Gender and Mutual Fund Liquidity

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We examine whether US mutual funds managed by females have a higher portfolio liquidity than those of their male counterparts. Single female managers' holdings are 8–25% more liquid than those of single-male-managed funds. When there is a transition from a male to a female manager, fund holdings liquidity increases compared with a male to male transition. The findings are consistent with the risk-averse and conservative decision-making behaviour of female managers. We do not find evidence to support the excessive trading hypothesis that predicts a higher portfolio liquidity for overconfident male fund managers. Our findings add to growing evidence that gender affects professionals' investment choices.

Introduction

We examine the role of the gender of fund managers in designing portfolio liquidity. Various studies have analysed the investment behaviours and performance of mutual fund managers based on their gender (Atkinson, Baird and Frye, 2003; Beckmann and Menkhoff, 2008; Niessen-Ruenzi and Ruenzi, 2019). However, the preferences of male and female fund managers for portfolio holdings remain mostly unknown. We focus on liquidity, as it is one of the preferred stock characteristics for portfolio holdings (Falkenstein, 1996; Gompers and Metrick, 2001; Pinnuck, 2004). Fund managers have to manage withdrawals, so they prefer to hold liquid stocks, a strategy that enables them to rotate portfolios rapidly (Chan and Lakonishok, 1995; Gompers and Metrick, 2001).

Mutual funds have liquid securities to build a safety cushion to manage liquidity risk in the event of a crisis. When fund managers face redemptions, they sell their liquid stocks first in order to accommodate withdrawals quickly and at a lower cost (Scholes, 2000; Clarke, Cullen and Gasbarro, 2007). In contrast, some studies argue that market volatility and fund withdrawals encourage fund managers to sell their illiquid stocks first in order to preserve fund liquidity (Vayanos, 2004; Ben-Rephael, 2017). Furthermore, holding highly liquid stocks in a portfolio minimizes implicit transaction costs (Falkenstein, 1996). Given the importance of the liquidity of portfolio holdings, it is intriguing to enquire whether the gender of fund managers plays a crucial role in asset allocation decisions.

We identify gender as the factor that explains discrepancies in managers' liquidity preferences. Mutual fund managers have comparable financial expertise and knowledge; hence, mutual fund management provides an enticing research setting in

[Correction added on 9 May 2023, after first online publication: Corresponding author details has been updated in this version.]

which to test whether gender affects professionals' investment choices. Barber *et al.* (2017) show that female fund managers are less likely to be promoted and have shorter tenures than male fund managers. They also find no significant difference between the performance of male and female fund managers, in terms of both returns and fund flows. Risk-averse and conservative decision-making behaviours are commonly associated with females, whereas overconfident behaviour impacts the investment decisions of males more than those of females. Female executives tend to reduce firms' leverage; hence, firms with higher risks are more likely to appoint a female CEO to reduce their riskiness (Martin, Nishikawa and Williams, 2009; Faccio, Marchica and Mura, 2016; Falconieri and Akter, 2023). Similar to executive directors, firms with a higher proportion of female directors in a board have lower risks (De Cabo, Gimeno and Nieto, 2012). Usman *et al.* (2021) show that female directors engage in efficient but not opportunistic related party transaction (RPTs); hence, their decisions are often more ethical and risk-averse. The mutual fund literature provides empirical evidence that female fund managers are more likely to avoid risky investments than are male managers (Beckmann and Menkhoff, 2008; Niessen-Ruenzi and Ruenzi, 2019). As a result, to fulfill liquidity needs promptly and with minimum cost during redemption, female managers are likely to hold more liquid stocks in their portfolio than are male managers. Stock liquidity decreases their default risks, as proposed by liquidity theory (Brogaard, Li and Xia, 2017). Therefore, we expect that female fund managers will exhibit a higher preference for portfolio liquidity than will male managers.

Besides risk-averse behaviour, one of the preferred corporate choices of female professionals related to stock liquidity is their temptation towards price-efficient stocks. The inclusion of female directors on corporate boards increases stock price informativeness and reduces information asymmetry (Gul, Srinidhi and Ng, 2011; Abad *et al.*, 2017). The preference of female fund managers for informationally efficient stocks leads to higher portfolio liquidity. Informationally transparent firms have lower transaction costs and higher liquidity (Berger *et al.*, 2020; Lang, Lins and Maffett, 2012). Consequently, compared with male fund managers, female managers prefer liquid stocks reflect prompt information.

In contrast, male professionals are more overconfident in their decisions than their female counterparts (Huang and Kisgen, 2013; Niessen-Ruenzi and Ruenzi, 2019). Compared with females, male traders' higher overconfident behaviour results in excessive trading and lower returns on investments (Barber and Odean, 2001). The excessive turnover in portfolios and aggressive movement of money into new securities increase transaction costs (Chan and Lakonishok, 1995). Therefore, allocating more assets to liquid stocks can facilitate the frequent transactions of male fund managers with minimum cost. It is plausible that the preference to trade in liquid stocks is higher for male managers than it is for female managers.

There exists a line of literature suggesting no disparities between the behaviours of male and female professionals. Fund managers possess risk management skills, and they have advanced financial education and market knowledge. These factors alleviate the gender effect on behavioural preferences. Hibbert, Lawrence and Prakash (2013) suggest that financial education mitigates the gender difference in risk aversion. Niessen-Ruenzi and Ruenzi (2019) document significantly lower inflows in female-managed funds than in male-managed funds because some investors with strong gender bias invest significantly less in female-managed funds. The self-selection mechanism among females for becoming fund managers can be another reason to assume that females are as confident and competitive as their male counterparts.

Sargis and Wing (2018) report that from 1990 to 2017, the US active equity funds and fixed-income funds grew in number from 1900 to 8500. However, men obtained 85–90% of these new roles, and women failed to take significant advantage of the increase in positions. Hence, the scrutiny risk is higher for female fund managers compared with males because they are small in number. The regular performance ranking of fund managers by market participants and investors' gender bias towards female-managed funds may lead to similar investment behaviours of female and male fund managers. Nekby, Thoursie and Vahtrik (2008) show that women selected to participate in male-dominated environments are likely to be highly competitive. Gregory *et al.* (2012) analysed gender differences in the market reaction following the trade announcements of directors and showed

that in the long-term females appear to have the same information and capacity to interpret this information as their male counterparts. Therefore, it is plausible that the preference for portfolio liquidity of female fund managers is no different from that of male managers. Finally, Aggarwal and Boyson (2016) found consistent results, with female-managed funds performing no differently from all male-managed funds with similar risk profiles.[1]

Using a sample of 1932 US domestic open-end single-managed equity funds from January 2000 to December 2017, with 10% (on average) run by single female managers, we show that the preference of female fund managers for holding liquid portfolios is higher than that of male managers. Consistent with the existing literature, we document that female fund managers are involved in less frequent trading than their male counterparts. However, male and female fund managers' net result of liquidity preference does not indicate a higher liquidity demand by male managers. Thus, we do not find substantial support for the hypothesis that the excessive trading of male fund managers motivates them to allocate assets to liquid stocks. The findings provide empirical evidence that gender differences exist in the asset allocation decisions of highly educated and experienced fund managers.

To identify the factors that motivate female fund managers to invest in more liquid stocks, we first test the riskiness of female-managed funds. The findings support the literature, namely that females are more risk-averse than their male counterparts. Therefore, they prefer to invest in a more liquid portfolio in order to promptly convert stocks into cash and provide protection from high trading costs during withdrawals. Second, we test stock price efficiency by using a price delay measure, following Hou and Moskowitz (2005). Price delay may result from a lack of liquidity or from investors' inattention towards a stock. The outcomes show that female fund managers favour stocks for which prices incorporate market and firm-specific information promptly. Therefore, consistent with the hypothesis, female fund managers' inclination towards price-efficient stocks leads to a portfolio liquidity that is higher than that of male managers. The liquidity preference of female fund managers gives them the advantage of investing in firms

where the information environment is transparent and restrict managers who try to exploit information asymmetries for personal benefits.

Some fund management companies may discriminate in their selection of a fund manager based on gender, or females may self-select more liquid funds to manage. Moreover, ownership structure, particularly institutional ownership, affects the stock's liquidity (Agarwal, 2007; Rubin, 2007). In this scenario, the gender of the fund manager has no impact on the fund's stockholding liquidity. Hence, it is critical to ascertain whether a fund manager prefers stocks with higher liquidity or whether stocks' inclusion in the fund portfolio upsurges their liquidity. Moreover, time-invariant fund-specific characteristics correlated with omitted explanatory variables give rise to endogeneity issues. We therefore apply a number of approaches to substantiate the authenticity of our results.

Regarding methodological aspects, first, we compare the liquidity preference of funds managed by female managers with a (propensity score) matched sample of funds run by male managers that are indistinguishable in terms of investment objectives, time, fund- and manager-level characteristics. Second, we compare the same funds' portfolio liquidity preference, as managed by managers of a different gender. For this purpose, we consider a sample of funds experiencing a transition from one manager to another, including male to male, female to female, male to female, and female to male fund manager (referred to as 'transition funds'). Finally, we apply a difference-in-differences approach on the transition funds to compare fund liquidity before and after transitions from male to female manager, with a control sample of male to male transition funds. The findings of propensity scores matching and difference-in-differences methodologies provide empirical evidence that a significant increase in portfolio liquidity occurs around the change from male to female fund managers compared with otherwise similar peers.

