact of XBRL adoption. For example, Li et al. (2013) and Liu et al. (2014) find that XBRL adoption increases analyst coverage and forecast accuracy, while it decreases analyst forecast dispersion. Li et al. (2013) also show a reduction in cost of capital and an improvement in stock liquidity after firms adopt XBRL. Dong et al. (2016) argue that the XBRL mandate reduces stock price synchronicity. Blankespoor (2014) finds that the XBRL mandate prompts firms to increase their footnote disclosures. As well, studies suggest that XBRL adoption reduces information asymmetry (Yoon et al. 2011; Li et al. 2013), provides incremental information content (Efendi et al. 2016), increases information efficiency (Kim et al. 2012), increases small institutions' responsiveness to 10-K information (Bhattacharya et al. 2018), and constrains opportunistic earnings management (Kim et al. 2013). One related study is that of Blankespoor, B.P. Miller et al. (2014), who examine investor *trading* behavior following the XBRL mandate. Focusing mainly on the first phase-in period (tier 1) of XBRL adopters, they find higher abnormal bid-ask spreads, lower abnormal liquidity, and lower abnormal trading volume in short windows around the 10-K filing date after the XBRL mandate. Blankespoor, B.P. Miller et al. (2014) conclude that for tier 1 XBRL adopters, XBRL does not reduce the information asymmetry during the initial year. Our study differs from Blankespoor, B.P. Miller et al. (2014) in the following two ways. First, Blankespoor, B.P. Miller et al. (2014) focus mainly on the first adoption year of tier 1 (large-cap) XBRL firms, while we study all tiers 1, 2, and 3 XBRL adopters (i.e., large-, medium-, and small-cap firms, respectively) in their post-adoption years. In the first XBRL adoption year, few XBRL tools were available, so it is possible that only a limited number of investors were utilizing XBRL filings

5. Harris and Morsfield (2012) also find that in the first XBRL adoption year less than 10 percent of respondents were using XBRL-formatted data.

(Harris and Morsfield 2012). Results from our robustness tests indicate that there are generally no XBRL effects on ownership breadth for tier 1 firms in their first adoption year, suggesting that our findings do not necessarily contradict those of Blankespoor, B.P. Miller et al. (2014). Second, Blankespoor, B.P. Miller et al. (2014) examine *trading* behaviors in a short window (several days) around the 10-K filing date (the effects disappear beyond 18 days after the 10-K filing date), while we investigate investor *holdings* at the fiscal year-end of the subsequent year in order to incorporate the lead–lag relationship between XBRL and investor shareholdings.

Hypothesis development

Impact of XBRL adoption on breadth of ownership

The SEC claims that the XBRL format of financial statement information provides benefits to investors in aggregating and analyzing data. We expect that XBRL adoption is associated with an increase in the breadth of firm share ownership, for the following reasons: (i) XBRL adoption decreases information-processing costs; and (ii) reduced information-processing costs contribute to enhanced quantity and quality of overall information available to investors.

First, investors are subject to time and resource constraints, as well as to cognitive limitations (Merton 1987; Hirshleifer and Teoh 2003; DellaVigna and Pollet 2009; Hirshleifer et al. 2009; Miller 2010; De Franco et al. 2011). As a result, average investors cannot fully process and utilize public information (Sims 2003, 2006), so that firm disclosures often reach only a portion of investors (Blankespoor, G.S. Miller et al. 2014; Drake et al. 2015). Investors with incomplete information do not include particular stocks in their portfolios (Merton 1987; Easley and O'Hara 2004), and thus limited attention and unfamiliarity lead investors to under-diversify their portfolio risks (Peng 2005; Luo 2008, 2010). Upon XBRL adoption, firms "tag" or label all quantitative disclosures in financial statements so that the numbers are machine-readable and interactive. The XBRL elements allow investors to extract and interpret information in a simpler and timelier manner. With the help of various open-source, user-friendly XBRL tools, investors can save a substantial portion of their information acquisition and processing costs without incurring many additional costs. As a result, investors are more likely to pay attention to, and to follow, a larger number of firms. This increased investor attention improves investor familiarity with (and/or informativeness of) such firms, and it increases demand for these firms' stocks (Merton 1987; Huberman 2001; Easley and O'Hara 2004).

Second, the reduced information-processing costs associated with XBRL adoption bring about an increase in total information content, both public and private, that is available to investors. On the one hand, the XBRL mandate reduces the cost of following a firm, and thus facilitates coverage of firm financial data by third parties, including analysts, media, banks, credit rating agencies, and other third-party XBRL intermediaries (Bhushan 1989; Barth et al. 2001). For example, Li et al. (2013) and Liu et al. (2014) find that XBRL adoption increases the number of analysts following a firm, who in turn generate more financial data and enlarge the total information available to investors. On the other hand, firms weigh the costs and benefits of disclosure (Diamond and Verrecchia 1991). Because XBRL facilitates investor use of firm-specific information, thus increasing the benefits of disclosure, firms increase their quantitative disclosures upon implementation of XBRL (Blankespoor 2014). As a consequence, the investor-perceived level of information uncertainty (information risk) decreases and more investors are subsequently attracted to XBRL firms, compared with non-XBRL firms.

Drawing on the aforementioned two benefits of XBRL adoption, we predict that XBRL firms attract more investors and therefore are more likely to be held by a larger number of shareholders, compared with non-XBRL firms. Thus, our first hypothesis, stated in alternative form, is as follows:

HYPOTHESIS 1. *Ceteris paribus, XBRL adoption attracts a larger number of shareholders, thus increasing breadth of share ownership.*

There are at least two reasons why Hypothesis 1 may not necessarily hold. First, learning a new technology is apparently costly to investors (Rai et al. 1997; Yao et al. 2010). Investors incur incremental learning costs when they first use XBRL-based financial data, which may offset the benefits associated with reduced information-processing costs. Second, while the SEC mandates its registrants to tag each piece of business and financial data, using a standardized official element in an agreed-upon taxonomy, it also allows customized extensions when a requisite tag does not exist. With the unrestricted use of customized extensions, comparability across XBRL filers may be impaired, and investors would be required to manually reconcile the tagged data (Boritz and No 2009; Debreceny et al. 2010; Kim et al. 2013).[6]

Impact of XBRL adoption on different types of investors

Another benefit associated with the XBRL mandate is that it offers a level playing field to investors with differing levels of endowments. Compared with individual investors, institutional investors are generally larger, more sophisticated, and better endowed, with access to greater financial resources and superior analytical skills. Individual investors rely on public financial reports as one of their key information sources. Previous studies have indicated that the information-processing costs of public disclosures matter more for individual investors than for institutional ones (Griffin 2003; Asthana et al. 2004; Miller 2010; Lee 2012; Lawrence 2013). Hodge et al. (2004) show that a search-facilitating technology such as XBRL helps nonprofessional investors acquire and integrate related financial information, while it has less impact on professional financial analysts. The SEC (2009) also argues that decreased information-processing costs induced by XBRL adoption reduce information barriers that separate small investors from larger investors. If this is the case, we expect that individual investors are likely to benefit more from the XBRL mandate than institutional investors.

Among institutional investors who hold stocks in the U.S. market, domestic institutional investors have better access to alternative information channels (e.g., social networks, local contacts), relative to foreign institutional investors (Covrig et al. 2007). Therefore, foreign institutional investors depend more on public financial filings and accordingly suffer more from financial opacity (Brennan and Cao 1997; Leuz et al. 2010). Maffett (2012) finds that local institutional investors utilize their information advantages over foreign institutional investors, and benefit more from opaque financial reporting. Lundholm et al. (2014) find that firms with less complex financial disclosures attract more nonlocal institutional investment. If XBRL adoption effectively makes it easier for all investors to access and process SEC filings, foreign institutional investors would benefit more from the reduced information-processing costs associated with XBRL adoption than local institutions. Although XBRL adoption also facilitates domestic institutional investors' information processing, these investors may have already possessed the necessary resources to acquire and integrate such information in ways similar to XBRL.

