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Encouraging retirement savings: The role of Chinese pension funds

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ABSTRACT

In 2018, the Chinese government introduced a regulatory framework for target pension funds, specifically Target Date Funds (TDFs) and Target Risk Funds (TRFs), marking their debut in the Chinese market. This framework imposed stringent requirements on fund family size, lock-in periods, and manager experience. Within this institutional context, we first document these funds characteristics are positively associated with fund returns and fund flows for TDFs & TRFs. Conversely, we find that these same restrictions provide little to no benefit for standard mutual funds. In the mechanism test, we further find that TDFs & TRFs are associated with greater flow stability, contributing to their outperformance over standard mutual funds. Moreover, managing TDFs & TRFs may inadvertently dampen the performance of non-TDFs and non-TRFs managed by the same fund family, potentially due to increased compliance and disclosure costs as well as fund family strategic considerations. Our results show that the regulatory requirements imposed on TDFs & TRFs are associated with both benefits and costs, suggesting the critical importance of recognizing the distinct policy implications for regulators, fund issuers, and investors, particularly in the context of retirement savings.

1. Introduction

The most striking demographic change over the past 30 years has been the rapid pace of the global population aging (Powell, 2010).[1] The physical effects of aging, coupled with the higher likelihood that the aged population possess mismatched skills in the labour market, contribute to a reduced capacity among the elderly to generate private income compared to younger individuals (Banister et al., 2012). At the same time, the demographic distribution has shifted dramatically. Since 2020, there have been more people over the age of 60 than children under the age of 5. This shift not only suggests less familial support for the elderly but also signals potential reduction in government retirement benefits due to a shrinking taxpaying population but an increasing aging population.

In particular, China faces the most acute demographic challenge compared to other regions of the world in the pace of aging (United Nations, 2022). From the National Bureau of Statistics of China, the population aged 65 and above reached 210.35 million, accounting

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[1] The natural growth rate of the global population ranged from 1.79% to 0.82% between 1980 and 2021, and the United Nations forecast the population growth rate will drop to negative in 2086 (United Nations, 2022). The World Health Organization (WHO) predicts that the proportion of persons aged 60 and older will roughly double between 2015 and 2050, increasing from 12% to 22%, and the population aged 60 and above will reach 2.1 billion in 2050.

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for 14.9% of the total population in 2022. Projections suggest this share will rise to 22% by 2040.[2] Compounding this trend, the natural population growth rate of China has fallen to −0.60‰ in 2022. These demographic shifts imply that the burden of retirement savings will increasingly fall on individual households. Traditionally, guided by the proverb "Bring up children for one's old age," Chinese families relied on children for elder support. However, the historical family planning policies, modern cultural changes and smaller family sizes have weakened this expectation (Chou, 2011; Niu et al., 2020). Additionally, despite rapid economic growth, rural areas remain less developed. These demographic shifts could have an even greater impact on rural residents, who face limited pension options, low incomes, meager savings, and a historically greater dependence on family support (Cai et al., 2012).

The retirement saving system in China follows the World Bank's popular three-pillar model.[3] Currently, basic pension insurance constitutes the first pillar and uses the pay-as-you-go (PAYG) model. It is regulated by the Chinese government and encompasses the Basic Old-Age Insurance System for Employees (BOISE) and Basic Pension Insurance for Urban and Rural Residents (BPIURR). The second pillar involves supplementary pension insurance, which consists of enterprise annuities and occupational annuities. The third pillar consists of commercial pensions and private pension funds. However, the composition of the three pillars is unbalanced in China. Wang et al. (2014) point out that China relies almost solely on public pensions to alleviate poverty among the elderly. The "China Aging Research Report 2022" indicates that the first pillar of pensions accounted for as much as 70% of the total retirement savings. Such a heavy reliance on the first pillar, not surprisingly, leaves a significant pension gap with the substantial surge in the aging population as discussed above. In 2020, 50 billion RMB was injected for the first time to fill the gap in basic pension insurance.[4] More importantly, this problem will only further exacerbate with the current demographic trend. The need to solidify the second and third pillars of retirement saving is urgent in China.

As a significant step toward promoting the third pillar of retirement savings in response to an aging population, the China Securities Regulatory Commission (CSRC) issued the Notice on Regulating the Development of Target Pension Securities Investment Funds (Trial) in February 2018. This policy established the regulatory framework for target pension funds, including Target Date Funds (TDFs) and Target Risk Funds (TRFs), significantly advancing China's voluntary personal pension system. To build consumer confidence, the policy introduced strict requirements regarding fund family size, lock-in periods, and manager experience on TDFs & TRFs. These regulatory standards distinguish TDFs & TRFs from standard mutual funds in China.

From an international perspective, TDFs & TRFs in China differ from those in the U.S. Although TDFs & TRFs have been widely used in 401(k) plans and individual retirement accounts in the U.S., these products are relatively new in China. Designed for retirement savings, TDFs automatically adjust their investment mix to reflect varied investment risk profiles over investor life cycles based on a specific target retirement date. Differently, TRFs focus on maintaining a consistent level of risk that aligns with an investor's risk tolerance, regardless of time horizon. Previous research finds mixed evidence regarding the efficiency of these specific retirement-saving tools (Elton et al., 2015; Elton et al., 2016; Balduzzi and Reuter, 2019). In the Chinese context, the urgent need to encourage private retirement savings, combined with the first-time introduction of TDFs & TRFs, and the strict and specific regulatory requirements for TDF & TRF issuers, motivate the key research question of this study. Specifically, for the TDFs & TRFs that have emerged under this institutional context, all of which meet regulatory requirements for fund family size, lock-in periods, and manager experience, do these specific characteristics relate to their performance? The investigation ultimately sheds light on the policy effectiveness in addressing the adequacy of household retirement savings.

It is also worth noting that mutual funds have become a major investment vehicle for Chinese households. Between 2008 and 2020, the net asset value of China's mutual funds grew impressively from 1.87 trillion RMB to 20.01 trillion RMB (You et al., 2023). The number of mutual funds surged from 409 to 7238 during the same period. While pension funds are still relatively new in China, there is no doubt that it will expand rapidly by borrowing experience from other developed markets. For example, nearly half of the assets in U.S. mutual funds originate from pension fund accounts, defined contribution retirement plan accounts, and individual retirement accounts.[5] Therefore, investigating (pension) fund performance in China, the third largest capital market by market capitalisation, could have important implications for global financial markets and household well-being.[6]

Our study includes all TDFs & TRFs introduced since 2018. To highlight whether the newly introduced TDFs & TRFs provide advantage over existing general saving means, we also include all open-end mutual funds that have data for our research covering 2004–2022 period. First, we examine whether the regulatory requirements on fund family size, lock-in period, and manager experience contribute to better fund performance of TDFs & TRFs, measured by fund returns and fund net inflows. In general, our results

[2] We source the statistics from American Enterprise Institute, more details can be found on the website: https://aei.org/.