We conduct one additional test to alleviate endogeneity concerns. The test relies on the instrumental variable approach, where we use a 'state-level gender equality index' as an instrument for the fund managed by a female manager (Di Noia, 2002). The friendlier a state is towards female equality, the more likely a fund (with its headquarters in that state) is to have a female manager. The results support our hypothesis that

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[1]Further comments on theory development and research hypotheses are available in Appendix A.

female-managed funds have a higher portfolio liquidity than male-managed funds. Additionally, we run our primary regression model by controlling for various stock-level variables that are likely to affect portfolio liquidity, and the results support our main conjecture.

Diversity in the context of mutual funds refers to the representation of different groups of people in the management and ownership of mutual funds. This includes diversity in terms of gender, race, ethnicity and socioeconomic background. Currently, the mutual fund industry is dominated by White men, with a lack of women, minorities and other underrepresented groups (Di Giuli, Garel and Petit-Romec, 2022; Marti-Ballester, 2023). This lack of diversity can lead to a narrow range of perspectives and investment strategies, which may limit the potential returns and performance of the funds. Additionally, research has shown that diverse teams tend to make better decisions and perform better financially. This is because different perspectives, ideas and backgrounds lead to a better understanding of the market and can lead to more innovative solutions (Babalos, Caporale and Philippas, 2015). A lack of diversity in the mutual fund industry can lead to a lack of innovative solutions and limited performance. Moreover, the lack of diversity in mutual funds also limits the access to investment opportunities for underrepresented groups and can perpetuate wealth inequality (Bliss and Potter, 2002). This is because mutual funds are a popular way for people to save for retirement and build wealth over time, and a lack of diversity in the industry means that underrepresented groups may have fewer opportunities to access these investment vehicles (Gangi *et al.*, 2020). Thus, diversity in mutual funds is crucial for a fair and efficient financial market, as well as for promoting the well-being of society by providing equal opportunities for wealth creation.

Our findings are consistent with the notion that behavioural disparities between genders exist and influence decisions, even in professional settings (e.g. Huang and Kisgen, 2013; Ho *et al.*, 2015; Faccio, Marchica and Mura, 2016). The analysis of liquidity preference among male and female fund managers contributes to the existing literature on the gender of mutual fund managers (e.g. Atkinson, Baird and Frye, 2003; Beckmann and Menkhoff, 2008; Niessen-Ruenzi and Ruenzi, 2019). Moreover, the findings support the argu-

ment that females are inclined towards informationally transparent stocks and the positive association between stock price efficiency and liquidity (e.g. Diamond and Verrecchia, 1991; Gul, Srinidhi and Ng, 2011; Lang, Lins and Maffett, 2012; Callen, Khan and Lu, 2013; Abad *et al.*, 2017). The study further contributes to the extant research that reports liquidity as one of the essential characteristics of stockholdings and its preference among institutional investors (e.g. Del Guercio, 1996; Falkenstein, 1996; Gompers and Metrick, 2001).

The rest of the paper is structured as follows. The details of the research methodology and data are presented first, followed by the applications of diagnostic tests, analysis, and a discussion of the results. A study of the endogeneity issues is given next, and finally some conclusions are offered.

Data and methodology

Data

This study considers US domestic actively managed open-end equity funds from January 2000 to December 2017. We follow the methodology of Kacperczyk, Sialm and Zheng (2008) to merge mutual funds' characteristics data from the Center for Research in Security Prices (CRSP) Survivorship Bias-Free Mutual Fund Database with holdings data from Thomson Reuters and stock prices data from the Center for Research in Security Prices (CRSP). In order to focus our analysis on actively managed open-end domestic equity mutual funds, for which the holdings data are most complete and reliable, we exclude international, municipal bonds, bond and preferred, money market, balanced and index funds from the data. Following Solomon, Soltes and Sosyura (2014), the MFLINKS table matches portfolio holdings with mutual fund characteristics. We exclude the share class observations reporting negative monthly net assets, turnover ratio, or expense ratio. We sum monthly net assets of all share classes to derive the monthly total net assets. The monthly fund return and expense ratio are value-weighted. For fund age and the turnover ratio, we consider the oldest share class.

To avoid incubation bias, we exclude a fund's monthly observations when the observation date is before the fund's inception date reported in CRSP. We also eliminate observations for which

fund names are missing.[2] From a fund's aggregated holdings data, we exclude funds that hold fewer than 10 stocks or that managed less than US\$1 million in the previous month (Kacperczyk, Sialm and Zheng, 2005). We require a fund to have at least 1 year of monthly returns. Following Pástor, Stambaugh and Taylor (2020), we measure the ratio of a fund's total net assets obtained by adding up CRSP share classes' net assets to the assets obtained by adding up the fund's holdings from Thomson Reuters. We eliminate any fund-month observation if the ratio exceeds 2.0 (i.e. 200%) or is less than 0.5 (i.e. 50%). We have a matched sample of 3165 domestic equity funds with 376,362 fund-month observations. We collected data on fund managers' characteristics from the Morningstar Direct (M.S.) database.[3]

The detailed data matching and cleaning procedure is explained in Appendix B. Our final sample covers 1932 unique funds with 124,363 fund-month observations. We observe that 113 (5.85%) are only-female-managed funds, and 1658 (85.82%) are only-male-managed fund, whereas 161 (8.33%) are funds managed by a single male or a single female manager at different times.

Dependent variable – portfolio liquidity

We use three proxies to measure fund liquidity: portfolio liquidity as developed by Pástor, Stambaugh and Taylor (2020); Amihud's (2002) measure; and the bid-ask spread. To derive liquidity measures, we retrieve the data of daily stock return, price, volume, bid price, ask price and market capitalization from the CRSP stock database.

Independent and control variables

We use the female dummy as the independent variable, which is equal to '1' if the fund is single-female-managed, and '0' if it is single-male-managed in the given month.

Following the literature on mutual funds, we control for the fund characteristics that are well known to affect fund liquidity, namely size, return, expense ratio, turnover ratio, age and flow

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[2]See, for example, Elton, Gruber and Blake (2001) and Evans (2009).

[3]For details of the matching procedure and data, see Appendix B.

(e.g. Ben-Rephael, 2017; Huang, 2020; Yan, 2008). Fund size is the natural log of the total net assets of the fund in millions of dollars at the end of a given month. Fund return is the asset-based value-weighted average of the returns of all the share classes. The fund expense ratio typically includes accounting, administrator, advisor, auditor, board of directors, custodial, distribution (12b-1), legal, organizational, professional, registration, shareholder reporting, sub-advisor and transfer agency fees, excluding the fund's brokerage costs or any investor sales charges, and we measure it as the value-weighted average of the net expense ratio of all the share classes. The fund turnover ratio is the minimum of the fund's dollar buys and sells during the fiscal year, scaled by the fund's average total net assets. Fund age is the natural log of fund age, measured as the difference between a fund's inception year and the current year. We also use fund flow, defined as the net growth in the total net assets of funds, as a percentage of their total net assets, adjusted for returns. Following Sirri and Tufano (1998), we measure fund flow as:

$$Flow_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1}(1 + R_{i,t})}{TNA_{i,t-1}}, \quad (1)$$

where $TNA_{i,t}$ is the total net assets of share class i at month t, and $R_{i,t}$ is the return of share class i earned in month t on assets under management. $TNA_{i,t-1}$ is share class i's total net assets at the end of the last month. Our measure of fund flow is the aggregated monthly flow of all share classes belonging to the fund.

Managers' demographic characteristics may affect their decision choices; therefore, we control for the manager's age and qualifications (Chevalier and Ellison, 1999; Niessen-Ruenzi and Ruenzi, 2019). Regarding Bachelors (undergraduate), Masters (graduate) and PhD (doctoral) degrees, we consider the highest degree earned by the manager. MBA is a dummy variable equal to '1' if the manager holds a Master of Business Administration degree, and to '0' otherwise. Our model includes a dummy variable for professional certification, equal to '1' if the fund manager has a professional certification such as CFA or CPA, and to '0' otherwise. Following Chevalier and Ellison (1999), we measure manager age by assuming that a manager is 21 years old at the time of completion of his/her undergraduate degree. We measured

manager age by taking natural log of manager age at year t.