In summary, reduced information-processing costs associated with XBRL adoption may lower information advantages that institutional investors have over individual investors, and that domestic institutional investors have over foreign institutional investors. Consistent with this argument, Yoon et al. (2011) find that in the Korean stock market XBRL adoption reduces relative bid-ask spread, a measure of information asymmetry. Therefore, we predict that XBRL adoption is associated with an increase in share ownership of less-endowed individual and foreign institutional investors. This may, in turn, squeeze out some of the better-endowed domestic

6. As discussed in Hypothesis 2 and tabulated in Table 3, the XBRL mandate is associated with a change in investor mix (more individual and foreign institutional investors, and fewer domestic institutional investors). The decrease in the overall share ownership of U.S. institutional investors, together with the fact that U.S. institutional investors hold larger stakes of firms in general, could potentially explain the results of our tests for Hypothesis 1. In other words, multiple individual (or foreign institutional) investors are needed to hold the same amount of shares as one (relatively large) U.S. institutional investor, which potentially explains the increase in overall breadth of ownership.

institutional investors, because with XBRL adoption such investors will no longer have substantial information advantages. To provide systematic evidence on these unresolved issues, we propose and test the following hypotheses, stated in alternative form:

HYPOTHESIS 2a. *Ceteris paribus, XBRL adoption is associated with an increase in share ownership of individual and non-U.S. foreign institutional investors.*

HYPOTHESIS 2b. *Ceteris paribus, XBRL adoption is associated with a decrease in share ownership of U.S. domestic institutional investors.*

On the contrary, one could argue that institutional investors may gain greater benefit from reduced information-processing costs because they can shift a substantial amount of their resources from data collection to analysis (Blankespoor, B.P. Miller et al. 2014). Domestic institutional investors may also further extend their information advantage and thus benefit more from lower information-processing costs. Blankespoor, B.P. Miller et al. (2014) find supporting evidence that the information asymmetry around 10-K filings between larger and smaller investors increases for first-phase XBRL adopters in their initial adoption year. In this case, our predictions in Hypotheses 2a and 2b may hold in the opposite direction.

Impact of XBRL adoption on breadth of ownership—Cross-sectional hypotheses

To better understand how the XBRL mandate benefits different types of investors, we explore several cross-sectional settings where one would expect that XBRL adoption would be expected to have a greater impact on shifting breadth of ownership. We predict that, if increased (decreased) share ownership for individual and foreign institutional investors (domestic institutional investors) after XBRL adoption is indeed due to investors' reduced information-processing costs, the impact of XBRL adoption on share ownership should be more pronounced for firms that exhibit higher information-processing costs. To generate systematic evidence on this issue, we propose and test the following hypotheses, stated in alternative form:

HYPOTHESIS 3a. *Ceteris paribus, the positive effect of XBRL adoption on individual and non-U.S. foreign institutional investors, if any, is stronger for firms with higher information-processing costs.*

HYPOTHESIS 3b. *Ceteris paribus, the negative effect of XBRL adoption on U.S. domestic institutional investors, if any, is more pronounced for firms with higher information-processing costs.*

3. Sample and variables

Sample selection

To empirically examine whether and how a firm's XBRL adoption influences the breadth of that firm's share ownership, we construct our sample by merging several key databases. First, we extract all XBRL filings submitted to the SEC from the Electronic Data Gathering, Analysis and Retrieval (EDGAR) database of interactive data filings and RSS feeds. Next, we obtain total number of common shareholders, financial data, and industry affiliations from COMPUSTAT North America, along with data on firm age, stock returns, and trading volume from CRSP. Additionally, we gather institutional holdings data from the FactSet/LionShares database. Following Grullon et al. (2004), Dyl and Elliott (2006), and Bodnaruk and Östberg (2013), we use the total number of shareholders to measure a firm's aggregate breadth of ownership. To investigate whether the impact of XBRL adoption varies systematically among different types of investors (Hypotheses 2a and 2b), we identify and separate institutional investors from general common shareholders. In addition, we partition institutional investors into foreign and domestic institutional investors based on the country origins of institutional investors.

TABLE 1
Sample and data

Panel A: Sample selection	Observations	Firms
Starting observations: COMPUSTAT firms in the CRSP database for the period 2005–2014	66,944	10,930
Less observations with missing COMPUSTAT and CRSP data information (including number of common shareholders)	(32,901)	(5,171)
Less foreign firms cross-listed on U.S. stock exchanges	(2,333)	(444)
Less banks	(820)	(125)
Final observations	30,890	5,190

Panel B: Sample distribution by year

Year	XBRL adoption	Non-XBRL adoption	Total observations	Percent
2005	0	3,319	3,319	10.74
2006	0	3,141	3,141	10.17
2007	0	3,136	3,136	10.15
2008	0	3,254	3,254	10.53
2009	283	2,806	3,089	10.00
2010	978	2,069	3,047	9.86
2011	2,617	364	2,981	9.65
2012	2,708	206	2,914	9.43
2013	2,696	247	2,943	9.53
2014	2,753	313	3,066	9.93
Total	12,035	18,855	30,890	100.00

Panel C: Summary statistics

Variables	*N*	Mean	Median	25th percentile	75th percentile	Std Dev
XBRL (t)	30,890	0.390	0.000	0.000	1.000	0.488
Number of Shareholders (1000s) *(t + 1)*	30,890	11.079	0.884	0.203	4.670	40.175
Number of Institutional Investors (t + 1)	30,890	209.449	122.000	34.000	249.000	277.708
Number of Institutional Investors (Foreign) (t + 1)	30,890	49.714	15.000	3.000	43.000	87.076
Number of Institutional Investors (Domestic) (t + 1)	30,890	159.734	105.000	30.000	205.000	194.646
Percentage of Individual Investor Holdings (t + 1)	30,890	0.434	0.357	0.127	0.742	0.339
Percentage of Institutional Investor Holdings (Foreign) (t + 1)	30,890	0.040	0.020	0.002	0.058	0.063

(The table is continued on the next page.)

TABLE 1 (continued)

Panel C: Summary statistics

Variables	*N*	Mean	Median	25th percentile	75th percentile	Std Dev
Percentage of Institutional Investor Holdings (Domestic) (t + 1)	30,890	0.525	0.595	0.237	0.809	0.320
Firm Age (years) (t)	30,890	19.766	15.000	7.000	27.000	17.066
Yearly Return (t)	30,890	0.010	−0.041	−0.251	0.184	0.448
Return on Assets (t)	30,890	−0.035	0.029	−0.029	0.070	0.242
Market Value (million $) *(t)*	30,890	3,814	543	132	2,305	10,721
Share Price ($) *(t)*	30,890	24.022	15.920	5.780	33.830	25.346
Return Volatility (t)	30,890	0.032	0.027	0.019	0.040	0.019
Turnover (t)	30,890	0.008	0.006	0.003	0.011	0.008

Notes: Panel A of this table provides the detailed sample selection procedures. Our final sample consists of 30,890 firm-year observations, representing 5,190 unique firms for the period 2005–2014. Panel B presents the number of observations in our sample by year. Of the 30,890 observations, 12,035 firm-years are XBRL adoption observations, while 18,855 firm-years are non-XBRL adoption observations. Panel C presents descriptive statistics for our sample firms. To alleviate potential problems associated with extreme outliers, we winsorize all the continuous variables at the 1st and 99th percentiles. *N* denotes the number of firm-year observations. All variables are defined in the Appendix.

Our sample period is 2005–2014. Because the SEC mandated the interactive data program in 2009, beginning our sample in 2005 ensures a reasonably long period within which to conduct our firm fixed effects models. Our sample period ends in 2014 because we try to investigate the impact of XBRL adoption on ownership breadth in the next year, and some of the variables are available only up to 2015. Panel A of Table 1 reports the detailed sample construction procedures. We exclude from the sample those firms for which the number of common shareholders is missing, or do not provide the financial and stock return data required to compute the variables used in our regressions. Voluntary XBRL adopters are included in the non-XBRL control group rather than in the XBRL treatment group because voluntary filings are not as timely or as well regulated as mandatory filings.[7] Foreign firms cross-listed on U.S. stock markets are excluded, as domestic institutions may not necessarily have information advantages over foreign institutions for these firms. Finally, firms in the banking industry are deleted, given that banks were required to file regulatory reports using XBRL as early as 2005 (Chen et al. 2018). These procedures generate a final sample of 30,890 firm-year observations, representing 5,190 unique firms for the period 2005–2014.