[3] In 1994, the World Bank introduced the well-known three-pillar retirement saving system to guide institutional and household practices. The first pillar relies on a basic public pension (mandatory and state-provided) designed to provide a basic level of income for all retirees, ensuring that no one falls into poverty in old age. It emphasizes the importance of universal coverage and adequacy, funded primarily through general taxation or payroll contributions. The second pillar consists of occupational or mandatory private savings schemes, often linked to employment. These schemes can be publicly or privately managed and are intended to supplement the basic pension, thereby improving retirement income adequacy. Pillar three, voluntary private savings, encourages individuals to save through private retirement accounts, tax incentives, and other financial products, giving them more control over their retirement planning.

[4] For more details, refer to the "Report on the execution of the central and local budgets for 2020 and on the draft central and local budgets for 2021", which was issued by the Ministry of Finance on 13 May 2021.

[5] See the 2024 Investment Company Fact Book.

[6] While another strand of literature examines retirement saving decisions through welfare and lifecycle utility frameworks (e.g., Cocco et al., 2005; Dahlquist et al. 2018), our study takes a different approach. We focus on studying the performance of new retirement saving vehicles emerging as a result of regulatory incentives. We leave these alternative perspectives for future research.

show supportive evidence that TDFs & TRFs with a bigger fund family size, a longer lock-in period, and a more experienced fund manager outperform. Next, as a comparison, we run the same analysis for standard mutual funds (which are not subject to the stricter requirements). The evidence is mixed as previously documented in the literature (Massa, 2003; Ding and Wermers, 2012). We find that only fund family size has a small positive effect on mutual fund returns, while lock-in period and manager experience generally exhibit a negative relationship with fund flows. Taken together, while the results support the efficiency of the stricter characteristics requirements on TDFs & TRFs which specifically serve the investment goal of retirement saving, imposing the same requirements on standard mutual funds may have an adverse impact (Khorana et al., 2005).

Additionally, we test the relative importance of fund family size, lock-in period and manager experience to different fund performance outcomes and provide guidance for investors' fund selection. Based on adjusted R-squared improvements of competing models, we find the most important factors for TDFs & TRFs returns are manager experience, lock-in period and fund family size in order. For fund flows of TDFs & TRFs, lock-in period ranks ahead of fund family size and manager experience. It may not be surprising as lock-in period would significantly influence investors' ability to withdraw from funds. When we perform the same analysis for standard mutual funds, the results are different. The most important factors of standard mutual fund returns and flows are lock-in-period and fund family size. Interestingly, the experience of fund managers consistently ranks as a lower priority. Moreover, the explanatory power of fund family size, lock-in period and manager experience, as indicated by adjusted R-squared, are consistently higher for TDFs & TRFs than standard mutual funds, highlighting these regulatory characteristics are uniquely suited to the pension fund structure. To ensure the robustness, log-likelihood ratio tests are conducted, providing additional evidence to the overall credibility of the full model.

The initial finding that TDFs & TRFs outperform mutual funds after accounting for regulatory requirements (i.e. on fund family size, lock-in periods, and manager experience) is further confirmed in the additional regression analyses including interaction terms In the further analysis, we explore the plausible mechanisms contributing to this outperformance. Specifically, we investigate whether this outperformance is due to better genuine skills in sub-fund selection among fund managers (i.e. selection of higher-quality sub-funds) or stronger mechanical flow stability under mandatory lock-ins. Our first mechanism test rules out the proposition of superior selection skills. In particular, we find that TDFs & TRFs are more likely to select sub-funds with weaker past performance. They also tend to include affiliated sub-funds from the same fund family, which exhibit relatively weaker past performance and higher expense ratios. This latter finding is consistent with Pool et al. (2016) and Chan et al. (2017), and points to the existence of agency problems in fund selection. Our second mechanism test documents supportive evidence. We find that stronger fund flow stability induced by mandatory lock-ins indeed increases the return performance among TDFs & TRFs, as compared to non-TDFs and non-TRFs.

The contrasting influence of fund family size, lock-in period and manager experience on pension funds and standard mutual funds motivates us to carry out further investigation at the fund issuer level. Specifically, we examine whether standard mutual funds managed by a TDF & TRF issuer outperform their counterparts that do not issue TDFs or TRFs. We propose two possible impacts: on the one hand, investors could view those issuing companies[7] that have successfully obtained licenses to establish TDFs & TRFs as more reliable and reputable (Gaspar et al., 2006; Bessler et al., 2016). On the other hand, TDF & TRF issuing companies need to meet stricter rules on transparency, disclosure and experience, increasing the risk of sharing private information with other funds, incurring higher regulatory and compliance costs, and hence losing competitive edges (Parida and Teo, 2018). Our results suggest that investors do not seem to favour TDF & TRF issuers. Non-TDFs & TRFs (i.e. standard mutual funds) operated under TDF & TRF issuers do not seem to benefit by meeting the additional regulatory and compliance requirements. Rather, issuing TDFs & TRFs could be a sign of higher costs, lower flexibility, and not profit-oriented for the issuers, which in turn lowers the overall performance of those non-TDFs & TRFs managed by the same issuers. To supplement the analysis, we extend our inquiry to examine the fund performance of fund issuers who meet the TDF & TRF issuance requirements (i.e., fund company size exceeds 20 billion RMB) but choose not to issue TDFs & TRFs. The results show that these fund companies exhibit better performance compared to those fund companies issuing TDFs & TRFs, further supporting the potential negative impact of becoming a TDF & TRF issuer. The results reveal several interesting implications. While the strict regulatory requirements offer benefits to TDFs & TRFs, they may simultaneously impose costs on the issuing companies and other funds managed by the same issuing companies. Our findings suggest that fund issuers should carefully evaluate the benefits and costs of issuing TDFs & TRFs. Similarly, household investors should take into account the potential impact when selecting investment funds.

Furthermore, we perform a series of robustness checks, including using placebo tests to address potential endogeneity, examining the separate effect of fund family size, lock-in period, and manager experience on fund performance, and employing alternative measures of fund family size and fund performance. All results remain highly consistent.