The model

This study aims to analyse the relationship between fund liquidity and the gender of the fund manager. We run the following regression model, including various controls for fund and manager attributes:

$$
\begin{aligned}
Port\_Liq_{i,t} = \; & \alpha + \beta_1 \, Female_{i,t} + \beta_2 \, Ret_{i,t} \\
& + \beta_3 \, Size_{i,t} + \beta_4 \, Exp_{i,t} + \beta_5 \, TOratio_{i,t} \\
& + \beta_6 \, Flow_{i,t} + \beta_7 \, Fund\_Age_{i,t} \\
& + \beta_8 \, Undergrad_{i,t} + \beta_9 \, Grad_{i,t} + \beta_{10} \, PhD_{i,t} \\
& + \beta_{11} \, MBA_{i,t} + \beta_{12} \, Cert_{i,t} \\
& + \beta_{13} \, Mgr\_Age_{i,t} + \varepsilon_{i,t}
\end{aligned} \tag{2}
$$

where $Port\_Liq_{i,t}$ is one of the three proxies used to measure the liquidity of fund i at time t. $Female_{i,t}$ is a dummy variable equal to '1' if fund i is managed by a single female manager, and to '0' if it is managed by a single male manager at time t. Fund return $Ret_{i,t}$, size $Size_{i,t}$, expense ratio $Exp_{i,t}$, turnover ratio $TOratio_{i,t}$, flow $Flow_{i,t}$ and age $Fund\_Age_{i,t}$ are characteristics of fund i at time t. $Undergrad_{i,t}$, $Grad_{i,t}$ and $PhD_{i,t}$ are dummy variables, where one of them is equal to '1', depending upon the highest degree, and the rest are '0'. $MBA_{i,t}$ is a dummy variable equal to '1' if the fund manager of the fund i holds an MBA degree at time t, and to '0' otherwise. $Cert_{i,t}$ is a dummy variable equal to '1' if the ith fund manager is a member of a professional certification body at time t, and to '0' otherwise. $Mgr\_Age_{i,t}$ is the age of the manager of fund i at time t.[4]

For the analysis, we employ the pooled ordinary least squares (OLS), which estimates the time-series and cross-sectional variation of the association between the gender of the mutual fund manager and portfolio liquidity. A large number of studies on the gender of professionals use pooled regression to generate baseline results (Ahmed and Ali, 2017; Faccio, Marchica and Mura, 2016;

Niessen-Ruenzi and Ruenzi, 2019). Pooled regression with fixed effects provides efficient and unbiased results.

Empirical results and discussion

Effect of gender on preference for portfolio liquidity

Table 1 presents the summary statistics, while the discussion of correlation analysis is available in Appendix C. We start our main empirical analysis by examining the impact of a fund manager's gender on portfolio liquidity and present the results in Table 2. Panel A displays the pooled regression results, where we regress each of the portfolio liquidity measures on the female dummy variable without controlling for fund- or manager-level characteristics. To address any impact of time and fund-related fixed factors, we include a year and fund fixed-effects model; the number of funds is 1932, and we have 18 years of data. It is necessary to have significant variations in the variables to apply fixed effects and to produce unbiased estimates. In our study, the variable of interest, namely gender of mutual fund manager, is expected to vary over time. Therefore, we use fund and time fixed effects to generate consistent estimates (Niessen-Ruenzi and Ruenzi, 2019). In order to make the small coefficients presentable, we measure bid-ask spread portfolio liquidity in basis points throughout the analysis.[5] The positive and significant coefficients for all three proxies indicate higher portfolio liquidity for female-managed funds.

The results of Panel A may be affected by the unobserved omitted funds, as well as by manager-specific variables. These characteristics may explain a significant portion of the variability in the portfolio liquidity preference of fund managers. Therefore, in Panel B, we present the model's findings in Equation (2), which controls for the relevant fund- and manager-level attributes (Solomon, Soltes and Sosyura, 2014; Niessen-Ruenzi and Ruenzi, 2019). Columns (1)–(3) show that Pástor, Stambaugh and Taylor's portfolio liquidity (Port_Liq_PST) is significantly higher for female-managed funds. The results indicate that the liquidity of female-managed funds is 25% higher than the average liquidity of male-managed funds, and this positive difference is significant at the 1% level. To exhibit the economic significance

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[4]The manager age data contain many missing observations because of the unavailability of many fund managers' graduation year. The unavailability of manager age data reduces our sample significantly. Our main results, however, are not affected by the inclusion of this variable.

[5]The Port_Liq_Sprd is scaled by 10^4.

Table 1. Summary statistics

	Sample mean (N = 124,363) (1)	Female funds (N = 11,381) (2)	Male funds (N = 112,982) (3)	Difference (Female–male) (4)	Difference (%) (Female–male) (5)
Port_Liq_PST	0.0381	0.0407	0.0378	0.0029∗∗∗	7.61
Port_Liq_Amhd	−0.0104	−0.0046	−0.0110	0.0063∗∗∗	60.58
Port_Liq_Sprd	−24.5700	−24.5597	−24.5755	0.0158	6.43
Ret	0.0044	0.0032	0.0045	−0.0013∗∗	−29.54
TNA (mil $)	1376.9553	678.2136	1447.3415	−769.1278∗∗∗	−55.86
Exp	0.0011	0.0012	0.0011	0.0001∗∗∗	9.09
TOratio	0.0763	0.0774	0.0762	0.0012∗	1.57
Flow	0.6858	0.2751	0.7272	−0.4521∗∗	−65.92
Fund_Age	14.5307	14.6777	14.5159	0.1618	1.11
N_Stocks	112.3043	86.9736	114.8560	−27.8824∗∗∗	−24.83
Undergrad	0.8328	0.8597	0.8301	0.0296∗∗∗	3.55
Grad	0.1402	0.1315	0.1411	−0.0096∗∗∗	−6.85
PhD	0.0257	0.0066	0.0276	−0.0210∗∗∗	−81.71
MBA	0.5735	0.5589	0.5749	−0.0160∗∗∗	−2.79
Cert	0.5807	0.6409	0.5747	0.0662∗∗∗	11.40
Mgr_Age	47.8083	47.4425	47.8470	−0.4045∗∗∗	−0.85

Note: This table presents average fund and manager characteristics for all our sample observations for the years 2000–2017. Column (1) shows descriptive statistics for all pooled observations; Column (2) is for female-managed funds; and Column (3) is for male-managed funds. Column (4) indicates the difference between the average characteristics of female- and male-managed funds. Column (5) expresses the difference as a percentage of the sample mean of fund and manager characteristics. The number of fund-month observations is displayed in the columns' titles. (*Port_Liq_PST*) is a measure of monthly portfolio liquidity introduced by Pástor, Stambaugh and Taylor (2020) and described in Equation (1). (*Port_Liq_Amhd*) is a measure of monthly portfolio liquidity that is the value-weighted average of Amihud liquidity of all the stocks held by a fund at time t. The illiquidity measure of Amihud (2002) is the daily ratio of absolute stock return to the dollar volume of the stock, described in Equation (2). (*Port_Liq_Sprd*) is a measure of monthly portfolio liquidity that is the value-weighted average of Bid_Ask Spread of all the stocks held by a fund at time t. This illiquidity measure is the daily quoted bid-ask spread of a stock divided by its midpoint, described in Equation (3). (*Female*) is a dummy variable equal to 1 if the fund is single-female-managed at time t, and to 0 if it is single-male-managed. (*Ret*) is a measure of monthly fund return and is equal to the value-weighted average of returns of all the share classes of a fund at time t. (*Size*) is a measure of monthly fund size and is equal to the natural log of the total net assets of all the share classes of a fund in a million dollars at time t. (*Exp*) is a measure of the monthly fund expense ratio and equal to the value-weighted average of the net expense ratio of all the share classes of a fund at time t. (*TOratio*) is a monthly fund turnover ratio measure equal to the minimum of the fund's dollar buys and sells during the fiscal year, scaled by the fund's average total net assets. The annual measure is divided by 12 to convert to a monthly frequency. (*Flow*) is a measure of monthly fund flow and is equal to the net growth in the total net assets of a fund, as a percentage of its total net assets adjusted for returns at time t, described in Equation (4). (*Fund_Age*) is a monthly fund age measure equal to the natural log of the difference between the fund's inception date and the date at time t. (*Undergrad*) is a dummy variable and equal to 1 if an undergraduate degree is the highest that a fund manager has earned, and to 0 otherwise. (*Grad*) is a dummy variable and equal to 1 if a graduate degree is the highest that a fund manager has earned, and to 0 otherwise. (*PhD*) is a dummy variable and equal to 1 if the PhD degree is the highest that a fund manager has earned, and to 0 otherwise. (*MBA*) is a dummy variable and equal to 1 if a fund manager has obtained a Master of Business Administration degree, and to 0 otherwise. (*Cert*) is a dummy variable and equal to 1 if a fund manager has obtained a professional qualification (e.g. CFA or CPA), and to 0 otherwise. (*Mgr_Age*) is a measure of the monthly fund manager's age and is equal to the natural log of the difference between the completion date of the manager's undergraduate degree and the date at time t. Significance is calculated based on a two-sided t-test. ∗∗∗, ∗∗ and ∗ denote 99%, 95% and 90% significance levels.

of the results, the coefficients of regressions between females and the three measures of portfolio liquidity are interpreted in comparison with the average portfolio liquidity of male-managed funds, namely coefficient/mean Port_Liq of male-managed funds (separately for each Port_Liq measure). We also observe that fund return, expense and turnover ratio are negatively related to Port_Liq_PST, whereas fund size and age are positively and significantly associated with it. The combined results of all the control variables in Column (1) show that Port_Liq_PST is markedly higher for the funds managed by managers having undergraduate or graduate degrees. All these associations are significant at the 1% level, and the goodness of fit of the models is about 84%.