Panel B of Table 1 reports the total number of observations, as well as the number of XBRL and non-XBRL adoption observations by year. Following the approach commonly used in recent XBRL literature (Li et al. 2013; Dong et al. 2016), a firm-year observation is regarded as an XBRL adoption observation when the firm-year is at or after the firm's initial XBRL adoption year, and is a non-XBRL adoption observation otherwise. We have approximately 3,000 total observations for each year. The first mandated XBRL adoption appeared in 2009, and thus XBRL adoption

7. Firms were able to voluntarily choose to adopt XBRL prior to the first-wave mandate for large-cap firms (June 2009). Prior to the XBRL mandate, standardized XBRL taxonomies created by the Financial Accounting Standards Board (FASB) did not exist, and voluntary XBRL filings were usually significantly delayed. Our findings do not change if we exclude voluntary XBRL adopters from the non-XBRL adoption control group.

observations are 0 in 2005 through 2008. Upon the first phase of mandated XBRL adoption in 2009, the number of XBRL adoption observations is 283. The number rises to 978 and 2,617 in the second and third phases of mandated XBRL adoption in 2010 and 2011, respectively, and to 2,708 in 2012, 2,696 in 2013, and 2,753 in 2014.[8]

Descriptive statistics

Panel C of Table 1 presents descriptive statistics of the breadth of ownership measures and control variables that will be used in our multivariate regression models.[9] Our sample consists of 30,890 firm-year observations, of which XBRL adoption observations (12,035 firm-years) represent 39.0 percent of the full sample. On average, sample firms have a mean (median) of 11.079 (0.884) thousand common shareholders, and a mean (median) of 209 (122) institutional investors. When we partition institutional investors into domestic and foreign institutional investors, we find that sample firms have, on average, 49.7 (159.7) foreign (domestic) institutional investors.

On average, individual investors, foreign institutional investors, and domestic institutional investors hold, respectively, 43.4 percent, 4.0 percent, and 52.5 percent of the common shares outstanding. For control variables, average firm age is 19.766 years. Average yearly return is 1.0 percent, and return on assets is −3.5 percent. Mean market value is 3,814 million dollars and average share price is 24.022 dollars. The mean value of return volatility is 0.032, while the mean for share turnover is 0.008. To mitigate potential problems arising from skewness, we apply natural logarithm transformation for most continuous variables included in our multivariate regression analyses.

4. Regression models and empirical results

Impact of XBRL adoption on breadth of ownership

This section investigates the impact of XBRL adoption on a firm's overall breadth of ownership (Hypothesis 1). The SEC mandates that firms adopt XBRL over three phase-in periods (tier 1 in 2009, tier 2 in 2010, and tier 3 in 2011). Following Bertrand and Mullainathan (2003), we take advantage of this staggered XBRL mandate to estimate a firm and year fixed effects model. As explained in more detail in Bertrand and Mullainathan (2003), a firm and year fixed effects model in staggered law implementation settings essentially represents a general case of traditional differences-in-differences (DID) research design.[10] This method is also discussed and recommended in Bertrand et al. (2004) and Roberts and Whited (2012). Empirically, we estimate equation (1) to test Hypothesis 1 as follows:

$$\begin{aligned} Breadth\ of\ Ownership_{t+1} = {} & \beta_0 + \beta_1 XBRL_t + \beta_2 Ln(Firm\ Age)_t + \beta_3 Yearly\ Return_t \\ & + \beta_4 Return\ on\ Assets_t + \beta_5 Ln(MV)_t + \beta_6 1/Share\ Price_t \\ & + \beta_7 Ln(Return\ Volatility)_t + \beta_8 Ln(Turnover)_t \\ & + Firm\ and\ Year\ fixed\ effects + \varepsilon_t. \end{aligned} \quad (1)$$

In equation (1), the dependent variable, *Breadth of Ownership*, is measured by the natural log of the total number of common shareholders in year $t + 1$. The variable of interest is the indicator

8. There are around 200 to 300 non-XBRL adopters in each year after the third phase of XBRL mandate in 2011 (e.g., 313 firms in 2014). There could be two circumstances: First, some firms have not adopted XBRL until now. These firms include currently inactive U.S. firms and international firms. Second, there are some late adopters who were supposed to adopt XBRL on or before 2011, but delayed adoption until 2015 or later. Our findings remain qualitatively identical even when we exclude those non-XBRL adopters.
9. All variables are without natural logarithm transformation.
10. As discussed in Bertrand and Mullainathan (2003), this research design deals effectively with the staggered law implementation (XBRL mandate) setting, and possesses several unique advantages that help to establish causality.

variable, *XBRL*, which takes the value of one if a firm-year is on or after a firm's initial XBRL adoption year, and zero otherwise.[11] To ensure that our results are not driven by other factors related to the breadth of ownership, we include a set of control variables, following previous studies (e.g., Bushee and Noe 2000; Grullon et al. 2004; Bae et al. 2011). Specifically, we include the natural logarithm of market value of equity (*Ln(MV)*) and *Firm Age.* Large firms that have existed for a long time are likely to be better known to investors and, accordingly, to attract a larger investor base. We incorporate *Return Volatility* to control for firm total risk, since investors may avoid high-risk firms. *Yearly Return* and *Return on Assets* are included to control for firm performance. On the one hand, investors are likely to be attracted to firms that are doing well. On the other hand, investors may tend to hold past losers and sell past winners (the "disposition effect"). The reciprocal of share price (*1/Share Price*) is included to control for the fact that small investors are more able to buy stocks with a lower share price (Amihud et al. 1999). In addition, the natural logarithm of share turnover (*Ln(Turnover)*) is included since larger groups of investors may prefer more liquid stocks. As discussed, we include firm and year fixed effects to apply a DID research design in a staggered XBRL mandate setting. The inclusion of firm fixed effects also helps to control for any unobservable firm characteristics that remain relatively constant over time. The inclusion of year fixed effects helps to control for confounding effects of any uncontrolled potential time trend or significant economic events in a specific year. Detailed definitions for all variables are set forth in the Appendix.

Column (1) of Table 2 reports the results of the multivariate regression in equation (1).[12] We find that XBRL adoption is positively associated with one-year-ahead ownership breadth. The estimated coefficient on *XBRL* is 0.080 and is statistically significant at less than the 5 percent level (p-value = 0.023), suggesting that firms have more common shareholders in the post-XBRL period. The coefficient of 0.080 is economically meaningful as well: after a firm adopts XBRL for the SEC filing of its annual report, the number of common shareholders increases by 8.00 percent. Results for the control variables are generally as expected and are consistent with the literature. As shown in column (1) of Table 2, older companies are associated with a larger number of shareholders. Consistent with Grullon et al. (2004), we find that both stock return performance and return on assets are negatively related to the number of shareholders. This finding is consistent with evidence on the "disposition effect," whereby investors (both individuals and professionals) tend to hold past losers and sell past winners (e.g., Kahneman and Tversky 1979; Odean 1998; Locke and Mann 2000). We also find that larger firms, firms with a lower share price, and firms with a higher share turnover tend to have more shareholders.

As a robustness check, in column (2) of Table 2, we further adjust standard errors by two-way clustering on each firm and year. In column (3) of Table 2, we include industry-year fixed effects to difference away unobserved time-varying trends at the industry level. The findings in columns (2) and (3) are quite similar to those reported in column (1). In Table 2, column (4) reports the multivariate regression results when we disaggregate the *XBRL* dummy variable into the three XBRL implementation groups: *Tier 1 XBRL*, *Tier 2 XBRL*, and *Tier 3 XBRL.* We expect that the XBRL effects are stronger for tiers 2 and 3 XBRL firms, but less so for tier 1 XBRL firms, because tier 1 firms are larger and thus more familiar to investors. As well, many of the open-source XBRL intermediaries or other free XBRL tools were not available when tier 1 firms initially adopted XBRL. Thus, tier 1 firms may exhibit less pronounced XBRL impacts than tiers 2 and 3 firms. Consistent with our expectation, column (4) shows that the coefficient on

11. The *XBRL* variable can be viewed as capturing the *Treatment*×*Post* effect in a traditional DID design that includes *Treatment*×*Post*, along with *Treatment* and *Post.* In equation (1), the roles of the *Treatment* and *Post* variables are replaced by the (more general) firm and year fixed effects, respectively.

12. Throughout this article, all reported two-sided p-values (in parentheses) for regression coefficients are based on robust standard errors adjusted for heteroskedasticity (White 1980) and firm clustering (Petersen 2009).