We contribute to the existing literature in the following ways. First, our research adds to the limited evidence related to retirement savings, in particular, the third pillar of savings, in China. Prior to the introduction of TDFs & TRFs, there were no formal government-initiated third pillar retirement saving mechanisms in China. It is vital to understand the effectiveness of the policy for all stakeholders. TDFs & TRFs have been widely discussed and studied in Western countries where the market is more developed and mature (Elton et al., 2015; Elton et al., 2016; Balduzzi and Reuter, 2019), but scarcely examined in the Chinese market. China differs from Western countries with its unique demographical, cultural and regulatory considerations, presenting different opportunities and challenges for its own TDFs & TRFs. Ultimately, a pension system is doomed to fail if it does not benefit household welfare. Our results demonstrate that regulatory requirements on fund family size, lock-in periods and manager experience are positively related to the performance of TDFs & TRFs, suggesting that these design features can promote long-term investment discipline among household investors and

[7] In our paper, the term "issuing companies" refers to fund management companies, which are interchangeably described as "fund companies" or "fund families." In China, mutual funds are both issued and managed by these fund management companies.

ultimately improve their self-funded retirement savings and welfare. Furthermore, our comparative analysis between pension and non-pension funds shows that TDFs & TRFs consistently outperform, thereby strengthening the case for their role in improving household investor outcomes. This evidence has important implications for policymaking. We convey a positive signal to the government regarding the effectiveness of TDFs & TRFs as the key component in the third pillar of the Chinese pension system. Our findings also highlight the need for better public awareness and education about the importance of pension funds as part of individuals' retirement planning.

Second, we observe that the regulatory requirements on fund family size, lock-in period, and fund manager experience, have positive effects on the fund returns and net flows of TDFs & TRFs. The findings provide evidence on key contributors to TDFs & TRFs performance, their relative importance, and hence the selection guidelines for investors. These findings provide an international lesson for other countries facing similar aging challenges by suggesting the incorporation of private pension funds into their pension systems: private pension funds are effective in alleviating demographic pressures, improving retirement income adequacy and reducing long-term fiscal burdens on public pension schemes.

Third, we find the regulatory requirements do not equally improve the returns of standard mutual funds and even reduce the net flows of mutual funds. We attribute these differences to the distinct investment objectives and characteristics of the pension funds. Since TDFs & TRFs are inherently long-term oriented pension funds, it is important to distinguish TDFs & TRFs from other mutual funds. While requirements on fund family size, lock-in period, and fund manager experience could protect long-term investment safety and preserve capital for pension funds, they could lead to liquidity constraints, regulatory and disclosure costs for standard mutual funds. It is therefore important for regulators and policymakers to recognize both the benefits and costs associated with the offering of TDFs & TRFs, and work towards a more balanced regulatory framework to encourage the participation of fund issuers, protect investors interests and ensure the long-term sustainability of the pension system.

Fourth, we identify several issues with TDFs & TRFs in China that require attentions from policymaker. Specifically, our results indicate a negative spillover to non-TDFs & TRFs within the same fund family, as well as a tendency for fund families to include affiliated sub-funds that have weaker past performance in TDFs & TRFs. These findings highlight the potential unintended consequences that require policymakers' attention. To maintain the benefits of TDFs & TRFs while reducing their costs, regulators could consider additional regulatory measures, such as limiting the inclusion of affiliated funds to mitigate agency problems, strengthening disclosure requirements and regulatory scrutiny, and adopting more rigorous performance benchmarks. Providing clearer guidelines to investors can also help reduce uncertainty and facilitate investors to make more informed decisions when choosing the appropriate investment funds.

The remainder of the paper is structured as follows. Section 2 outlines the institutional background, related literature and hypotheses. Section 3 presents the data and methodology. In Section 4, the main results are described. In Section 5 and Section 6, further analysis and robustness checks are shown. Finally, the conclusion is shown in Section 7.

2. Institutional background, related literature and hypotheses

2.1. International lessons for China's pension reform

From a global perspective, many households under-save for retirement, prompting policymakers to experiment with mechanisms to bolster personal retirement savings (Cribb and Emmerson, 2016). Personal pension funds have emerged as a key vehicle, and cross-country evidence now provides concrete guidance on how such funds should be structured to maximise household welfare. Rather than merely documenting practices abroad, these experiences provide important lessons for China's pension reform, particularly on how Chinese TDFs & TRFs should be introduced, designed and regulated in a meaningful way that truly improve household wealth.

The most notable example, the U.S. 401(k) system, illustrates how regulatory architecture can shape outcomes. Introduced in the early 1980s, this defined-contribution (DC) plan grew to hold more than US $12.5 trillion[8] by 2023, overtaking the combined assets of public and private defined-benefit plans (Curtis et al., 2025). Empirical work shows that 401(k)s can match or outperform traditional defined benefit (DB) plans in sustaining retirement income (Samwick and Skinner, 2004). Equally important, reforms such as fee disclosure requirements lowered plan costs and improved investment choices, even if participants' cost comprehension remained imperfect (Badoer et al., 2020). Research on fund menu design finds that affiliated funds are often favoured and underperforming proprietary funds are rarely removed (Pool et al., 2016).

This highlights a fundamental institutional feature: in the U.S., plan sponsors enjoy wide menu design flexibility, but are constrained ex post by fiduciary duties and litigation risk. By contrast, China takes a more prescriptive approach, TDFs & TRFs are subject to ex-ante regulatory restrictions on sub-fund eligibility, glide-path structure, and lock-in periods. These rules reduce discretion for fund issuers and limit agency problems but also constrain product innovation. Together, these insights demonstrate how disclosure mandates, fiduciary safeguards, and limits on affiliated products can strengthen investor protection and long-term household outcomes, offering direct guidance for the regulatory design of Chinese pension products.

Other advanced economies reinforce the point that institutional architecture matters for household welfare. Australia's compulsory superannuation, the first mandatory private scheme in the English-speaking world, significantly increased household wealth and reliance on self-funded retirement income (Connolly, 2007; Kingston and Thorp, 2019). The U.K.'s automatic-enrolment policy

[8] Moreover, the Pension Protection Act of 2006 permitted the use of TDFs as default investment vehicles in employer-sponsored retirement plans, thereby establishing them as a key component of many 401(k)s (Parker et al., 2022).

required employers to default workers into pension plans, sharply boosting participation and contributions (Cribb and Emmerson, 2016). Germany's Riester pension adopted a voluntary but heavily subsidised approach; although subsidies encouraged take-up, product complexity dampened participation (Börsch-Supan et al., 2012). Collectively, these cases show that regulatory levers—mandatory contributions, tax incentives, automatic enrolment, and subsidies—can foster long-term savings discipline and enhance household financial autonomy.