Columns (4)–(6) of Panel B display a significantly positive association between Amihud's

Table 2. Fund manager gender and preference for portfolio liquidity

Panel A. Gender and portfolio liquidity without controls

	Port_Liq_PST (1)	Port_Liq_Amhd (2)	Port_Liq_Sprd (3)
Female	0.0099***	0.0006**	1.2630***
	(16.69)	(2.12)	(3.02)
Year fixed effect	Yes	Yes	Yes
Fund fixed effect	Yes	Yes	Yes
No. of obs.	124,363	124,363	124,363
Adj. R-squared	0.8429	0.6171	0.7205

Panel B. Gender and portfolio liquidity with controls

	Port_Liq_PST			Port_Liq_Amhd			Port_Liq_Sprd		
	All controls (1)	Fund controls (2)	Manager controls (3)	All controls (4)	Fund controls (5)	Manager controls (6)	All controls (7)	Fund controls (8)	Manager controls (9)
Female	0.0095***	0.0095***	0.0099***	0.0012***	0.0011***	0.0008***	1.9918***	2.092***	1.2376***
	(15.44)	(15.54)	(16.57)	(4.05)	(3.52)	(2.76)	(4.40)	(4.65)	(2.94)
Ret	−0.0048***	−0.0048***	-	0.0024	0.0024	-	9.5592***	9.4985***	-
	(−3.94)	(−3.98)		(1.43)	(1.43)		(6.51)	(6.47)	
Size	0.0054***	0.0054***	-	0.0041***	0.0041***	-	4.0280***	4.0246***	-
	(41.84)	(41.79)		(24.21)	(24.19)		(30.05)	(30.02)	
Exp	−1.6139***	−1.6079***	-	0.8876	0.8857	-	−1945.30***	−1964.20***	-
	(−4.26)	(−4.26)		(1.50)	(1.50)		(−3.76)	(−3.80)	
TOratio	−0.0163***	−0.0159***	-	0.0128***	0.0125***	-	7.0946***	7.6553***	-
	(−11.57)	(−11.41)		(5.23)	(5.11)		(5.37)	(5.79)	
Flow	0.0206	0.0207	-	−0.0018	−0.0017	-	−9.0872	−8.9632	-
	(1.06)	(1.07)		(−0.77)	(−0.72)		(−1.35)	(−1.32)	
Fund_Age	0.0023***	0.0021***	-	−0.0024***	−0.0023***	-	−5.8234***	−6.0324***	-
	(4.03)	(3.80)		(−5.03)	(−4.84)		(−12.24)	(−12.66)	
Undergrad	0.0040***	-	−0.0004	0.0030*	-	0.0005	−7.2871*	-	−2.1912
	(3.00)		(−0.32)	(1.71)		(0.36)	(−1.71)		(−0.72)

Table 2. (Continued)

	Port_Liq_PST			Port_Liq_Amhd			Port_Liq_Sprd		
	All controls	Fund controls	Manager controls	All controls	Fund controls	Manager controls	All controls	Fund controls	Manager controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Grad	0.0049***	-	−0.0007	0.0032*	-	−0.0001	−6.4583	-	−2.0399
	(3.41)		(−0.56)	(1.82)		(−0.07)	(−1.51)		(−0.67)
PhD	−0.0001	-	−0.0024	0.0081***	-	0.0054***	−13.100***	-	−8.5473***
	(−0.05)		(−1.60)	(4.39)		(3.51)	(−2.99)		(−2.66)
MBA	0.0002	-	0.0000	−0.0007**	-	−0.0011***	−0.5895**	-	−1.0124***
	(0.43)		(0.07)	(−2.22)		(−3.62)	(−2.01)		(−3.62)
Cert	0.0004	-	0.0000	0.0008***	-	0.0016***	−0.0280	-	0.3074
	(0.82)		(0.06)	(3.53)		(6.90)	(−0.08)		(0.96)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	113,855	113,855	124,363	113,855	113,855	124,363	113,855	113,855	124,363
Adj. R-squared	0.8475	0.8475	0.8429	0.6252	0.6251	0.6173	0.7233	0.7232	0.7207

Notes: This table presents the findings of the regression of portfolio liquidity on the gender of single-managed funds. Panel A exhibits the results without the fund- and manager-level controls. Panel B shows the findings of the regression model given in Equation (5). The dependent variable is portfolio liquidity, $Port\_Liq$. We use three proxies, $Port\_Liq\_PST$, $Port\_Liq\_Amhd$ and $Port\_Liq\_Sprd$, to measure portfolio liquidity. The independent variable is $Female$, which is equal to 1 if the fund is single-female-managed at time t, and to 0 if it is single-male-managed. $Port\_Liq\_Sprd$ and $Flow$ are measured in basis points. The results are presented with fund and year fixed effects. The t-statistics based on White robust standard errors are reported in parentheses. ***, ** and * denote 99%, 95% and 90% significance levels. See Table C1 in the appendix for the explanation of the fund- and manager-level control variables. See Table C6 in the appendix for the regression results with the control variable of Mgr_Age.

$$Port\_Liq_{i,t} = \alpha + \beta_1 \, Female_{i,t} + \beta_2 \, Ret_{i,t} + \beta_3 \, Size_{i,t} + \beta_4 \, Exp_{i,t} + \beta_5 \, TOratio_{i,t} + \beta_6 \, Flow_{i,t} + \beta_7 \, Fund\_Age_{i,t} + \beta_8 \, Undergrad_{i,t}$$
$$+ \beta_9 \, Grad_{i,t} + \beta_{10} \, PhD_{i,t} + \beta_{11} \, MBA_{i,t} + \beta_{12} \, Cert_{i,t} + \beta_{13} \, Mgr\_Age_{i,t} + \varepsilon_{i,t}$$

portfolio liquidity and female-managed funds. The female-managed funds report an 11% higher Port_Liq_Amhd than the average liquidity of male-managed funds, and this positive relationship is significant at the 1% level. Column (4) findings reveal a significantly higher Port_Liq_Amhd for funds with a large size, higher turnover ratios, and managed by a manager who holds an undergraduate or graduate or PhD degree who has professional certification. Conversely, old funds and funds managed by a manager with an MBA degree have a lower portfolio liquidity. The goodness of fit of these three models is about 62%. We find consistent results for the third proxy of liquidity. Columns (7)–(9) provide evidence that female-managed funds prefer a higher bid-ask spread portfolio liquidity than do male-managed funds. The liquidity of single-female-managed funds is 8% higher than the mean portfolio liquidity of single-male-managed funds and is significant at the 1% level. The fund and manager-specific control variables show a significant association with Port_Liq_Sprd. The overall goodness of fit of these models is about 72%.[6]

Based on the results presented in Table 2, we conclude that the gender of mutual fund managers does affect the choice of portfolio liquidity, and that female fund managers have a higher preference for liquidity than do male managers (Huang, 2020; Ahmed and Ali, 2017). By combining the three proxies of the portfolio liquidity, it is evident that the funds managed by single female managers are 8–25% more liquid than single-male-managed funds. Consistent with Pástor, Stambaugh and Taylor (2020), the overall results demonstrate that funds with more liquid portfolios are larger and cheaper. Two of the proxies' coefficients indicate that funds managed by managers having a graduate degree are positive. In contrast, managers holding an MBA degree are negatively related to portfolio liquidity.

To test the notion that male managers are overconfident (Barber and Odean, 2001), we run a regression on fund trading and the gender of fund managers. We measure aggressive trading by using the fund turnover ratio (Niessen-Ruenzi and Ruenzi, 2019).[7] A higher turnover ratio depicts excessive trading by the fund. Consistent with the literature, the results show that male-managed funds carry significantly higher trading than do female-managed funds. However, we reject the hypothesis that overconfident male fund managers prefer higher portfolio liquidity to minimize their high trading costs.[8]

To explore the asymmetric behaviour of portfolio liquidity, we apply the quantile regression method proposed by Koenker and Bassett (1978) and Koenker (2005). Quantile regression can provide detailed insight into the relationship between portfolio liquidity and the gender of mutual fund managers. Quantile regression extends the regression model to conditional quantiles of the dependent variable, and each quantile regression defines a particular centre or tail point of a conditional distribution. This regression overcomes the restrictions of the traditional conditional-mean regression models and allows the estimation of various quantile functions (Babalos, Caporale and Philippas, 2015). The main advantage of quantile regression over least squares regression is its flexibility for modelling data with heterogeneous conditional distributions. Hence, for a robustness check, applying quantile regression is appropriate for our data. The regression results of the relationship of Pástor, Stambaugh and Taylor's portfolio liquidity and the gender of a mutual funds manager are consistent with our main findings. The positive and significant impact of a female fund manager is stronger for portfolio liquidity (Port_Liq_PST) in higher quantiles. The association of female fund manager and Amihud portfolio liquidity (Port_Liq_Amhd) is positive and significant (at the 1% level of significance) until the 50th quantile. The results are inconsistent with our main findings and show a significantly negative relationship between female fund manager and bid/ask spread portfolio liquidity (Port_Liq_Sprd) for the 5th and 10th quantile (Sonza and Valcanover, 2019).[9]

To overcome autocorrelation concerns, we run our primary regression analysis by controlling for lagged liquidity variables. We also control for

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[6]We have many missing observations for the control variable of manager age, that is, Mgr_Age. The inclusion of this variable significantly reduces the number of observations for our regression analysis. Although the results do not change with this variable, we present the findings in the Appendix (Table C6).

[7]Descriptions of all the variables are in the Appendix (Table C1).

[8]The regression results are in the Appendix (Table C8).

[9]The quantile regression results are in the Appendix (Table C5).

various stock-specific characteristics that may affect a fund manager's preference to hold the stock. The results are consistent and are presented in the Appendix (Table C7).