TABLE 2
Impact of XBRL adoption on breadth of ownership (Hypothesis 1)

	Dep Var: *Ln (Number of Shareholders)*			
	(1)	(2)	(3)	(4)
Variables	Firm fixed effects	Two-way clustering	Industry × Year fixed effects	Disaggregate *XBRL* into three adoption groups
XBRL	**0.080****	**0.080****	**0.078****	
	(0.023)	**(0.027)**	**(0.034)**	
Tier 1 XBRL				**0.022***
				(0.059)
Tier 2 XBRL				**0.044****
				(0.032)
Tier 3 XBRL				**0.101*****
				(0.001)
Ln (Firm Age)	0.093***	0.093***	0.091***	0.084***
	(0.000)	(0.000)	(0.000)	(0.000)
Yearly Return	−0.015***	−0.015***	−0.016***	−0.017***
	(0.004)	(0.001)	(0.003)	(0.001)
Return on Assets	−0.024	−0.024*	−0.025	−0.027
	(0.164)	(0.051)	(0.160)	(0.115)
Ln (MV)	0.077***	0.077***	0.078***	0.078***
	(0.000)	(0.000)	(0.000)	(0.000)
1/Share Price	0.058***	0.058***	0.062***	0.060***
	(0.000)	(0.000)	(0.000)	(0.000)
Ln (Return Volatility)	0.007	0.007	0.001	0.005
	(0.530)	(0.526)	(0.893)	(0.666)
Ln (Turnover)	0.021***	0.021***	0.023***	0.022***
	(0.000)	(0.000)	(0.000)	(0.000)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	No	Yes
Industry×Year fixed effects	No	No	Yes	No
Observations	30,890	30,890	30,890	30,890
Adjusted R^2	0.950	0.950	0.950	0.950

Notes: This table examines the relation between XBRL adoption and breadth of ownership. Our sample consists of 30,890 firm-year observations for the period 2005–2014. The variable of interest is the *XBRL* dummy variable in columns (1) to (3). Column (1) presents the main regression results as shown in equation (1). In column (2), the standard errors are adjusted for both firm and year clustering. We include industry-year fixed effects in column (3) to difference away unobserved time-varying trends at the industry level. In column (4), we disaggregate *XBRL* into three implementation groups: *Tier 1 XBRL*, *Tier 2 XBRL*, and *Tier 3 XBRL.* In all four columns, the dependent variables are the natural log of the number of shareholders in year $t + 1$. Except in column (2), two-sided p-values (in parentheses) are calculated based on standard errors adjusted for heteroskedasticity (White 1980) and firm clustering (Petersen 2009). *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Values after XBRL adoption are shown in bold. All variables are defined in the Appendix.

Tier 1 XBRL is positive but only marginally significant (0.022, p-value = 0.059), while the coefficients on *Tier 2 XBRL* and *Tier 3 XBRL* are not only positive and larger in magnitude, but are also much more significant (0.044, p-value = 0.032, 0.101, p-value = 0.001, respectively) compared

TABLE 3
XBRL adoption and breadth of ownership—Different types of investors (Hypothesis 2)

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	*Ln (Number of Institutional Investors)*	*Ln (Number of Institutional Investors (Foreign))*	*Ln (Number of Institutional Investors (Domestic))*	*Percentage of Individual Investor Holdings*	*Percentage of Institutional Investor Holdings (Foreign)*	*Percentage of Institutional Investor Holdings (Domestic)*
XBRL	**−0.003**	**0.091*** **	**−0.033*** **	**0.010*** **	**0.004** **	**−0.014*** **
	(0.413)	**(0.000)**	**(0.001)**	**(0.009)**	**(0.015)**	**(0.007)**
Ln(Firm Age)	0.024	0.032	0.031	−0.016**	−0.004***	0.020***
	(0.570)	(0.252)	(0.434)	(0.018)	(0.006)	(0.003)
Yearly Return	−0.029***	−0.058***	−0.016**	0.004**	−0.003***	−0.001
	(0.000)	(0.000)	(0.032)	(0.029)	(0.000)	(0.439)
Return on Assets	0.138***	0.069**	0.141***	−0.030***	−0.002	0.032***
	(0.000)	(0.013)	(0.000)	(0.000)	(0.245)	(0.000)
Ln(MV)	0.272***	0.407***	0.233***	−0.054***	0.010***	0.044***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
1/Share Price	−0.141***	−0.011	−0.126***	0.016***	−0.001	−0.016***
	(0.000)	(0.525)	(0.000)	(0.000)	(0.425)	(0.000)
Ln(Return Volatility)	0.007	0.038***	−0.003	0.009**	−0.001	−0.008**
	(0.611)	(0.009)	(0.859)	(0.020)	(0.207)	(0.036)
Ln(Turnover)	0.020***	0.045***	0.017**	−0.007***	0.002***	0.006***
	(0.006)	(0.000)	(0.015)	(0.000)	(0.000)	(0.002)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	30,890	30,890	30,890	30,890	30,890	30,890
Adjusted R^2	0.954	0.948	0.955	0.923	0.838	0.919

Notes: This table investigates whether the relation between XBRL adoption and breadth of ownership differs systematically across different types of investors (e.g., institutional investors, non-U.S. foreign vs. U.S. domestic institutional investors), as well as the relation between XBRL adoption and shareholding percentage of individual, non-U.S. foreign, and U.S. domestic institutional investors. Our sample consists of 30,890 firm-year observations for the period 2005–2014. We classify institutional investors as (i) foreign institutional investors that do not domicile in the United States, and (ii) domestic institutional investors that domicile in the United States, In column (1), the dependent variable is the natural log of the number of institutional investors in year $t + 1$. In column (2), the dependent variable is the natural log of the number of foreign institutional investors in year $t + 1$. In column (3), the dependent variable is the natural log of the number of domestic institutional investors in year $t + 1$. In columns (4) through (6), the dependent variables are the shareholding percentage of individual investors, foreign institutional investors, and domestic institutional investors, respectively. Two-sided p-values (in parentheses) are calculated based on standard errors adjusted for heteroskedasticity (White 1980) and firm clustering (Petersen 2009). ** and *** denote significance at the 5 percent and 1 percent levels, respectively. Values after XBRL adoption are shown in bold. All variables are defined in the Appendix.

with those on *Tier 1 XBRL*. Taken together, our results in Table 2 support Hypothesis 1, suggesting that XBRL firms attract more common shareholders and thus have higher breadth of ownership, compared with non-XBRL firms.

Impact of XBRL adoption on different types of investors

This section investigates whether the effect of XBRL adoption on breadth of ownership differs systematically across different types of investors (Hypotheses 2a and 2b). Specifically, we separately examine the impact of XBRL adoption on individual, non-U.S. foreign, and U.S. domestic institutional investors.

We estimate regressions similar to those in equation (1), and present the regression results in Table 3. In column (1), the dependent variable is the natural log of the number of general institutional investors in year $t + 1$, while in columns (2) and (3), the dependent variables are the natural

log of the number of foreign and domestic institutional investors in year $t + 1$, respectively.[13] As shown in column (1), the coefficient on *XBRL* is positive but not significant (−0.003, p-value = 0.413). Combined with the significantly positive coefficient on *XBRL* in column (1) of Table 2, when the number of common shareholders is the dependent variable, the insignificant change in the number of institutional investors from the pre- to the post-XBRL period suggests that the increase in number of shareholders is driven mainly by an increase in individual investors.[14] In column (2), the coefficient on *XBRL* is significantly positive (0.091, p-value = 0.000), implying that the number of foreign institutional investors increases by 9.10 percent after a firm switches to XBRL. Together, these findings indicate that the number of individual investors and foreign institutional investors who invest in stocks of XBRL firms is greater in the post-XBRL period than in the pre-XBRL period. In column (3), we find that the estimated coefficient on *XBRL* is negative and statistically significant (−0.033, p-value = 0.001), suggesting that in the post-XBRL period, XBRL adoption decreases the number of domestic institutional investors who invest in a firm's stock by 3.30 percent.

In columns (1) to (3) of Table 3, we examine the impact of XBRL adoption on the number of various types of investors. The *number* of a particular type of investor is different from the *percentage* of shares held by that type of investor.[15] To further substantiate our conclusions, we also examine the effect of XBRL adoption on the percentage of shares held by various types of investors. Columns (4) to (6) of Table 3 present the results. In column (4), the dependent variable is the percentage of individual investor holdings in year $t + 1$, which is computed as 100 percent minus the percentage of institutional investor holdings. We find that XBRL adoption leads to an increased percentage of individual investor holdings (the coefficient on *XBRL* is 0.010, p-value = 0.009). Given that the average percentage of shareholdings by individual investors is 43.4 percent (as reported in panel C of Table 1), the coefficient of 0.010 represents a 2.30 percent (0.010/0.434) increase in common shares held by retail investors. As shown in columns (5) and (6), we find that XBRL adoption increases the percentage of foreign institutional investor holdings; however, it decreases the percentage of domestic institutional investor holdings.[16] Note that, due to inevitable data limitations in FactSet/LionShares, it is possible that some foreign institutional investments could be classified as retail investments. However, as we are more concerned with comparing changes in share ownership between the less-endowed individual and foreign institutional investors and well-endowed domestic institutional investors, this data limitation should not severely affect our findings and related interpretations.