These international lessons are particularly relevant for China, which faces not only the shared challenge of population aging but also demographic dynamics shaped uniquely by its past family planning policies. The One-Child Policy, introduced in 1979, initially succeeded in curbing rapid population growth and improving population quality (Cao et al., 2015). However, after more than three decades, its negative consequences have become increasingly apparent. The natural population growth rate has steadily declined, falling from 16.61‰ in 1987 to −0.60‰ in 2022. Attempts to reverse this trend through the Universal Two-Child Policy in 2015 and the Three-Child Policy in 2021 brought only a brief uptick in 2016, followed by continued decline. Unlike other aging societies, China's demographic transition is occurring with unprecedented speed and scale. The shrinking share of young workers not only intensifies labour shortages but also heightens the economic burden of supporting a growing elderly population. To indicate, the old-age dependency ratio—the proportion of people aged 65 and over relative to the working-age population—is projected to surge from 19.7% in 2020 to 50% by 2050, according to the "China Aging Research Report 2022".

In response to the aging challenge, China has widely implemented a three-pillar pension system since the 1990s. Pensions serve as a critical source of post-retirement income, helping to ensure the elderly's financial security and resource accessibility (Lu and Shelley, 2021). However, significant gaps in pension coverage have emerged, as noted in the introduction. To strengthen the third pillar of retirement savings, the government introduced TDFs & TRFs in 2018. Further reinforcing this effort, the State Council issued the Opinions on Promoting the Development of Personal Pensions on April 8, 2022. Since then, personal pension accounts have experienced rapid growth, with the number of accounts exceeding 50 million by the end of 2023.

Complementing pension reforms, China also announced in 2024 a gradual increase in the statutory retirement age. Under the new plan, the retirement age for male employees will be raised from 60 to 63, and for female workers and cadres (such as teachers, healthcare professionals, and administrators) from 50/55 to 55/58 over the next 15 years, following a voluntary and flexible approach. As Bidewell et al. (2006) argue, delaying retirement can enhance individual savings and superannuation funds, provide greater monetary rewards, and improve retirement preparedness.

Nevertheless, despite these policy efforts, the profound demographic shifts mean that the responsibility for retirement savings is increasingly shifting to individual households (Lusardi and Mitchell, 2011). Retirement planning is a long-term process critical for ensuring a smooth transition into old age and maintaining quality of life (Yeung, 2013). Pension funds, in particular, provide an effective financial instrument for individuals to accumulate retirement savings and help narrow the emerging pension gap (Bongini and Cucinelli, 2019).

This study represents one of the first empirical investigations into the effectiveness of China's newly implemented third-pillar retirement policies. By focusing on the performance of TDFs & TRFs under strict regulatory frameworks, it provides critical early evidence on whether these measures are achieving their intended goals of enhancing retirement security amid an accelerating demographic transition.

2.2. Target pension funds

Unlike in other countries, a comprehensive target pension fund system in China only began following the implementation of the trial policy for target pension securities investment funds in 2018. Shortly thereafter, fourteen target pension funds—categorized into two types, TDFs & TRFs, and structured as FOFs[9]—became available to investors on August 6, 2018.

Considering the decline in human capital as individuals age, TDFs provide dynamic exposure to stocks, bonds, and other asset classes by gradually reducing equity allocations and increasing fixed-income holdings as the target retirement date nears (Elton et al., 2015; Levy and Levy, 2021; Parker et al., 2023). Each TDF specifies a maturity date (e.g., the China AMC Pension Goal Date 2040), so investors can select a fund aligned with their intended retirement age. This built-in glide path ensures that portfolio risk automatically decreases over time, suiting households that prefer a default mechanism to match changing risk capacity across the life cycle.

By contrast, TRFs are structured around a stable risk profile rather than a retirement date. They maintain a constant mix of equities, bonds, and other assets, classified as conservative, moderate, or aggressive, so that investors retain full control over their long-term risk exposure (Elton et al., 2016). Aggressive TRFs, for example, allocate a higher share of equities and lower-rated bonds, while conservative ones emphasise fixed income.

Regarding their lock-in period, we also observe significant difference between TDFs & TRFs. Based on our summary statistics, the minimum holding period is 41.25 years for TDFs and 21.92 years for TRFs. The longer lock-in period of TDFs reflects their distinct glide-path design, which encourages long-term holding aligned with the retirement year.

Together, these products offer complementary solutions for Chinese households with varying appetites for investment risk and degrees of engagement in retirement planning (Elton et al., 2016): TDFs for those seeking an age-based, automatically de-risking

[9] FOFs do not invest directly in stocks and bonds, but rather in equity funds, bond funds, and money market funds.

strategy, and TRFs for those who wish to lock in a desired risk level throughout the investment horizon.

The number of TDFs & TRFs in China grew from virtually non-existent to 143 and 207,[10] respectively, from 2018 to 2022. As relatively new financial instruments, TDFs & TRFs have yet to be thoroughly explored in the Chinese market. TDFs & TRFs in China are subject to more stringent requirements regarding the scale of their fund family size, lock-in period, and manager experience. Specifically, according to the trial policy, fund families must maintain an average mutual fund management scale (excluding money market funds) of at least 20 billion RMB over the past three years; with a lock-in period of no less than one year; and with more experienced managers compared to other funds.[11] Additionally, sub-funds included in TDFs & TRFs must also meet quality criteria: they must have a minimum operating history of two years, and their average net assets over the last two quarters must be at least 200 million yuan. Fund names must include "Pension Goal", and disclosure obligations are more stringent than for conventional funds. Fund companies need to first meet these regulatory requirements and then obtain approval from the China Securities Regulatory Commission before they can list their funds on the market. These conditions are mandated by regulation, and not left to fund-family discretion.[12]

Given their status as lifecycle investment funds, TDFs & TRFs represent a significant segment of the mutual fund industry (Lewis, 2008). It is crucial to investigate their performance in China, especially considering the rapid growth of the country's mutual fund market.

2.3. Hypotheses

In this study, we examine how the three fund characteristics (fund size, lock-in periods, and manager experience), as reflected in the mandatory setup rules on TDFs & TRFs affect fund performance. The results aim to provide evidence on the effectiveness of regulating fund characteristics in promoting retirement savings within the current Chinese pension system.

According to the trial regulation of target pension funds, fund families must maintain an average mutual fund management scale (excluding money market funds) of at least 20 billion RMB over the past three years. Generally, a fund company manages a collection of funds, commonly referred to as a "fund family" (Nanda et al., 2004). A fund family is responsible for managing and marketing funds of different scales, and it is also associated with a high level of rigor and complexity in the decision-making process (Gaspar et al., 2006). Many empirical studies confirm the inherent advantages of fund family size on fund performance (Chen et al., 2004; Pollet and Wilson, 2008; Bhojraj et al., 2012). Chen et al. (2004) explain that a larger fund family size captures the economies of scale associated with marketing efforts aimed at enhancing fund performance in the market. Meanwhile, compared to small-fund families, larger-fund families tend to invest heavily in their research departments, purchase proprietary research, gain access to management at conferences, and enjoy resource advantages, which in turn improve their fund performance (Bhojraj et al., 2012). Sirri and Tufano (1998) also reveal that fund visibility and brand awareness are enhanced with larger fund family sizes. In addition, larger fund family size tends to generate increased investor popularity, leading to a higher influx of fund flows from investors (Sirri and Tufano, 1998; Chen et al., 2004; Benson et al., 2008). Based on the above evidence in the existing literature, we propose our H1a and H1b as below:

H1a: A larger fund family size positively affects the fund returns of TDFs & TRFs.