Factors stimulating female fund managers' preference for portfolio liquidity

To explain the factors that lead to a higher portfolio preference by female fund managers than by male managers, first, we test their risk-averse behaviour. We measure portfolio risk, the value-weighted average of monthly volatility of all the stocks held in a portfolio. Stock volatility is the standard deviation of a stock's daily return. To examine the relationship between a fund manager's gender and the portfolio's riskiness, we run the model given in Equation (3):

$$
\begin{aligned}
Port\_Risk_{i,t} = {} & \alpha + \beta_1\, Female_{i,t} + \beta_2\, Ret_{i,t} \\
& + \beta_3\, Size_{i,t} + \beta_4\, Exp_{i,t} + \beta_5\, TOratio_{i,t} \\
& + \beta_6\, Flow_{i,t} + \beta_7\, Fund\_Age_{i,t} \\
& + \beta_8\, Undergrad_{i,t} + \beta_9\, Grad_{i,t} \\
& + \beta_{10}\, PhD_{i,t} + \beta_{11}\, MBA_{i,t} \\
& + \beta_{12}\, Cert_{i,t} + \beta_{13}\, Mgr\_Age_{i,t} \\
& + \varepsilon_{i,t} \qquad\qquad\qquad\qquad (3)
\end{aligned}
$$

where the variables are as defined in Section 3.

In Table 3, Columns (1) and (2) display the results with all fund- and manager-level control variables and the year and fund fixed effects. Consistent with the literature, we find that female fund managers are more risk-averse in portfolio management than their male counterparts. Our study assumes that risk-averse female fund managers exhibit a high preference for liquid stocks because they have a lower default risk (Brogaard, Li and Xia, 2017). Moreover, with a liquid portfolio, they can promptly fulfill investors' liquidity needs with lower transaction costs. Hence, risk behaviour associated with the gender of mutual fund managers can influence their liquidity preference.

Second, we test our hypothesis, which expects that females' preference for information transparency encourages them to hold more liquid stocks in the portfolio. The literature on stock price efficiency describes how if the information environment is uncertain or opaque, incorporates stock price slowly incorporating newly arriving value-relevant information (Callen, Khan and Lu, 2013). Hence, in our study, we assume that female fund managers are more likely to hold stocks whose prices have fewer delays in responding to the latest information.

Following Hou and Moskowitz (2005), we measure the delay variable. The weekly market return from Fama and French (1993) can capture a stock response as relevant news arrives.[10] As the price delay measure requires a year of prior weekly returns history (52 weeks), our calculation begins from 1999. We consider the past 52 weeks of returns corresponding to the last week of every month. Moreover, we exclude firm-year-month observations if, in 25 weeks out of the past 52, weekly stock returns are missing.[11]

Columns (3) and (4) in Table 3 show the findings of the regression model with fund and year fixed effects and control variables. The results provide empirical evidence that single female managers' funds significantly reduce holding those stocks whose prices are not efficient in integrating available information. Consistent with the literature, female managers are more inclined towards price-efficient stocks, and it signals their preference for firms with a high-quality information environment. Informationally transparent firms have higher liquidity (Lang, Lins and Maffett, 2012). Hence, we conclude that increased information efficiency encourages female managers to prefer a more liquid portfolio.

Endogeneity

We apply various approaches to mitigate any endogeneity concerns. We use the entire sample and a sub-sample of funds that experience replacing one manager with another manager. This sub-sample of 'transition funds' consists of all fund-month observations of those funds experiencing at least one event of transition from either male to male, male to female, female to male, or female to female.

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[10]The market return is from the Kenneth R. French-Data Library: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[11]Econometric specifications are available in Appendix C.

Table 3. Factors for the higher portfolio liquidity preference of female fund managers

	Port_Risk		Delay	
	All controls with manager age (1)	All controls without manager age (2)	All controls with manager age (3)	All controls without manager age (4)
Female	−0.0005**	−0.0003*	−0.0072**	−0.0092***
	(−1.99)	(−1.94)	(−2.40)	(−5.36)
Ret	−0.0302***	−0.0324***	−0.0175**	−0.0196***
	(−31.05)	(−46.38)	(−2.16)	(−3.49)
Size	−0.0005***	−0.0002***	−0.0074***	−0.0064***
	(−7.70)	(−5.12)	(−9.73)	(−13.88)
Exp	−1.1324***	−0.7550***	17.7828***	11.3949***
	(−4.76)	(−5.06)	(5.81)	(6.04)
TOratio	0.0029***	0.0038***	−0.0030	0.0095*
	(2.81)	(6.06)	(−0.40)	(1.71)
Flow	0.0019	0.0036	−0.0080	−0.0109
	(0.58)	(1.34)	(−0.14)	(−0.23)
Fund_Age	−0.0009***	−0.0009***	0.0161***	0.0164***
	(−4.39)	(−6.25)	(6.25)	(9.72)
Undergrad	0.0007	−0.0022	0.0217**	0.0550***
	(1.44)	(−1.36)	(2.50)	(3.67)
Grad	0.0021***	−0.0014	0.0125	0.0504***
	(4.47)	(−0.87)	(1.51)	(3.35)
PhD	0.0000	-0.0025	0.0000	0.0504***
	-	(−1.55)	-	(3.27)
MBA	0.0005***	0.0001	−0.0001	0.0015
	(2.62)	(0.62)	(−0.04)	(1.30)
Cert	−0.0001	-0.0000	0.0109***	0.0034***
	(−0.58)	(−0.17)	(4.17)	(2.59)
Mgr_Age	0.0023***	-	−0.0050	-
	(4.34)		(−0.75)	
Year fixed effect	Yes	Yes	Yes	Yes
Fund fixed effect	Yes	Yes	Yes	Yes
No. of obs.	55,253	113,855	55,253	113,855
Adj. R-squared	0.6446	0.6350	0.6316	0.6267

Columns (1) and (2) present the findings of the regression of portfolio risk on the single-female-managed funds. The dependent variable is monthly portfolio risk, *Port_Risk*, which is the value-weighted average of monthly volatility of all the stocks held by a fund at time t. Columns (3) and (4) report the findings of the regression of portfolio stock prices' delay on the single-female-managed funds. The dependent variable is monthly portfolio delay, *Delay*, the value-weighted average of price delay of all the stocks held by a fund at time t. The price delay measure is one minus the ratio of the restricted R^2 over the unrestricted R^2. The independent variable is *Female*, which is equal to 1 if the fund is single-female-managed at time t, and to 0 if it is single-male-managed. *Flow* is measured in basis points. The results are presented with fund and year fixed effects. The t-statistics based on White robust standard errors are reported in parentheses. ***, ** and * denote 99%, 95% and 90% significance levels. See Table C1 in the appendix for an explanation of all the variables.

$$Port\_Risk_{i,t} = \alpha + \beta_1\,Female_{i,t} + \gamma\,Controls_{i,t} + \varepsilon_{i,t},$$
$$Delay_{i,t} = \alpha + \beta_1\,Female_{i,t} + \gamma\,Controls_{i,t} + \varepsilon_{i,t}.$$

Propensity score matching and univariate analysis

Following Faccio, Marchica and Mura (2016), we compare the liquidity of funds managed by female managers with the liquidity of a (propensity score) matched sample of peers run by male managers that are indistinguishable in terms of the var-ious fund- as well as manager-level characteristics. Each pair of matched funds manifests no observable differences in relevant attributes except for the gender of the manager.

We consider female-managed funds as a treatment group, with male-managed funds belonging to a control group. We calculate propensity scores by running a probit regression where the

dependent variable is a dummy and takes the value '1' if the fund belongs to the treatment group or '0' if the fund is from the control group. We consider the fund-level characteristics as independent variables, that is, fund return, fund size, expense ratio, turnover ratio, flow and fund age. Notably, the propensity score is estimated within the same fund investment objective and date. To find an adequately precise nearest neighbour match (with replacement) between the female-managed funds and the peer funds in the control group, we consider only the pairs where the maximum difference between their propensity scores does not exceed 0.01 in the absolute term. Additionally, we select the unique pair with a minimum difference between their propensity scores. We re-run the probit regression on post-match pairs of treatment and control groups. We find that most of the fund-level characteristics' coefficients lose their significance, confirming that the matched pairs are almost the same regarding their fund-related attributes.

Table 4, Panel A reports the comparison of Port_Liq_PST, Port_Liq_Amhd and Port_Liq_Sprd with the matched samples. The results show that average portfolio liquidity (for the three measures) of female managers' funds is higher than the portfolio liquidity of male-managed funds, even when other relevant characteristics between the fund pairs are virtually equal. Hence, we suggest that the gender-related differences in portfolio liquidity do not result from the observable fund characteristics. In addition, we obtain the propensity score as a function of fund- and manager-level characteristics (i.e. undergrad, grad, PhD, MBA, cert and manager age), within the same fund investment objectives and date. Table 4, Panel B presents a comparison of portfolio liquidity between the matched funds, and the results support the outcomes in Panel A.

We implement the same propensity score matching approach to the sub-sample of transition funds. Only female-managed transition funds are in the treatment group, and male-managed transition funds belong to the control group. As mentioned above, we calculate the probability (propensity score) as a function of fund-level and then fund- and manager-level characteristics. All other conditions are the same to match the treatment fund with an identical control fund and to obtain unique pairs. The findings presented in Table 4, Panels C and D are consistent with the earlier re-

sults. Comparing the three proxies of portfolio liquidity confirms that even transition funds managed by females tend to hold more liquid portfolios than the otherwise matched male-managed transition funds, even when the pairs' observable characteristics are virtually identical.