In summary, consistent with Hypotheses 2a and 2b, we find that XBRL adoption attracts more less-endowed investors (i.e., individual investors and foreign institutional investors), while it decreases share ownership of well-endowed investors (i.e., domestic institutional investors). Our findings are consistent with the premise that, while XBRL adoption decreases information-processing costs for all types of investors, less-endowed investors benefit more from the interactive XBRL filings. Our findings suggest that XBRL adoption provides a level playing field for investors with differing levels of endowments, and support the SEC (2009) claim that XBRL adoption reduces informational barriers that separate small investors from large investors.

13. Firms with no institutional investors are assigned a value of 0 for number of institutional investors; thus, we use the natural log transformation of 1 plus the number of general institutional investors, as well as foreign and domestic institutional investors.
14. Grullon et al. (2004) use the same approach to draw inferences on individual investors, based on their results with common shareholders and institutional investors.
15. The total number of shareholders could be unlimited, which allows us to investigate the effect of XBRL adoption on the total number of common shareholders.
16. If we add the percentage of shares held by different types of investors (individual, foreign institutional, and domestic institutional investors), it always equals 100 percent. As such, the sum of the three coefficients in a row, one from each of columns (4), (5), and (6), would be zero.

Impact of XBRL adoption on breadth of ownership—Conditional on information-processing costs

To test whether the effect of XBRL on the asymmetric shift in share ownership is mainly due to reduced information-processing costs brought about by the XBRL mandate (Hypotheses 3a and 3b), we explore several cross-sectional settings where information-processing costs vary across firms. Specifically, we estimate equation (2):

$$\begin{aligned} &\textit{Breadth of Ownership}_{t+1} \textit{ or Percentage of Shareholdings}_{t+1} = \beta_0 + \beta_1 XBRL_t \\ &\quad + \beta_2 XBRL_t \times \textit{Complexity Measure}_t + \beta_3 \textit{Complexity Measure}_t \\ &\quad + \beta_4 Ln(\textit{Firm Age})_t + \beta_5 \textit{Yearly Return}_t + \beta_6 \textit{Return on Assets}_t + \beta_7 Ln(MV)_t \\ &\quad + \beta_8 1/\textit{Share Price}_t + \beta_9 Ln(\textit{Return Volatility})_t + \beta_{10} Ln(\textit{Turnover})_t \\ &\quad + \textit{Firm and Year fixed effects} + \varepsilon_t. \end{aligned} \tag{2}$$

In equation (2), the dependent variables and the control variables are the same as in Tables 2 and 3. We add to equation (2) an interaction term between *XBRL* and *Complexity Measure* (in addition to *XBRL* and *Complexity Measure*). *Complexity Measure* is intended to capture cross-firm differences in information-processing costs. We expect the XBRL effect to be more pronounced for firms for which information is inherently more costly to process. Therefore, when examining individual or foreign institutional investors (domestic institutional investors), Hypothesis 3a (Hypothesis 3b) translates into a positive (negative) value of β_2 in equation (2).

Following Cohen and Lou (2012), Blankespoor (2014), and Chen et al. (2018), we employ the following two measures to proxy for firm complexity: (1) the number of business segments that a firm has in different 3-digit SIC industry groups (*#Segments*); and (2) *Analyst Dispersion*, which is the standard deviation of analyst earnings forecasts, scaled by the mean analyst forecast. Additionally, as the third complexity measure, we employ the number of non-tabulated quantitative details scaled by the number of words in a firm's 10-K report (*#Numbers/#Words*).[17] If a greater number of quantitative details are not reported in table format, it is likely that the firm is trying to bury the key numbers within uninformative quantitative details, which greatly increases the costs of processing the firm's 10-K. Thus, the larger the value of our three complexity measures, the higher the information-processing costs to investors.

Panel A of Table 4 presents the regression results for testing Hypotheses 3a and 3b. Panel A1 of Table 4 presents the cross-sectional analysis when we use *#Segments* to measure firm information-processing costs. We find that the coefficient estimates on *XBRL×#Segments* are significantly positive in columns (1) and (2) (0.016, p-value = 0.032; 0.014, p-value = 0.027, respectively) and significantly negative in column (3) (−0.013, p-value = 0.031). These findings suggest that the positive (negative) effect of XBRL adoption on the number of common shareholders and foreign institutional investors (domestic institutional investors) is stronger for firms with higher information-processing costs. In columns (4) to (6), the dependent variables are the shareholding percentage of individual, foreign, and domestic institutional investors, respectively. The results and their interpretations are quite similar to those in columns (1) to (3). In panel A2 (panel A3) of Table 4, we interact *XBRL* with *Analyst Dispersion* (*#Numbers/#Words*). Although the significance levels differ, the regression results are very similar to those reported in panel A1 of Table 4. For brevity, we do not repeat detailed discussions about empirical results here. In summary, our findings in the cross-sectional tests support Hypotheses 3a and 3b, suggesting that the XBRL mandate shifts ownership breadth asymmetrically by reducing information-processing costs.

17. We use Perl to count the numbers and words in firms' 10-K filings, excluding the MD&A section. Please see supporting information, "Appendix S1: Perl parsing of SEC filings and counting of numbers and words," as an addition to the online article.

TABLE 4
Impact of XBRL adoption on breadth of ownership—Conditional on information-processing costs (Hypothesis 3)

Variables	(1) *Ln (Number of Shareholders)*	(2) *Ln (Number of Institutional Investors (Foreign))*	(3) *Ln (Number of Institutional Investors (Domestic))*	(4) *Percentage of Individual Investor Holdings*	(5) *Percentage of Institutional Investor Holdings (Foreign)*	(6) *Percentage of Institutional Investor Holdings (Domestic)*
Panel A: Impact of XBRL adoption on breadth of ownership—Conditional on information-processing costs						
Panel A1: Number of business segments as firm complexity measure (N = 30,890)						
XBRL×#Segments	0.016**	0.014**	−0.013**	0.003*	0.002***	−0.005**
	(0.032)	(0.027)	(0.031)	(0.065)	(0.006)	(0.029)
Panel A2: Analyst forecast dispersion as firm complexity measure (N = 21,563)						
XBRL×Analyst Dispersion	0.073**	0.123**	−0.107**	0.006**	0.010**	−0.016**
	(0.019)	(0.031)	(0.048)	(0.031)	(0.027)	(0.047)
Panel A3: Number of quantitative details as firm complexity measure (N = 30,890)						
XBRL×(#Numbers/#Words)	0.512**	0.564***	−0.393**	0.344**	0.044**	−0.388*
	(0.024)	(0.005)	(0.036)	(0.029)	(0.031)	(0.051)
Panel B: Impact of XBRL adoption on breadth of ownership—Conditional on official XBRL tags ratio (N = 30,890)						
XBRL×(#Official XBRL Tags/#XBRL Tags)	0.042**	0.009**	−0.020*	0.006**	0.004***	−0.010**
	(0.029)	(0.046)	(0.056)	(0.026)	(0.003)	(0.032)

Notes: Panel A of this table examines whether the impact of XBRL adoption on breadth of ownership varies with firms' information-processing costs (Hypothesis 3). In panel A1, we use *#Segments* as the firm complexity measure. In panel A2, we use *Analyst Dispersion* as the firm complexity measure. We lose some observations because we require non-missing *Analyst Dispersion* data. In panel A3, we use *#Numbers/#Words* as the firm complexity measure. The higher the value of the above three measures, the higher the complexity of firm filings and the higher the information-processing costs. Panel B of this table investigates whether the impact of XBRL adoption on breadth of ownership varies with the ratio of official XBRL tags in the XBRL reports. *#Official XBRL Tags /#XBRL Tags* is the number of standardized official XBRL tags divided by the total number of XBRL tags in a XBRL report, and it measures the "reliability" or "informativeness" of XBRL adoption. In all panels, we include the same control variables as in Tables 2 and 3, but for the sake of brevity results for the control variables are not reported. Two-sided p-values (in parentheses) are calculated based on standard errors adjusted for heteroskedasticity (White 1980) and firm clustering (Petersen 2009). *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Variables are defined in the Appendix.