H1b: A larger fund family size positively affects the fund flows of TDFs & TRFs.

Lock-in period refers to the minimum holding period for which investors hold with no withdrawal (Ayayi, 2005). Aragon (2007) and Aiken et al. (2021) discern that hedge funds with lock-in periods improve their performance by reducing liquidity risk and increasing management flexibility. Cumming et al. (2015) find that hedge funds with longer lock-in periods offer fund managers greater discretion in managing risk levels. In particular, a longer lock-in period provides managers with greater freedom to implement their investment strategies (Agarwal et al., 2009), including controlling fund portfolios, adjusting asset allocations, and making strategic investment decisions, without worrying about investors' redemption demands. In addition to the managerial perspective, a longer lock-in period also helps investors navigate market cycles and benefit from the compounding of long-term investments. TDFs & TRFs not only require a lock-in period but also have long-term investment goals, encouraging investors to hold their investments for the long term and pursue stable asset growth.

According to the "Notice on Regulating the Development of Target Pension Securities Investment Funds (Trial)", the lock-in period for TDFs & TRFs could be 12 months and longer. When the lock-in period is at least 1, 3, or 5 years, the fund's total allocation to risky assets (such as stocks, equity funds, hybrid funds, and commodity funds) must not exceed 30%, 60%, and 80%, respectively. This structure reflects the general practice in fund management that a longer investment horizon justifies higher exposure to risk. Notably, all funds in our sample are open-end. After the initial lock-in period expires, investors can either stay invested or redeem their shares.

[10] We acknowledge that the sample size of TDFs & TRFs in this study is relatively small, as this remains a relatively new area of research. Nevertheless, our analysis provides valuable initial insights, and we hope that future studies will extend these findings using larger samples and broader coverage when more data is available.

[11] Specially, according to the trial regulation, fund managers are expected to give priority to appointing investment research personnel who meet the following qualifications for managing target funds: (i) at least five years of experience in securities investment, securities research and analysis, or securities investment fund research, evaluation, or analysis within the financial industry, including a minimum of two years in securities investment; or (ii) at least five years of experience in asset allocation for pension funds or insurance funds.

[12] The regulatory framework for target pension funds is set by the central government and applies uniformly across the country. As such, all TDFs & TRFs are national-level funds governed by the same set of rules, and there is currently no sub-national heterogeneity in their regulation or availability.

However, as new investors continuously enter the fund, a portion of the total assets remains effectively 'locked' at all times. Given the short history of TDFs & TRFs in China, combined with the rapid growth of the fund sector and an aging population, we anticipate that the proportion of 'locked' assets remain substantial compared to the volume of redemptions. Based on the above discussion, we propose our H2a and H2b as follows:

H2a: Funds with a longer lock-in period are associated with a higher level of fund return of TDFs & TRFs.

H2b: Funds with a longer lock-in period are associated with a higher level of fund flow of TDFs & TRFs.

The trial regulation also requires more experienced fund managers for managing target pension funds, i.e. (i) at least five years of experience in securities investment, securities research and analysis, or securities investment fund research, evaluation, or analysis within the financial industry, including a minimum of two years in securities investment; or (ii) at least five years of experience in asset allocation for pension funds or insurance funds. Several studies have observed that fund managers with greater experience, longer tenure, older age, and early career stares during recession tend to generate excess returns compared to their counterparts, holding other factors constant (Golec, 1996; Clare, 2017; Chen et al., 2021a; Clare et al., 2022). Experienced fund managers not only possess superior skills, as observed by Ding and Wermers (2012) in their study of domestic U.S. equity funds, but also help fund teams accumulate stock analysis expertise and build strong connections with sell-side analysts and corporate CEOs. Moreover, fund managers often gather private information (e.g., stock valuations) to enhance performance when they have favorable relationships with CEOs, particularly if they share the same alma mater (Cohen et al., 2008). Based on the above, we propose the following hypotheses, H3a and H3b:

H3a: Fund managers who are of greater experience are associated with a higher level of fund return of TDFs & TRFs.

H3b: Fund managers who are of greater experience are associated with a higher level of fund flow of TDFs & TRFs.

Our hypotheses therefore focus on whether the regulatory requirements imposed on TDFs & TRFs—fund family size, lock-in periods, and managerial experience—and going beyond these minimum thresholds, influence fund outcomes. As a contrast, we also test whether the same characteristics affect the outcomes of standard mutual funds. Unlike TDFs & TRFs, conventional mutual funds face no such lower limits: lock-in periods are typically absent, manager experience is unconstrained, and family size can be well below the regulatory threshold applied to pension funds. Because TDFs & TRFs were only introduced after these rules came into effect, every fund in this category necessarily satisfies the requirements, while mutual funds remain unaffected. Consequently, the mechanisms through which these characteristics operate for TDFs & TRFs differ from those for mutual funds. Our empirical setting is explicitly designed to capture this regulatory distinction.

3. Data and methodology

3.1. Sample and data

We start with all fund data available from the WIND and CSMAR databases. We classify TDFs & TRFs from FOFs based on WIND identification. The remaining funds are standard mutual funds. To ensure sample representativeness, we cross-check the data between the WIND and CSMAR databases. Our final sample comprises 9276 open-end funds from 2004 to 2022, with a total of 167,084 fund-quarter observations. Following standard practice in the existing literature, we winsorize all continuous variables at the 1st and 99th percentiles to mitigate the effect of outliers.

3.2. Measuring fund return and fund flow

Fund return and fund flow are the key outcome variables of interest in our study. Our main fund return measure is the Fama-French three-factor alpha, which includes market risk, size and book-to-market value in the model (Fama and French, 1993; Yan, 2008; Rao et al., 2020). The regression model is below:

$$r_{i,t} - r_{f,t} = a_i + \beta_{1,i} \times \left(r_{m,t} - r_{f,t}\right) + \beta_{2,i} \times SMB_{i,t} + \beta_{3,i} \times HML_{i,t} + \varepsilon_{i,t} \tag{1}$$

where $r_{i,t}$ is the return of fund i at month t, and $r_{m,t}$ represents the return of the corresponding Shanghai Stock Exchange-Shenzhen Stock Exchange (SSE-SZSE) index. The risk-free rate $r_{f,t}$ is the monthly interest rate of the official one-year term deposit (Chen et al., 2018). $r_{m,t} - r_{f,t}$ is the excess return of funds. $SMB_{i,t}$ (small minus big) is the average return on the small-capitalization stock portfolio minus the average return on the large-capitalization stock portfolio.$HML_{i,t}$(high minus low) is the average return on a high book-to-market stock portfolio minus the average return on a low book-to-market stock portfolio. To calculate quarterly alpha (a_i), we use a rolling window of 24 months to obtain monthly fund returns, and then aggregate them into quarterly returns (Amihud and Goyenko, 2013).