Finally, following Huang and Kisgen (2013), we run univariate regressions on the matched sample of transition funds to examine the gender differences in portfolio liquidity. Table 4, Panel E reports that, compared with the matched male-managed funds, female-managed transition funds are positively and significantly associated with all three proxies of portfolio liquidity. Columns (1)–(3) give the regression results for the propensity score-matched funds that are indistinguishable regarding the fund-level characteristics, whereas Columns (4)–(6) are the findings of the matched funds concerning fund- and manager-level characteristics.

Pooled regression analysis of transition funds

Following Faccio, Marchica and Mura (2016), we run a traditional panel regression analysis by including the controls. The omission of these controls might lead us to wrongly attribute the differences in portfolio liquidity to fund manager gender disparities. We compare fund managers of different genders managing the same fund in the fixed effects regressions. The transitions might be accompanied by changes in fund manager characteristics other than gender. Hence, we run a panel regression analysis with fund and year fixed effects, controlling for the fund- and manager-specific observable characteristics. We restrict our sample to the funds experiencing either male to female or female to male transitions only.

The findings in Table 5, Panel A exhibit a significantly positive relationship between female-managed funds and the three proxies of portfolio liquidity. The observable fund- and manager-level characteristics show a significant association with the measures of portfolio liquidity. However, the results reveal that portfolio liquidity is higher when a female manager manages the fund than when a male manager manages the same fund. Following Huang and Kisgen (2013), we repeat the above-applied panel regression analysis with fixed effects and controls. For this analysis, we include in our

Table 4. Propensity score matching and univariate analysis for female-managed funds

Panel A. Propensity score matching using fund-level characteristics – all funds

	Mean-female funds (N = 10,282) (1)	Mean-male funds (N = 10,282) (2)	Difference (Female–Male) (3)	t-statistic (4)
Port_Liq_PST	0.0409	0.0353	0.00562***	7.02
Port_Liq_Amhd	−0.00482	−0.0135	0.0087***	18.51
Port_Liq_Sprd	−25.8000	−29.1000	3.3000***	6.35

Panel B. Propensity score matching using fund- and manager-level characteristics – all funds

	Mean-female funds (N = 4,946) (1)	Mean-male funds (N = 4,946) (2)	Difference (Female–male) (3)	t-statistic (4)
Port_Liq_PST	0.0489	0.0367	0.0122***	9.89
Port_Liq_Amhd	−0.0053	−0.0136	0.00834***	12.05
Port_Liq_Sprd	−25.8000	−30.1000	4.3000***	5.19

Panel C. Propensity score matching using fund-level characteristics – transition funds

	Mean-female funds (N = 5,267) (1)	Mean-male funds (N = 5,267) (2)	Difference (Female-Male) (3)	t-statistic (4)
Port_Liq_PST	0.0523	0.0427	0.00952***	8.05
Port_Liq_Amhd	−0.00291	−0.00814	0.00523***	10.81
Port_Liq_Sprd	−22.6000	−26.2000	3.6000***	5.18

Panel D. Propensity score matching using fund- and manager-level characteristics – transition funds

	Mean-female funds (N = 2155) (1)	Mean-male funds (N = 2155) (2)	Difference (Female-Male) (3)	t-statistic (4)
Port_Liq_PST	0.0638	0.0562	0.00759***	2.78
Port_Liq_Amhd	−0.0041	−0.00674	0.00264***	4.11
Port_Liq_Sprd	−27.1000	−29.4000	2.3000**	1.99

Panel E. Univariate regression of propensity score matched transition funds

	Fund-level characteristics			Fund- and manager-level characteristics		
	Port_Liq_PST (1)	Port_Liq_Amhd (2)	Port_Liq_Sprd (3)	Port_Liq_PST (4)	Port_Liq_Amhd (5)	Port_Liq_Sprd (6)
Female	0.0095*** (8.05)	0.0052*** (10.81)	3.5666*** (5.18)	0.0076*** (2.78)	0.0026*** (4.11)	2.3443** (1.99)
Constant	0.0428*** (51.14)	−0.0081*** (−23.78)	−26.2000*** (−53.83)	0.0562*** (29.12)	−0.0067*** (−14.82)	−29.4000*** (−35.26)
No. of Obs.	10,534	10,534	10,534	4310	4310	4310
Adj. R-squared	0.0060	0.0109	0.0025	0.0016	0.0037	0.0007

Note: This table presents the results of the propensity score matching approach and the univariate regression analysis of the three measures of portfolio liquidity and the matched female- and male-managed funds. The propensity score is estimated within the same investment objective and time. We are applying propensity scores to the whole sample. Panel A and B compare portfolio liquidity between the two gender groups similar in only fund-level characteristics and in fund- and manager-level characteristics, respectively. Using propensity scores for the transition funds sample, Panel C and D compare portfolio liquidity between the two gender groups similar in only fund-level characteristics and in fund- and manager-level characteristics, respectively. Significance is calculated based on a two-sided t-test. Panel E presents the univariate regression of portfolio liquidity on the female- and the matched male-managed transition fund. The dependent variable is portfolio liquidity. The independent variable is *Female*, which is equal to 1 if the transition

Table 4. (Continued)

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fund belongs to the treatment group and to 0 if it belongs to the matched control group. *Port_Liq_Sprd* is measured in basis points. The t-statistics based on White robust standard errors are reported in parentheses. ***, ** and * denote 99%, 95% and 90% significance levels. See Table C1 in the appendix for the explanation of all the variables.

sample all the funds experiencing either male to male, female to female, male to female, or female to male transitions during our sample period. The results of Table 5, Panel B strongly support the evidence of the higher preference in female-managed funds for portfolio liquidity.

Difference-in-differences regression analysis considering transition events

We apply a difference-in-differences approach for our empirical examination comparing portfolio liquidity before and after transitions from a male to a female fund manager with a control sample of male to male transition funds (Huang and Kisgen, 2013). We refer to the treatment group of funds with a male to female transition as Female_Trans. This analysis sample is for 12 months before and 12 months after a change, excluding the month when the transition occurs. We require a fund manager to solely manage the fund for at least 12 months (the month he or she is hired and the 11 months following) to ensure that the manager has enough time to make essential portfolio composition changes. We exclude a transition event if observations are missing for 12 months before or after the transition.

The results from the difference-in-differences analysis are reported in Table 6. In Columns (1) and (2), the positive and significant coefficient of *Female_Trans × Post* indicates that female fund managers prefer higher Pástor, Stambaugh and Taylor's portfolio liquidity, compared with male fund managers. The findings are significant at the 1% level. We report the t-statistics based on White standard errors, which indicate that portfolio liquidity increases when female managers start managing a fund. Columns (3)–(6) carry similar analyses for the Amihud and bid-ask spread's portfolio liquidity measures. These tests show that female-managed funds become more liquid after a transition from male to female manager. The coefficient of the *Female_Trans × Post* variable is positive

and statistically significant, as shown in Columns (3) and (5).

Although, the findings of the robustness test do not support the argument that change in fund liquidity is symmetric with gender transition, our study provides empirical evidence that the magnitude of portfolio liquidity is higher for a female-managed fund than for a fund managed by a male manager.[12]

Instrumental variable approach

We conduct one additional test to rule out any remaining endogeneity concerns. We implement an instrumental variable approach. The instrument that we use is the state's gender status equality index, initially developed by Sugarman and Straus (1988) and updated by Di Noia (2002). The measure analyses the extent to which females have the same access as men to economic resources, legal rights and positions of political power in each of the 50 US states. The state's gender equality index is a composite index to represent the cumulative effect of economic, legal and political indicators. It assigns each of the states a score for its gender status equality. The scores range from 33.6 (Alabama) to 73.1 (Washington), where higher values indicate more gender equality.

Following Huang and Kisgen (2013), we hypothesize that the more friendly a state is towards female equality, the more likely a fund with its headquarters located in that state is to appoint a female manager. Based on the fund's headquarter location, we allocate each fund the state's gender status equality value. The purpose of using this instrumental variable is that there is a high possibility that the measure is correlated with the decision to hire a female fund manager; however, it is doubtful that it will affect our portfolio liquidity proxies. The only way it may affect the outcome variables is through its direct relationship with the gender of the fund manager.[13] Hence, this measure rea-

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[12]The results are presented in Appendix C (Table C9).

[13]Econometric specifications are available in Appendix C.