In panel B of Table 4, we extend the cross-sectional analysis by examining whether the relationship between the XBRL mandate and ownership breadth varies with the degree of standardized official elements in an agreed-upon taxonomy in the XBRL reports. Plumlee and Plumlee (2008) argue that investors may demand some level of assurance and compliance on the XBRL "tagging" process, because of concerns about the potential material misstatements in that tagging process. Du et al. (2013) find that the number of errors in XBRL reporting decreases substantially for multiple XBRL filers. We extend previous XBRL studies by adopting a measure that potentially captures the "reliability" or "informativeness" of XBRL implementation, that is, the ratio of standardized official XBRL tags over the total number of XBRL tags in an XBRL filing (*#Official XBRL Tags/#XBRL Tags*), following previous XBRL literature (Boritz and No 2009; Debreceny et al. 2010; Kim et al. 2013; Hoitash and Hoitash 2018). We replace the *Complexity Measure* variable in equation (2) with the official tag ratio measure, and report the regression results in panel B of Table 4. Findings reveal that the coefficient estimates on the interaction term *XBRL×(#Official XBRL Tags/#XBRL Tags)* are significantly positive in columns (1), (2), (4), and (5), while they are significantly negative in columns (3) and (6), suggesting that the impacts of XBRL adoption on ownership breadth are more pronounced when the XBRL filings contain more standardized official XBRL tags. These findings are consistent with Plumlee and Plumlee (2008), who posit that XBRL filings are more reliable and useful when there are fewer misstatements in the tagging process.

Impact of XBRL adoption on information asymmetry

Following Yoon et al. (2011), Li et al. (2013), and Blankespoor, B.P. Miller et al. (2014), in this subsection we investigate the direct impact of the XBRL mandate on a firm's information quality. Amihud et al. (1999) and Grullon et al. (2004) suggest that a broader ownership structure is associated with higher stock liquidity (i.e., lower information asymmetry). In Table 2, we find that the XBRL mandate is positively related to the overall investor base, suggesting that XBRL adoption could potentially reduce information asymmetry. However, Table 3 also shows that XBRL adoption changes the mix of sophisticated and unsophisticated investors, suggesting that the net effect of XBRL adoption on information quality could be mixed. To examine the impact of the XBRL mandate on the information environment in our setting, we estimate a regression model similar to equation (1) by replacing the dependent variable with the widely adopted information asymmetry measure: the bid-ask spread.[18] The empirical results are tabulated in Appendix S2.[19] We find that the coefficient estimate on *XBRL* is negative and marginally significant (−0.092, p-value = 0.072), suggesting that XBRL adoption is generally associated with a reduction in information asymmetry, although the effect is only marginally significant.

5. Additional tests

We recognize concerns about potential endogeneity in establishing the causal relation between information-processing costs and breadth of ownership. For this reason, in our main model we take advantage of the staggered XBRL implementation to estimate a firm and year fixed effects model in equation (1), which essentially represents a general case of DID research design. As discussed in more detail in Bertrand and Mullainathan (2003), this research design possesses several unique advantages and can greatly alleviate endogeneity concerns. However, we cannot completely rule out the possibility that our results suffer from endogeneity. In this section, we run a variety of expanded analyses and robustness tests to further mitigate potential problems of reverse causality or correlated omitted variables.

18. An alternative measure for information asymmetry is the Amihud (2002) illiquidity measure (AIM). Regression results on this alternative measure are very similar to findings on the bid-ask spread measure.

19. Please see supporting information, "Appendix S2: Impact of XBRL adoption on information asymmetry," as an addition to the online article.

Dynamic effects of XBRL adoption on breadth of ownership

We first follow Bertrand and Mullainathan (2003) to examine the dynamic effects of XBRL adoption on breadth of ownership. Specifically, we replace *XBRL* with three year indicators, $Year_{t-1}$, $Year_t$, and $Year_{t+n}$, to denote the relative years around initial XBRL adoption. $Year_{t-1}$ is a dummy variable that equals one for observations in the one-year period prior to the initial adoption year, and zero otherwise; $Year_t$ is a dummy variable that equals one for observations in the initial adoption year, and zero otherwise; and $Year_{t+n}$ is a dummy variable that equals one for observations one or more years subsequent to the initial adoption year, and zero otherwise. The dummy variable $Year_{t-1}$ allows us to assess whether any ownership effect may be found prior to initial XBRL adoption, while dummy variables $Year_t$ and $Year_{t+n}$ allow us to capture the XBRL effect in the adoption year and in subsequent years, respectively.

Table 5 presents the results of the dynamic effects of XBRL adoption. We find that the signs of the coefficients are as expected and the same as documented earlier, in that the sign and significance of the coefficient on $Year_t$ are similar to those of the coefficient on XBRL in Table 3. Moreover, we find that the coefficients on $Year_{t-1}$ are statistically insignificant, suggesting that there is no effect of XBRL adoption on breadth of ownership prior to the XBRL mandate. Further, we find that the coefficients on $Year_t$ and $Year_{t+n}$ are both significant, indicating that, beginning from the XBRL adoption year, there is a significant effect of the XBRL mandate on breadth of ownership. The fact that the coefficients on $Year_t$ and $Year_{t+n}$ are both significant suggests that the effect of XBRL adoption on investor share ownership is long lasting, for at least two years.

Investor type-level analysis

In this subsection, we examine changes in ownership structure at the level of investor type. Our analysis focuses on one specific type of investors: namely, the less-endowed foreign institutional investors. Specifically, we investigate how these investors' investments in the U.S. stock market evolve over time surrounding the XBRL adoption year.[20]

First, we investigate the average number of firms and percentage of shares in a firm held by a foreign institutional investor in each year of our sample period of 2005–2014. Empirical results are tabulated in panel A of Table 6. We find that, starting from the initial XBRL mandate year (2009), the average number of firms held by a foreign institutional investor rises gradually. For example, on average, a foreign institutional investor invests in 89 and 88 U.S. firms in 2005 and 2008, respectively, while the numbers increase to 93 in 2010 and 104 in 2014 (after the XBRL mandate). The percentage of firms in the entire U.S. stock market over our sample period that are held by a foreign institutional investor also presents a similar increasing trend. Panel A of Table 6 shows that the average percentage of shares in a firm held by a foreign institutional investor remains relatively stable across the sample period.

In panel B of Table 6, we partition the sample firms into tiers 1, 2, and 3 XBRL adoption groups, and for each tier of firms we tabulate the time-series summary statistics on the average number of firms held by a foreign institutional investor. Consistent with our main findings in Tables 2 and 3, we find that the average number of tier 1 firms held by a foreign institutional investor starts to rise progressively from 2009, while the average number of tier 2 (tier 3) firms held by a foreign institutional investor starts to increase gradually from 2010 (2011). Panel B of Table 6 also provides a number of interesting insights. For example, the average number of tier 2 (tier 3) firms held by a foreign institutional investor is 24.2 (9.7) in 2008, while the number is 24.6 (11.1) in 2009, which is the initial year of the tier 1 XBRL mandate. These findings suggest that when foreign institutional investors increase total investment in tier 1 XBRL adopters in 2009 (48.0, compared to 45.9 in 2008), they do not reduce their investments in tiers 2 and 3 firms

20. Though not tabulated for brevity, we also find that when we alternatively focus on individual investors, the empirical results and related interpretations are very similar.

TABLE 5
Dynamic effects of XBRL adoption on breadth of ownership

Variables	(1) *Ln (Number of Shareholders)*	(2) *Ln (Number of Institutional Investors (Foreign))*	(3) *Ln (Number of Institutional Investors (Domestic))*	(4) *Percentage of Individual Investor Holdings*	(5) *Percentage of Institutional Investor Holdings (Foreign)*	(6) *Percentage of Institutional Investor Holdings (Domestic)*
$Year_{t-1}$	**0.024**	**0.037**	**0.001**	**−0.004**	**0.001**	**0.003**
	(0.290)	**(0.434)**	**(0.985)**	**(0.371)**	**(0.686)**	**(0.790)**
$Year_t$	**0.071****	**0.102*****	**−0.035*****	**0.009****	**0.005****	**−0.014****
	(0.018)	**(0.005)**	**(0.002)**	**(0.041)**	**(0.036)**	**(0.043)**
$Year_{t+n}$	**0.091*****	**0.121*****	**−0.048*****	**0.015****	**0.008*****	**−0.023*****
	(0.001)	**(0.000)**	**(0.006)**	**(0.045)**	**(0.000)**	**(0.005)**
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	30,890	30,890	30,890	30,890	30,890	30,890
Adjusted R^2	0.950	0.948	0.955	0.924	0.838	0.919

Notes: This table examines the dynamic effects of XBRL adoption on breadth of ownership and shareholding percentage, following Bertrand and Mullainathan (2003). Specifically, we replace *XBRL* with three year indicators: $Year_{t-1}$, $Year_t$, and $Year_{t+n}$ to denote the relative years around initial XBRL adoption. $Year_{t-1}$ is a dummy variable that equals one for observations in the one-year period prior to the initial adoption year, and zero otherwise; $Year_t$ is a dummy variable that equals one if a firm adopts XBRL in the current year, and zero otherwise; $Year_{t+n}$ is a dummy variable that equals one for observations one or more years subsequent to the initial adoption year, and zero otherwise. The dummy variable $Year_{t-1}$ allows us to assess whether any ownership effect may be found prior to initial XBRL adoption, while dummy variables $Year_t$ and $Year_{t+n}$ allow us to capture the XBRL effect in the adoption year and one or more years later, respectively. Our sample consists of 30,890 firm-year observations for the period 2005–2014. We include the same control variables as in Tables 2 and 3, but for the sake of brevity results for the control variables are not reported. Two-sided *p*-values (in parentheses) are calculated based on standard errors adjusted for heteroskedasticity (White 1980) and firm clustering (Petersen 2009). ** and *** denote significance at the 5 percent and 1 percent levels, respectively. Values after XBRL adoption are shown in bold. Variables are defined in the Appendix.