Following Sirri and Tufano (1998), Goldstein et al. (2017), and Fong et al. (2018), we estimate net fund flows by considering the difference in total net assets of each fund between two consecutive quarters, taking into account the corresponding fund return. The fund flow $Flow_{i,t}$ for fund i in quarter t is defined as:

$$Flow_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1} \times (1 + Return_{i,t})}{TNA_{i,t-1}} \tag{2}$$

where $TNA_{i,t}$ is the total net asset value of fund i at the end of quarter t, and $Return_{i,t}$ is the rate of return of fund i during quarter t.

3.3. Baseline model

Our baseline model estimation is as follows:

$$Y_{c,i,t} = a_i + \beta_1 FundFamilySize_{i,t} + \beta_2 LockInPeriod_{i,t} + \beta_3 Experience_{i,t} + Controls + \theta' FundTypeFE + \psi' QuarterFE + \varepsilon_{i,t} \quad (3)$$

where $Y_{c,i,t}$ represents either quarterly Fama-French three-factor return or quarterly fund flow. To test our main hypotheses, our main explanatory variables are *FundFamilySize*, *LockInPeriod*, and *Experience*. *FundFamilySize* represents the natural logarithm of the total assets under management of the fund's family (Yan, 2008; Bai et al., 2019), *LockInPeriod* represents the minimum holding period required by the fund, and *Experience* denotes the fund managers' experience in the fund management industry measured in number of years (Bai et al., 2019; Chen et al., 2021b; Huang et al., 2021). *Controls* include the following: *FundSize* captures the natural logarithm of the total net assets of the fund (Chen et al., 2004; Yan, 2008), *FundAge* is the number of years since the fund was established (Chen et al., 2004; Yan, 2008), *ExpenseRatio* is calculated as the ratio of a fund's management fee and custodian fee to the total net assets of funds (Yan, 2008), *Gender* takes the value of one if the fund management team includes at least one male manager, and zero otherwise, and *Degree* measures the highest education attainment of a fund management team (*Degree* ranges from 1 to 4 for no tertiary qualification, Undergraduate, Master and MBA/EMBA, and Doctorate, respectively). In our regression, fund type[13] and quarter fixed effects are included throughout to control for omitted variable bias (Sensoy, 2009; Hartzmark and Sussman, 2019). Robust standard errors apply in all regressions. For further details on variable definitions, please refer to Appendix A.

4. Main results

4.1. Descriptive statistics

Table 1 presents the summary statistics of our main variables for the full sample in Panel A1,[14] TDFs & TRFs in Panel A2, and mutual funds in Panel A3. The average quarterly risk-adjusted returns (Fama-French three-factor alpha) for all funds, TDFs & TRFs, and mutual funds are 0.37%, 0.44%, and 0.37%, respectively. It indicates that on a risk-adjusted basis, TDFs & TRFs in general outperform the full universe of funds by more than 0.07% on average. Additionally, the variation in risk-adjusted return is smaller for TDFs & TRFs, with a standard deviation of the alpha being 0.0128, while the corresponding number is 0.0272 for the full sample.

In terms of fund flow, the average fund flows for all funds, TDFs & TRFs, and mutual funds are 0.0896, 0.0990, and 0.0896, indicating the popularity of TDFs & TRFs compared to other funds. Regarding our main explanatory variables, the average fund family size for the TDFs & TRFs and mutual funds is similar, being 26.78 and 25.63 in order. Additionally, the median value of lock-in period is 0 for mutual funds compared to 36 months for TDFs & TRFs. This aligns with our expectations due to the compulsory lock-in period of the latter. Consistent with the regulatory requirements, fund managers of TDFs & TRFs are more experienced; on average, they have 11.4 years of experience in fund management, compared to 10.1 years for mutual funds. Moreover, we find that TDFs & TRFs, on average, have similar fund sizes to other funds, but a lower expense ratio. TDFs & TRFs are also generally younger.

Furthermore, in Table 1, Panels B1-B3, we present the parametric correlation matrix of the variables for all funds, TDFs & TRFs, and mutual funds. These correlations provide preliminary support for our main hypotheses. For TDFs & TRFs, we find the relationships between the three-factor alpha and each fund family size, lock-in period, experience are all positive. Additionally, we observe a significant positive correlation between lock-in period and fund flow. Moreover, as reported in Table 1, Panels B1–B3, the covariates exhibit low pairwise correlations, suggesting the absence of substantial linear relationships among them. The correlations between three-factor alpha and fund flow with the control variables also align with our predictions in general, lending support to the choice of our model.

4.2. The impact of the determinants in different fund groups

In this section, we employ formal regression analysis to examine how the key explanatory variables relate to fund performance in terms of return and attracting net inflows.[15] First, we perform the analysis within each fund group: TDFs & TRFs as our main interest, and standard mutual funds for comparison.

4.2.1. Baseline results-fund return

We run Eq. (3) using fund Fama-French three-factor alpha as the outcome variable. The results are shown in Table 2.

We observe a positive and significant relationship between fund family size and fund returns for TDFs & TRFs and mutual funds.

[13] In our sample, fund type is classified into Investment Style, Aggressive Growth, Stable Growth, Growth, Value, Robust Value-added, Capital Guaranteed & Value Added, Appreciation, Balance, Income, and Index funds. The data is obtained from CSMAR.

[14] Full sample includes all funds (i.e. TDFs, TRFs and mutual funds).

[15] All performance measures in this study are based on net returns (after fees), reflecting the actual returns received by investors and providing a measure with greater economic relevance. These returns are net of management, custody, and other applicable fees. They also allow fair comparisons between funds. Moreover, in China, there is no systematic distinction between fees for pension and non-pension products in our dataset, meaning that any fee differences are unlikely to drive the observed performance patterns.