Table 5. Female fund manager and preference for portfolio liquidity of transition funds

Panel A. Regression analysis of male to female and female to male transition funds

	Port_Liq_PST		Port_Liq_Amhd		Port_Liq_Sprd	
	All controls with manager age (1)	All controls without manager age (2)	All controls with manager age (3)	All controls without manager age (4)	All controls with manager age (5)	All controls without manager age (6)
Female	0.0105***	0.0110***	0.0014*	0.0008**	2.0359**	0.2907
	(7.26)	(14.89)	(1.91)	(2.20)	(2.13)	(0.62)
Ret	−0.0056	−0.0087*	0.0072	0.0017	19.2000***	14.7000***
	(−0.79)	(−1.80)	(1.27)	(0.51)	(3.19)	(3.68)
Size	0.0034***	0.0053***	0.0056***	0.0031***	6.4965***	3.2863***
	(4.49)	(13.18)	(7.60)	(10.79)	(7.98)	(8.97)
Exp	−24.0376***	−10.6622***	5.6796**	4.1629***	−4386.3000	−1654.3000
	(−4.43)	(−3.79)	(2.49)	(2.96)	(−1.30)	(−0.89)
TOratio	−0.0550***	−0.0488***	0.0308***	0.0065***	12.3000	3.0688
	(−3.33)	(−8.48)	(5.22)	(3.37)	(1.29)	(0.94)
Flow	−0.0398	−0.0363	0.0148	0.0044	−0.0004	−0.0022
	(−0.31)	(−0.09)	(0.45)	(0.82)	(−0.04)	(−0.40)
Fund_Age	0.0444***	0.0255***	−0.0069***	−0.0024***	−11.9000***	−6.1508***
	(12.62)	(14.06)	(−4.94)	(−2.96)	(−3.83)	(−3.91)
Undergrad	−0.0122***	−0.0089***	0.0044***	0.0034**	−3.3749	−13.1000***
	(−3.16)	(−2.81)	(3.92)	(2.41)	(−1.16)	(−2.81)
Grad	0.0070*	−0.0058*	0.0084***	0.0061***	1.7614	−10.4000**
	(1.69)	(−1.74)	(4.89)	(4.05)	(0.63)	(−2.21)
PhD	0.0000	−0.0275***	0.0000	0.0288***	0.0000	−31.6000***
	−	(−7.10)	−	(6.74)	−	(−5.27)
MBA	0.0179***	0.0072***	−0.0006	0.00005	3.6683***	1.7126***
	(10.16)	(8.78)	(−0.58)	(0.10)	(3.19)	(3.33)
Cert	0.0466***	0.0090***	0.0025*	0.0023***	1.4353	−1.0359
	(19.39)	(8.47)	(1.75)	(4.38)	(1.03)	(−1.54)
Mgr_Age	−0.0288***	-	−0.0045**	-	−4.1164	-
	(−5.81)		(−2.37)		(−1.02)	
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	5961	12,095	5961	12,095	5961	12,095
Adj. R-squared	0.8677	0.8213	0.6958	0.7741	0.7590	0.7301

Table 5. (*Continued*)

Panel B. Regression analysis of male to female, female to male, male to male, and female to female transition funds

	Port_Liq_PST		Port_Liq_Amhd		Port_Liq_Sprd	
	All controls with manager age (1)	All controls without manager age (2)	All controls with manager age (3)	All controls without manager age (4)	All controls with manager age (5)	All controls without manager age (6)
Female	0.0084***	0.0124***	0.0020***	0.0006**	2.3727***	1.4103***
	(5.80)	(18.46)	(3.06)	(2.17)	(2.75)	(3.10)
Ret	−0.0094***	−0.0066***	0.0037	−0.0002	9.4526***	7.5954***
	(−2.64)	(−3.01)	(1.07)	(−0.09)	(2.88)	(3.68)
Size	0.0089***	0.0060***	0.0054***	0.0030***	4.8834***	3.3744***
	(18.14)	(30.25)	(12.66)	(15.49)	(12.95)	(17.96)
Exp	0.9191	−0.8512	1.0279	1.4092	807.7000	−135.0000
	(0.99)	(−1.24)	(0.92)	(1.57)	(0.72)	(−0.17)
TOratio	−0.0237***	−0.0398***	0.0322***	0.0193***	24.0000***	14.9000***
	(−4.87)	(−16.11)	(9.56)	(12.68)	(7.44)	(7.00)
Flow	−0.0206	0.0107	0.0002	−0.0042*	−0.0004	−0.0009
	(−0.31)	(0.15)	(0.01)	(−2.02)	(−0.24)	(−0.38)
Fund_Age	0.0235***	0.0067***	−0.0098***	−0.0043***	−10.2000***	−5.7300***
	(11.09)	(6.80)	(−9.71)	(−7.59)	(−7.20)	(−7.75)
Undergrad	0.0179***	0.0110***	−0.0014	0.0053***	0.8548	−11.3000***
	(5.74)	(6.78)	(−1.39)	(3.57)	(0.36)	(−2.40)
Grad	0.0044	0.0103***	−0.0020***	0.0049***	0.5707	−11.5000**
	(1.53)	(5.86)	(−2.83)	(3.26)	(0.26)	(−2.42)
PhD	0.0000	0.0071***	0.0000	0.0105***	0.0000	−17.2000***
	–	(3.90)	–	(6.46)	–	(−3.56)
MBA	−0.0034***	−0.0006	−0.0037***	−0.0023***	−3.0067***	−1.4303***
	(−3.26)	(−1.44)	(−5.21)	(−8.01)	(−3.82)	(−4.59)
Cert	0.0099***	0.0011**	0.0004	0.0012***	0.5817	0.7510**
	(8.20)	(2.27)	(0.91)	(4.74)	(0.91)	(2.06)
Mgr_Age	0.0111***	–	−0.0002	–	0.2020	–
	(4.13)		(−0.10)		(0.10)	
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	21,886	47,518	21,886	47,518	21,886	47,518
Adj. R-squared	0.8395	0.8361	0.5653	0.5761	0.7220	0.7136

Note: This table presents the regression of portfolio liquidity on the single-female-managed transition funds. The model is given in Equation (5). Panel A reports the results from male to female and female to male transition funds. Panel B shows the regression results using panel observations of all the transition funds, including male to female, female to male, male to male, and female to female. The dependent variable is portfolio liquidity, *Port_Liq*. *Port_Liq_Sprd* and *Flow* are measured in basis points. The results are presented with fund and year fixed effects. The *t*-statistics based on White robust standard errors are reported in parentheses. ***, ** and * denote 99%, 95% and 90% significance levels. See Table C1 in the appendix for an explanation of all the variables.

Table 6. Difference-in-differences regression for transition funds

	Port_Liq_PST		Port_Liq_Amhd		Port_Liq_Sprd	
	(1)	(2)	(3)	(4)	(5)	(6)
Female_Trans × Post	0.0133***	0.0069***	0.0041***	0.0001	1.5754***	1.3554
	(5.12)	(6.02)	(6.17)	(0.19)	(2.78)	(1.26)
Post	−0.0027**	−0.0011**	−0.0004	0.0002	0.9383***	2.6364***
	(−2.18)	(−2.28)	(−0.78)	(0.50)	(2.83)	(8.43)
Ret	−0.0253**	−0.0060	−0.0048	0.0007	−6.4226	7.1154**
	(−2.29)	(−1.57)	(−0.66)	(0.17)	(−1.38)	(2.03)
Size	0.0043***	0.0056***	−0.0003**	0.0065***	0.6694***	5.3207***
	(10.10)	(10.30)	(−2.43)	(8.07)	(4.94)	(10.70)
Exp	−28.4981***	−0.8991	−1.7258**	−4.0899***	139.8000	1085.7000
	(−8.75)	(−1.05)	(−2.25)	(−3.81)	(0.28)	(0.64)
TOratio	−0.1251***	−0.0448***	0.0406***	0.0084***	19.9000***	3.6957
	(−17.63)	(−9.18)	(12.99)	(2.64)	(8.99)	(1.08)
Flow	0.0266	0.0043	−0.0070	−0.0025	−0.0002	−0.0004
	(0.85)	(0.21)	(−0.47)	(−1.47)	(−1.22)	(−0.26)
Fund_Age	−0.0094***	−0.0081***	0.0023***	−0.0021	−1.1627***	−3.7455*
	(−7.20)	(−2.96)	(6.06)	(−1.19)	(−2.87)	(−1.87)
Undergrad	0.0412***	0.0117***	0.0108***	0.0074***	10.7000***	9.7681***
	(13.34)	(6.06)	(6.76)	(4.03)	(10.14)	(3.96)
Grad	0.0399***	0.0066***	0.0138***	0.0073***	11.2000***	10.4000***
	(12.56)	(3.01)	(8.46)	(4.05)	(10.23)	(4.06)
PhD	0.0246***	0.0079***	0.0147***	0.0052***	10.2000***	6.3305***
	(7.08)	(3.71)	(8.36)	(2.81)	(8.51)	(2.50)
MBA	0.0056***	−0.0025***	−0.0037***	−0.0017***	−1.3375***	−1.9400***
	(4.98)	(−3.65)	(−7.88)	(−3.54)	(−3.53)	(−4.07)
Cert	−0.0062***	−0.0016**	0.0052***	−0.0011***	1.5446***	0.9625*
	(−5.53)	(−2.32)	(9.97)	(−4.17)	(4.09)	(1.71)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effect	No	Yes	No	Yes	No	Yes
No. of obs.	10,772	10,772	10,772	10,772	10,772	10,772
Adj. R-squared	0.1516	0.8758	0.1013	0.6250	0.6452	0.7440

Notes: This table presents the findings of the difference-in-differences regression of portfolio liquidity after the male to female transition. The dependent variable is portfolio liquidity, *Port_Liq*. *Female_Trans* is a dummy variable equal to 1 if the fund is a male to female transition fund and to 0 if the fund is a male to male transition fund. *Post* is a dummy variable equal to 1 if month t+1 is after the transition and to 0 if it is before the transition. *Female_Trans × Post* is the multiplication of transition funds and Post variables. *Port_Liq_Sprd* and *Flow* are measured in basis points. The results are presented with and without fund and year fixed effects. The t-statistics based on White robust standard errors are reported in parentheses. ***, ** and * denote 99%, 95% and 90% significance levels. See Table C1 in the appendix for an explanation of all the variables.

$$Port\_Liq_{i,t+1} = \alpha + \beta_1 \, Female\_Trans_i \times Post_{i,t+1} + \beta_2 \, Post_{i,t+1} + \gamma \, Controls_{i,t} + \varepsilon_{i,t}.$$