TABLE 6
Investor type-level analysis—Changes in the size of the portfolio or rebalancing?

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Panel A: Time-series share ownership of foreign institutional investors										
Average number of firms held by a foreign institutional investor	89.0	90.9	88.8	88.0	**92.0**	**93.0**	**95.0**	**97.7**	**100.2**	**104.3**
Percentage of firms in the entire market held by foreign institutional investors (in %)	2.68	2.89	2.83	2.70	**2.98**	**3.05**	**3.19**	**3.35**	**3.40**	**3.40**
Average percentage of shares in a firm held by foreign institutional investors (in %)	0.127	0.133	0.136	0.133	0.132	0.134	0.133	0.133	0.135	0.132
Panel B: Changes in the size of portfolio or rebalancing across XBRL adopters and non-XBRL adopters										
Average number of tier 1 firms held by a foreign institutional investor	45.2	45.7	45.0	45.9	**48.0**	**48.8**	**48.9**	**48.6**	**49.3**	**49.5**
Average number of tier 2 firms held by a foreign institutional investor	21.2	22.4	22.0	24.2	24.6	**27.6**	**28.5**	**28.8**	**30.0**	**30.7**
Average number of tier 3 firms held by a foreign institutional investor	8.9	9.0	9.3	9.7	11.1	11.0	**14.7**	**16.3**	**15.5**	**17.1**

Notes: This table focuses on one specific type of less-endowed investor and examines how XBRL adoption impacts the investment allocation of foreign institutional investors. Panel A presents the time-series share ownership of foreign institutional investors in our sample period of 2005–2014. In panel B, we partition the sample firms into three XBRL adoption tiers and tabulate the average number of each tier of firms held by a foreign institutional investor in each year of our sample period. Values after XBRL adoption are shown in bold.

in 2009 to build up their position in tier 1. Taken together, the results in Table 6 suggest that our main findings in Tables 2 and 3 represent more of a change in the size of portfolio for each group of investors, rather than a rebalancing between XBRL adopters and non-adopters (i.e., changes in the control group).

Cross-sectional and time-series falsification tests

We employ several falsification tests to further alleviate concerns that our results may be driven by differences in firm size between XBRL and non-XBRL firms or by unobservable time trends in share ownership.

First, the XBRL mandate is staggered by firm size; larger firms are required to adopt XBRL earlier. To alleviate the concern that our findings are attributable to the differences of firm size between XBRL and non-XBRL firms, we adopt two *cross-sectional* falsification tests. We begin by restricting our sample to XBRL adopters, and we examine the differences in share ownership between large XBRL firms and small XBRL firms. We identify large XBRL firms (above median market float) as the treatment sample and small XBRL firms (below median market float) as the control sample, and rerun all our main tests. As shown in panel A of Appendix S3, we find that there is no significant (within-group) difference in share ownership between large and small XBRL firms.[21] Similarly, in panel B of Appendix S3, we restrict our sample to non-XBRL adopters, and examine the differences in share ownership between large and small non-XBRL firms. Again, we found insignificant coefficient estimates across all six columns.

Second, to alleviate the concern that our results may be driven by unobservable time trends in share ownership, we employ two *time-series* falsification tests. As the first test, we create a placebo XBRL adoption year that is three years prior to the actual XBRL adoption year for each of the phase-in groups. That is, the pseudo-XBRL adoption year is 2006 for tier 1 XBRL adopters, 2007 for tier 2 XBRL adopters, and 2008 for tier 3 XBRL adopters. We rerun all our main tests using the indicator variable *Pseudo-XBRL* in the period 2005–2009. Regression results in panel C of Appendix S3 indicate that there is no confounding effect of time trend in share ownership coinciding with the XBRL impact prior to the XBRL adoption. Similarly, as the second *time-series* falsification test, we create a placebo XBRL adoption year that is two years after the actual XBRL adoption year for each of the phase-in groups. We restrict our sample to the period 2010–2014, and re-estimate our main tests using the *Pseudo-XBRL* indicator variable. The findings in panel D of Appendix S3 suggest that there is no time trend in share ownership after XBRL adoption that would possibly explain our main findings in Tables 2 and 3.

Robustness tests

We perform several additional robustness tests to improve the validity of our findings. The empirical results are briefly summarized in Table 7.

First, we adopt an explicit DID research design with two periods (pre-XBRL versus post-XBRL periods) and two groups (treatment versus control groups) by taking advantage of different XBRL phase-in periods.[22] Because tier 1 and tier 2 firms adopt XBRL in different years, we implement the explicit DID design for tier 1 and tier 2 firms separately. In panel A1 of Table 7, the treatment group consists of tier 1 XBRL adopters, while the control group is composed of tier 2 XBRL adopters. We find that the coefficients on *Treatment* × *Post* are generally insignificant,

21. Please see supporting information, "Appendix S3: Falsification tests" as an addition to the online article.

22. This method clearly defines the treatment and control groups, and it shortens the time periods around the XBRL adoption. However, several shortcomings prevent us from adopting this explicit DID research design as our main model. The first is that explicit DID design applies to tier 1 and tier 2 XBRL adopters only. Tier 3 XBRL adopters, more than half of our sample firms, cannot be examined because they have no control firms in the explicit DID research design. The second is that explicit DID design captures effects in the first adoption year, but it does not take into account XBRL effects in years subsequent to the initial adoption year, even though the subsequent effects are strong, as shown in our dynamic model.

TABLE 7
Robustness tests

Variables	(1) *Ln (Number of Shareholders)*	(2) *Ln (Number of Institutional Investors (Foreign))*	(3) *Ln (Number of Institutional Investors (Domestic))*	(4) *Percentage of Individual Investor Holdings*	(5) *Percentage of Institutional Investor Holdings (Foreign)*	(6) *Percentage of Institutional Investor Holdings (Domestic)*
Panel A1: Explicit DID research design—Treatment group: Tier 1 XBRL adopters; Control group: Tier 2 XBRL adopters (sample period: 2008–2009; N = 2,059)						
Treatment×Post	0.008	0.015	−0.016	0.004	0.006***	−0.009*
	(0.440)	(0.732)	(0.148)	(0.434)	(0.004)	(0.054)
Panel A2: Explicit DID research design—Treatment group: Tier 2 XBRL adopters; Control group: Tier 3 XBRL adopters (sample period: 2009–2010; N = 4,238)						
Treatment×Post	0.037**	0.040**	−0.025*	0.012***	0.003**	−0.015***
	(0.035)	(0.037)	(0.051)	(0.001)	(0.017)	(0.001)
Panel B: Change specification (N = 25,700)						
ΔXBRL	0.031**	0.026**	−0.022**	0.017*	0.001**	−0.018*
	(0.044)	(0.017)	(0.012)	(0.081)	(0.046)	(0.079)
Panel C1: RDD—Tier 1 XBRL adopters (sample period: 2009; N = 557)						
XBRL	0.057	0.240*	−0.204	0.030	0.014**	−0.044**
	(0.537)	(0.060)	(0.152)	(0.261)	(0.033)	(0.040)
Panel C2: RDD—Tier 2 XBRL adopters (sample period: 2010; N = 744)						
XBRL	0.017**	0.250***	−0.151**	0.051**	0.002	−0.053**
	(0.041)	(0.007)	(0.016)	(0.031)	(0.164)	(0.033)