Table 1

Descriptive statistics. Panels (A1–A3) and (B1–B3) of Table 1 report summary statistics and the parametric correlations of the main variables, respectively. Our sample spans from 2004 to 2022. Appendix A provides more details on variable definitions. *, **, and *** indicate levels of statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A1: All funds

Variables	N	Mean	Sd	Min	Max	Median
ThreeFactorAlpha	167,084	0.0037***	0.0272	−0.0874	0.0963	0.0022
FiveFactorAlpha	167,084	0.0027***	0.0267	−0.0865	0.0951	0.0014
FundFlow	158,031	0.0896***	0.8146	−0.7859	6.3937	−0.0212
FundFamilySize	167,084	25.6394***	1.5125	21.1333	28.0839	25.7420
LockInPeriod	167,084	0.6817***	4.1961	0	60	0
Experience	149,183	10.0794***	3.9231	2	22	10
FundAge	167,084	4.0141***	3.5543	0	16	3
FundSize	167,084	19.9387***	1.7736	14.6344	23.4756	20.0593
ExpenseRatio	167,084	1.1641***	0.5682	0.2000	2.0500	1.1500
Gender	155,131	0.8301***	0.3756	0	1	1
Degree	155,131	3.1066***	0.4092	1	4	3

Panel A2: TDFs & TRFs

Variables	N	Mean	Sd	Min	Max	Median
ThreeFactorAlpha	1,504	0.0044***	0.0128	−0.0874	0.0661	0.0044
FiveFactorAlpha	1,504	0.0033***	0.0117	−0.0865	0.0660	0.0019
FundFlow	1,334	0.0990***	0.6541	−0.7859	6.3937	0.0065
FundFamilySize	1,504	26.7767***	0.8593	23.8939	28.0839	27.0057
LockInPeriod	1,504	30.9574***	15.8448	12	60	36
Experience	1,147	11.3697***	3.3359	2	22	11
FundAge	1,504	1.5080***	1.0547	0	4	1
FundSize	1,504	19.0312***	1.4699	15.4281	23.4756	19.2019
ExpenseRatio	1,504	0.9183***	0.1707	0.4000	1.2000	0.9500
Gender	1,372	0.7762***	0.4169	0	1	1
Degree	1,372	3.1618***	0.4007	2	4	3

Panel A3: Mutual funds

Variables	N	Mean	Sd	Min	Max	Median
ThreeFactorAlpha	165,580	0.0037***	0.0273	−0.0874	0.0963	0.0022
FiveFactorAlpha	165,580	0.0027***	0.0268	−0.0865	0.0951	0.0014
FundFlow	156,697	0.0896***	0.8158	−0.7859	6.3937	−0.0217
FundFamilySize	165,580	25.6291***	1.5133	21.1333	28.0839	25.7199
LockInPeriod	165,580	0.4067***	2.6621	0	36	0
Experience	148,036	10.0694***	3.9256	2	22	10
FundAge	165,580	4.0368***	3.5610	0	16	3
FundSize	165,580	19.9470***	1.7740	14.6344	23.4756	20.0661
ExpenseRatio	165,580	1.1664***	0.5700	0.2000	2.0500	1.2000
Gender	153,759	0.8305***	0.3752	0	1	1
Degree	153,759	3.1061***	0.4093	1	4	3

Panel B1: All funds

	ThreeFactorAlpha	FiveFactorAlpha	FundFlow	FundFamilySize	LockInPeriod	Experience	FundAge	FundSize	ExpenseRatio	Gender	Degree
ThreeFactorAlpha	1										
FiveFactorAlpha	0.8739***	1									
FundFlow	0.0516***	0.0509***	1								
FundFamilySize	0.0750***	0.0692***	0.0003	1							
LockInPeriod	−0.0068***	−0.0113***	−0.0102***	0.0887***	1						
Experience	0.0222***	0.0290***	−0.0099***	0.1763***	0.0700***	1					

(*continued on next page*)

Table 1 (*continued*)

Panel A3: Mutual funds											
FundAge	0.0094***	0.0008	−0.0303***	0.0768***	−0.1267***	0.1166***	1				
FundSize	−0.0004	0.0037	0.0573***	0.2081***	−0.0159***	0.0015	0.1162***	1			
ExpenseRatio	0.0547***	0.0214***	−0.0687***	−0.1813***	−0.0089***	−0.0309***	0.2214***	0.0104***	1		
Gender	0.0060**	0.0039	−0.0062**	−0.0326***	−0.0083***	−0.0513***	0.0115***	0.0112***	0.1749***	1	
Degree	−0.0025	0.0006	−0.0041	−0.0311***	0.0096***	−0.0415***	−0.0028	−0.0234***	0.0717***	0.0970***	1
Panel B2: TDFs & TRFs											
	ThreeFactorAlpha	FiveFactorAlpha	FundFlow	FundFamilySize	LockInPeriod	Experience	FundAge	FundSize	ExpenseRatio	Gender	Degree
ThreeFactorAlpha	1										
FiveFactorAlpha	0.7862***	1									
FundFlow	0.0092	0.0227	1								
FundFamilySize	0.1558***	0.1287***	0.0441	1							
LockInPeriod	0.1351***	0.0646**	0.0676**	0.1339***	1						
Experience	0.0920***	0.0631**	0.0317	0.0447	0.0924***	1					
FundAge	0.1702***	0.1625***	0.0161	0.2193***	0.0292	0.0500*	1				
FundSize	0.1034***	0.1095***	−0.0144	0.0343	−0.3614***	−0.0545*	0.2206***	1			
ExpenseRatio	0.0920***	0.0618**	0.0384	0.0827***	0.5012***	−0.0882***	0.1388***	−0.1647***	1		
Gender	0.0082	−0.0030	0.0263	0.0799***	0.0615**	0.0425	0.0891***	0.0469*	0.0907***	1	
Degree	−0.0995***	−0.1047***	−0.0528*	−0.0360	−0.0109	−0.0700**	−0.0010	−0.0207	−0.1205***	−0.0058	1
Panel B3: Mutual funds											
	ThreeFactorAlpha	FiveFactorAlpha	FundFlow	FundFamilySize	LockInPeriod	Experience	FundAge	FundSize	ExpenseRatio	Gender	Degree
ThreeFactorAlpha	1										
FiveFactorAlpha	0.8741***	1									
FundFlow	0.0518***	0.0510***	1								
FundFamilySize	0.0749***	0.0691***	0.0000	1							
LockInPeriod	−0.0168***	−0.0173***	−0.0206***	0.0585***	1						
Experience	0.0219***	0.0288***	−0.0102***	0.1752***	0.0745***	1					
FundAge	0.0094***	0.0007	−0.0304***	0.0818***	−0.1282***	0.1189***	1				
FundSize	−0.0007	0.0035	0.0578***	0.2132***	0.0442***	0.0032	0.1132***	1			
ExpenseRatio	0.0548***	0.0215***	−0.0690***	−0.1794***	0.0227***	−0.0298***	0.2194***	0.0088***	1		
Gender	0.0061**	0.0040	−0.0065**	−0.0324***	−0.0018	−0.0518***	0.0104***	0.0103***	0.1752***	1	
Degree	−0.0022	0.0009	−0.0038	−0.0321***	0.0018	−0.0418***	−0.0020	−0.0228***	0.0729***	0.0982***	1