Table 7. Preference for portfolio liquidity – instrumental variable approach

	First stage (1)	Port_Liq_PST Second stage (2)	Port_Liq_Amhd Second stage (3)	Port_Liq_Sprd Second stage (4)
Instrumented_Female	-	0.0661***	0.0321***	0.4700
		(6.91)	(4.73)	(0.10)
Ret	−0.0224	−0.0182***	−0.0053**	1.6000
	(−1.35)	(−6.06)	(−2.04)	(0.87)
Size	−0.0048***	0.0053***	0.0011***	0.8200***
	(−9.03)	(49.63)	(16.47)	(18.01)
Exp	27.8319***	−24.1122***	−5.5284***	−1160.8000***
	(13.19)	(−32.65)	(−13.70)	(−5.37)
TOratio	−0.0103	−0.0280***	0.0231***	12.2300***
	(−1.04)	(−14.23)	(13.07)	(12.98)
Flow	−0.1000	0.0347	0.0059	−0.0008
	(−0.78)	(1.48)	(1.26)	(−1.12)
Fund_Age	0.0112***	−0.0039***	0.0005***	−0.2000*
	(8.27)	(−11.98)	(3.02)	(−1.76)
Undergrad	−0.0066	−0.0203***	−0.0202***	−0.3000
	(−0.28)	(−6.38)	(−15.76)	(−0.09)
Grad	−0.0096	−0.0179***	−0.0197***	−0.0871
	(−0.40)	(−5.56)	(−15.07)	(−0.03)
PhD	−0.0769***	−0.0230***	−0.0209***	−6.2000**
	(−3.13)	(−6.74)	(−13.29)	(−2.09)
MBA	−0.0080***	0.0058***	−0.0028***	−1.6000***
	(−4.45)	(17.33)	(−11.77)	(−10.93)
Cert	0.0294***	−0.0093***	0.0018***	0.3300*
	(16.69)	(−21.77)	(5.85)	(1.77)
Equality_Index	0.0036***	-	-	-
	(18.91)			
Year fixed effect	Yes	Yes	Yes	Yes
Style fixed effect	Yes	Yes	Yes	Yes
No. of obs.	112,842	112,842	112,842	112,842
Adj. R-squared	0.0157	0.1770	0.0981	0.6340
F-statistics	38.58	-	-	-
[p-value]	[0.00]			

This table presents the findings of the two-stage least squares regression. Column (1) reports the results from the first-stage ordinary least squares regression with the female dummy as the dependent variable. *Equality_Index* is the state's gender equality index. F-statistics from the first-stage regression are at the bottom of the table. Columns (2), (3) and (4) show the results for the second-stage regressions with the three measures of portfolio liquidity as the dependent variables. *Instrumented_Female* is the fitted value of the female dummy from the first-stage regression. *Port_Liq_Sprd* and *Flow* are measured in basis points. The results are presented with year and fund style fixed effects. The t-statistics based on White robust standard errors are reported in parentheses. ***, ** and * denote 99%, 95% and 90% significance levels. See Table C1 in the appendix for an explanation of all the variables.

$$Female_i = \varphi + \gamma_1 \, Equality\_Index_i + \gamma \, Controls_{i,t} + \varepsilon_{i,t},$$
$$Port\_Liq_{i,t} = \alpha + \beta_1 \, Instrumented\_Female_i + \gamma \, Controls_{i,t} + \varepsilon_{i,t}.$$

sonably fulfills the requirements of an instrumental variable.

Column (1) of Table 7 reports the results of the first-stage regression. It can be concluded that the gender equality index is significantly associated with having a female manager manage the fund. The association is significant at the 1% level. The F-statistic is 38.58, which confirms the strength of the instrument. Columns (2)–(4) depict the second-stage analysis outcomes and confirm our

study's main findings. In our analysis, the positive coefficient of Port_Liq_Sprd is insignificant; however, the other two measures are positively and significantly related to female-managed funds. Subsequently, we conclude that funds with a higher tendency to appoint female fund managers have a higher portfolio liquidity.

In summary, our results show the economic significance and marginal impact of gender-related leadership transition, which is consistent with the

previous literature that has suggested that companies with more diverse leadership tend to perform better financially. This is often attributed to the fact that diverse teams bring different perspectives and approaches to decision-making, which can lead to more innovative solutions and better risk management (Flabbi *et al.*, 2019). Additionally, companies that are seen as promoting gender equality may be more attractive to customers and employees, which can lead to increased sales and a more talented and engaged workforce (Iman, Nazarov and Obydenkova, 2022; Karim, Naeem and Ismail, 2022). Furthermore, having more women in leadership positions can help to break down gender stereotypes and discrimination in the workplace, creating a more equitable and inclusive environment for all employees. In terms of the marginal impact of gender-related leadership transition, the marginal impact of increasing the representation of women in leadership roles can be significant, but it may depend on the specific context and the number of women already in leadership positions. For example, studies have found that having a critical mass of women in leadership roles, rather than just a token representation, is associated with better financial performance for companies (Lafuente and Vaillant, 2019; Karim, 2021). Additionally, the literature suggests that having women in leadership roles can lead to greater gender equality and diversity within the organization, which can have a positive impact on employee morale, productivity and innovation (Gull, Atif and Hussain, 2023). However, it is important to note that other factors such as the culture and policies of the organization play a crucial role in determining the success of gender-related leadership transition.

Conclusion

This study provides empirical evidence that the preference of female fund managers to hold a liquid portfolio is significantly higher than that of male managers. This finding is consistent with the conjecture that stocks that incorporate available information efficiently attract female fund managers more than male fund managers. Hence, female managers' preference for informationally transparent stocks motivates them to hold more liquid stocks in the portfolio. Consistent with the literature, this study reports a lower portfolio risk

of female-managed funds. On average, we document that female-managed funds are smaller in size, earn a lower return, receive lesser flow and hold a smaller number of stocks in their portfolio than male-managed funds. Further, the analysis of portfolio liquidity change around manager transition indicates that portfolio liquidity increases after a male to female transition compared with a male to male transition. We use the gender status equality index as an instrumental variable in the 2-Stage Least Squares (2SLS) analysis. The results support the conjecture that female managers' funds have higher portfolio liquidity than male-managed funds.

Third, this paper provides new insights regarding gender differences in the asset allocation decisions of fund managers. Female fund managers prefer to hold more liquid assets; however, we must consider the tradeoff between liquidity and returns (Amihud and Mendelson, 1986). A liquidity-preferred portfolio has a higher tendency to deteriorate fund performance owing to lower returns. Although female-managed funds are less risky and satisfy the investors' liquidity needs, especially during a crisis, they receive a lower inflow than male-managed funds. Literature suggests that funds inflow of male-managed funds is higher than those of female-managed. Hence, male managers may enjoy a higher inflow even with a less liquid holdings portfolio. The literature provides evidence that a less liquid portfolio has a higher tendency of earning positive returns.

The relationship between gender and mutual fund liquidity has several managerial implications. We conclude that mutual funds managed by women tend to have higher liquidity than those managed by men. This may be due to differences in investment styles or risk aversion. Managers who are aware of this relationship tend to choose to hire or promote more women in leadership roles within their fund management teams. This could lead to an increase in liquidity and potentially better performance for the fund. Additionally, managers may also implement policies and procedures to encourage their investment teams to take a more liquidity-focused approach to portfolio management. This could include setting specific liquidity targets or allocating a certain percentage of assets to more liquid investments. Overall, understanding the relationship between gender and mutual fund liquidity can provide valuable insights for fund managers looking to improve

the performance and risk management of their funds.

On policy fronts, the relationship between gender and mutual fund liquidity has multiple implications as well. One implication is that regulators can consider implementing policies to promote gender diversity within the mutual fund industry. This could include initiatives to increase the number of women in leadership roles within fund management companies, or to encourage more women to pursue careers in finance. Another implication is that regulators may review the current rules and regulations that govern mutual funds to ensure that they do not inadvertently discriminate against women-led funds. For example, regulations that limit the amount of leverage that funds can use or that require funds to hold certain minimum levels of liquidity may disproportionately affect funds managed by women, which tend to have higher liquidity than those managed by men. Additionally, policymakers may also consider implementing measures to promote liquidity in the mutual fund industry more generally. This could include encouraging better disclosure of liquidity risks or implementing regulations to limit the use of leverage by mutual funds. In essence, understanding the relationship between gender and mutual fund liquidity can provide valuable insights for policymakers looking to promote gender diversity and seeking to improve the stability and resilience of the mutual fund industry.

Although the study offers several practical implications, it has a few research limitations. Cumming, Johan and Zhang (2019) show that mutual fund fees influence fund performance and fund flow. Using mutual fund fee structure as a control to test the impact of gender on fund liquidity may show interesting results. However, owing to data limitations, this variable is not included in robustness check. Based on the theoretical underpinnings of the study, because we report that the magnitude of portfolio liquidity is higher for a female-managed fund as compared with a fund managed by a male manager, there is still a need to explore these findings in different country settings and using various methodological approaches. As a result, our robustness results do not support the argument that change in fund managers is symmetric with gender transition as proposed by earlier empirical studies (Falconieri and Akter, 2023; Gao, Liu and Wang, 2022; Zhang, 2022); therefore, further investigation of the current nexus is

required to provide firm evidence in theory and literature.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section at the end of the article.