Notes: This table reports results of various robustness tests. Panels A1 and A2 report explicit differences-in-differences research design results for the impact of XBRL adoption on breadth of ownership and shareholding percentage. Panel B employs an alternative change specification. The dependent variables are changes in ownership breadth (shareholding percentage), as measured by change in ownership breadth (shareholding percentage) measures from year t to year $t + 1$. The variable of interest is the difference in XBRL across two consecutive years (*ΔXBRL*), which takes the value of one for the initial XBRL adoption year, and zero for all remaining sample years. Panels C1 and C2 report results using a regression discontinuity design (RDD) that compares the XBRL effect for firms that are just above and just below the XBRL mandate public float cutoffs ($5 billion for tier 1 adopters and $700 million for tier 2 adopters). All tests include the same control variables as in Tables 2 and 3 (except for the change analyses in panel B, where the control variables are calculated as changes from year t to year $t + 1$), but for the sake of brevity results for the control variables are not reported. Two-sided p-values (in parentheses) are calculated based on standard errors adjusted for heteroskedasticity (White 1980) and firm clustering (Petersen 2009). *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Variables are defined in the Appendix.

except in columns (5) and (6), suggesting that there are generally no XBRL effects on ownership breadth for tier 1 firms in the first adoption year. Combined with the only marginally significant coefficient on *Tier 1 XBRL* in column (4) of Table 2, this finding indicates that the effect of tier 1 XBRL adoption on breadth of ownership rises only in years subsequent to the initial adoption year, but does not emerge immediately in the initial adoption year. The insignificant results for tier 1 firms could be due to there being few XBRL tools available when they initially adopt XBRL in 2009. This finding helps to reconcile our findings with those of Blankespoor, B.P. Miller et al. (2014), who conclude that XBRL might not reduce information asymmetries during the initial year for tier 1 XBRL adopters. Similarly, panel A2 of Table 7 identifies tier 2 firms as the treatment group and tier 3 firms as the control group. We find that the coefficients on *Treatment×Post* are generally significant and the signs of the coefficients are as expected, suggesting that the effects of tier 2 XBRL adoption begin to rise following their first adoption year.

Second, in panel B of Table 7, we implement a change specification in which *ΔXBRL*, which represents the difference in XBRL over two consecutive years, is an indicator variable that equals one for the initial XBRL adoption year, and zero for all remaining years. This change specification captures the initial-year XBRL adoption effects. As shown in panel B, the empirical findings are generally consistent with the main findings in Tables 2 and 3.

Third, following Chava and Roberts (2008), Iliev (2010), and Tan (2013), we adopt a Regression Discontinuity Design (RDD) that compares the XBRL effect for firms that are just above and just below the XBRL mandate public float cutoffs ($5 billion for tier 1 adopters, and $700 million for tier 2 adopters).[23] Similar to the findings for the explicit DID design, panel C1 of Table 7 shows that the XBRL effect is quite weak in the first adoption year for tier 1 firms. Comparatively, panel C2 of Table 7 shows that for tier 2 firms the XBRL effect begins to emerge in the first adoption year.[24] Again, the weak results for tier 1 firms could be a result of the limited number of XBRL tools available in the early years.

6. Conclusion

We investigate whether information-processing costs affect investor decisions to include a firm's stock in their investment portfolios, as well as which type of investors benefit more from reduced information-processing costs. To that end, we use the recent XBRL mandate as a natural experiment to capture the reduction of the unobservable information-processing cost. We find that XBRL mandate is associated with an increase in the total number of a firm's shareholders. In addition, we discover that XBRL adoption is associated with an increase (decrease) in share ownership of individual and non-U.S. foreign institutional investors (U.S. domestic institutional investors). Further evidence demonstrates that the XBRL effect is more pronounced for firms with inherently greater information-processing costs and for firms adopting more standardized XBRL tags, which implies that the asymmetric shift in share ownership is prompted by decreased information-processing costs induced by XBRL. The XBRL mandate also reduces information asymmetry (as measured by bid-ask spread). A detailed investor type-level analysis reveals that the impact of reduced information-processing costs on ownership breadth mainly represents more of a change in the size

23. Similar to the explicit DID research design, RDD does not apply to tier 3 XBRL adopters, given that almost all firms switched to XBRL in the third phase-in period. What is more, RDD captures only the effects in the first adoption year, and entirely neglects XBRL effects in years subsequent to the initial adoption year, even though the subsequent effects are strong, as shown in our dynamic model.

24. In constructing the sample observations for RDD analysis, we try to ensure that we have a reasonably large number of observations and, at the same time, that we maintain a balanced sample above and below the public float cutoffs, with reasonably similar firm characteristics. In so doing, for tier 1 XBRL adoption analysis we define the treatment XBRL firms as those with a public float between $5 billion and $20 billion, and the control non-XBRL firms as those with a public float within the range of $1 billion and $5 billion. For tier 2 XBRL adoption analysis, we identify XBRL firms with a public float between $700 million and $2 billion as the treatment group, and non-XBRL firms with a public float between $200 million and $700 million as the control group.

of portfolio for each type of investor, rather than a rebalancing between XBRL adopters and non-adopters.

Our empirical finding that the XBRL mandate is positively related to the breadth of firm share ownership is consistent with the SECs claim that XBRL adoption decreases information-processing costs, thereby facilitating investment decisions with respect to a firm's equity stock. Moreover, our findings of the asymmetric shift in share ownership suggest that XBRL adoption benefits less-endowed investors to a greater extent than well-endowed investors. It is worth noting that several explanations could be related to the decrease in domestic institutional investor ownership, and future research can further explore those possibilities. For example, the XBRL mandate coincides largely with the 2008 financial crisis, and domestic institutional ownership may decrease due to the crisis. It is also possible that domestic institutional investors shift their investments to non-XBRL adoption countries or simply leave the U.S. stock market.

In conclusion, our study provides early evidence in support of the SEC's assertion that by decreasing the information disadvantages for less sophisticated investors, a reduction in information-processing costs facilitates establishment of a level playing field for market participants with differing endowments. To our knowledge, our study is one of only a few to examine the SEC's claim that a saving in information-processing costs caused by XBRL adoption reduces the informational barriers that separate small investors from large investors (SEC 2009). Given the scarcity of evidence, we recommend further research in this direction.

Appendix
Variable definitions

Variable	Definition
Dependent variables	
Ln (Number of Shareholders)	Natural log of the number of common shareholders; a breadth of ownership measure (COMPUSTAT)
Ln (Number of Institutional Investors)	Natural log of 1 plus the number of institutional investors; a breadth of ownership measure (FactSet/LionShares)
Ln (Number of Institutional Investors (Foreign))	Natural log of 1 plus the number of non-U.S. foreign institutional investors; a breadth of ownership measure (FactSet/LionShares)
Ln (Number of Institutional Investors (Domestic))	Natural log of 1 plus the number of U.S. domestic institutional investors; a breadth of ownership measure (FactSet/LionShares)
Percentage of Individual Investor Holdings	1 – shareholding percentage of institutional investors (FactSet/LionShares)
Percentage of Institutional Investor Holdings (Foreign)	Shareholding percentage of non-U.S. foreign institutional investors (FactSet/LionShares)
Percentage of Institutional Investor Holdings (Domestic)	Shareholding percentage of U.S. domestic institutional investors (FactSet/LionShares)
Variable of interest	
XBRL	One if a firm adopts XBRL in preparing its financial statement, and zero otherwise (EDGAR)
Control variables	
Ln (Firm Age)	Natural log of the number of years the firm has existed on the CRSP database (CRSP)
Yearly Return	Yearly buy and hold return adjusted by value-weighted market index return (CRSP)
Return on Assets	Operating income before depreciation scaled by total assets (COMPUSTAT)
Ln (MV)	Natural log of the number of shares outstanding multiplied by the share price (COMPUSTAT)
1/Share Price	Reciprocal of year-end share price (COMPUSTAT)

(The Appendix is continued on the next page.)

Appendix (continued)

Variable	Definition
Ln (Return Volatility)	Natural log of the standard deviation of daily returns over the year (CRSP)
Ln (Turnover)	Natural log of the annual average of monthly trading volume divided by shares outstanding (CRSP)
Other variables	
#Segments	The number of business segments that a firm has in different three-digit SIC industries (COMPUSTAT)
Analyst Dispersion	The standard deviation of analyst earnings forecasts, scaled by mean analyst estimate (I/B/E/S)
#Numbers/#Words	The number of quantitative details not presented in tables, scaled by number of words in firm 10-K reports (excluding the MD&A section)

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article.

Appendix S1: Perl parsing of SEC filings and counting of numbers and words

Appendix S2: Impact of XBRL adoption on information asymmetry

Appendix S3: Falsification tests