Table 2
Baseline results. This table reports our baseline results examining the effect of regulatory requirements (fund family size, lock-in period, and manager experience) on fund performance from 2004 to 2022. We divide the sample into two groups: TDFs & TRFs and mutual funds. The dependent variables are measured by Fama-French three-factor alpha and fund flow in columns (1)–(2) and (3)–(4), respectively. We include fund family size, lock-in period, and manager experience as our main explanatory variables. Control variables include fund size, fund age, expense ratio, and managers' gender and degree. We also control for fund type and quarter fixed effects, and robust standard errors are applied in all regressions. The p-values of regression coefficients are reported in parentheses, and *, **, *** indicate levels of statistical significance at 10%, 5%, and 1%, respectively. See Appendix A for more details on variable definitions.

Variables	Three-factor alpha		Fund flow	
	TDFs & TRFs	Mutual funds	TDFs & TRFs	Mutual funds
	(1)	(2)	(3)	(4)
FundFamilySize	0.0009**	0.0004***	−0.0077	−0.0213***
	(0.03)	(0.00)	(0.79)	(0.00)
LockInPeriod	0.0002***	−0.0004***	0.0041***	−0.0086***
	(0.00)	(0.00)	(0.00)	(0.00)
Experience	0.0002**	−0.0001***	0.0033	−0.0020***
	(0.01)	(0.00)	(0.69)	(0.00)
FundSize	0.0008***	0.0006***	−0.0003	0.0376***
	(0.00)	(0.00)	(0.98)	(0.00)
FundAge	0.0038***	−0.0003***	−0.0141	−0.0068***
	(0.00)	(0.00)	(0.71)	(0.00)
ExpenseRatio	−0.0082***	0.0045***	−0.0475	−0.1052***
	(0.00)	(0.00)	(0.69)	(0.00)
Gender	−0.0026***	0.0003**	0.0734*	0.0140**
	(0.00)	(0.05)	(0.09)	(0.02)
Degree	−0.0028***	0.00003	−0.1059***	0.0061
	(0.00)	(0.86)	(0.00)	(0.26)
Constant	−0.0285**	−0.0310***	0.4978	−0.2371***
	(0.02)	(0.00)	(0.58)	(0.00)
Observations	1,147	148,036	1,022	140,246
Adjusted R-squared	0.3370	0.0896	0.0124	0.0210
Fund type fixed effects	YES	YES	YES	YES
Quarter fixed effects	YES	YES	YES	YES

The coefficient of fund family size for TDFs & TRFs is 0.0009, which means that one unit increase in fund family size results in a 0.09% improvement in these funds' quarterly returns. The findings validate our hypothesis that funds with larger fund family sizes possess inherent advantages that contribute to superior fund returns (Chen et al., 2004; Pollet and Wilson, 2008; Bhojraj et al., 2012).

Furthermore, we find a positive association between lock-in period and fund returns for TDFs & TRFs. Every time the lock-in period extends by one month, the return increases by 0.02%. As discussed earlier, a longer lock-in period allows managers to exercise greater control over the fund portfolios, asset allocation, and strategic investment decisions, which is particularly important for long-term investment objectives such as retirement savings. Better alignment between fund investment decisions and its objectives ultimately improves fund returns. Conversely, we observe a negative relationship between lock-in period and fund returns for mutual funds. Since lock-in periods are not required for mutual funds due to their varied investment objectives, a longer lock-in period, which restricts investors' ability to move away from poor-performing funds, may result in less market competition, lower peer pressure among funds, and poorer returns. The finding highlights the importance of aligning regulatory focus with the investment objectives of funds.

Additionally, we find mixed results for manager experience. On the one hand, our analysis reveals that more experienced managers generate higher returns for TDFs & TRFs. One year increase in the manager experience raises the return by 0.02%. This aligns with previous findings that fund managers' skills and access to private information grow with their experience, significantly enhancing fund performance (Golec, 1996; Clare et al., 2022). However, on the other hand, the results reveal a negative relationship between manager experience and fund returns for mutual funds. The mixed relationship is consistent with the argument posed by Chevalier and Ellison (1999) that manager experience could relate to fund returns in both ways because younger managers (typically less experienced) might do better since they work harder to advance their career, but worse because of a lack of experience. In our context, for TDF & TRF which focus on a more defined long-term investment goal, we do find the regulatory requirement on manager experience benefits investors.

To summarize, we find the regulatory requirements imposed on TDFs & TRFs benefit their fund returns, although other than fund family size, lock-in period and fund manager experience do not equally improve returns of mutual funds. The results also highlight the importance of distinguishing TDFs & TRFs from other mutual funds due to their significantly different investment objectives.

4.2.2. Baseline results-fund flow

Next, we run Eq. (3) using fund flows as the outcome variable. The results are presented in columns (3) and (4) of Table 2. We observe that lock-in period significantly affects fund flows for TDFs & TRFs. A one unit increase in lock-in period will improve fund flow of TDFs & TRFs by 0.41%. However, we do not find evidence supporting the impact of fund family size and experience on attracting fund flows for TDFs & TRFs. Designed as long-term retirement-oriented products, TDFs & TRFs focus on life-cycle asset

allocation rather than short-term returns, which reduces investors' motivation to direct additional flows based on fund family size. Additionally, when investors choose TDFs & TRFs, they do not necessarily prefer those managed by managers with a longer experience, possibly due to the compulsory high threshold of experience mandated on all TDFs & TRFs already. Incremental manager experience beyond this point does not necessarily generate significant differences in terms of fund flows.

Interestingly, the results on fund flows of mutual funds are in stark contrast. As column (4) of Table 2 shows, bigger fund families, longer lock-in periods and more experienced fund managers result in net fund outflows for all standard mutual funds. Funds with a longer lock-in period could be less attractive to investors due to the reduced flexibility (Simon, 2011), and more experienced fund managers may not outperform (Chevalier and Ellison, 1999) resulting in decreased fund flows. On fund family size, our results are consistent with Brown and Wu (2016) who find that larger funds with longer histories attract, on average, less capital as a percentage of their asset size, regardless of fund performance. This is consistent with their model, in which the positive drift in fund size comes from the convex relationship between the estimated aggregate skill and equilibrium size. As the uncertainty in aggregate skill decreases over time, the drift becomes weaker. Similar to the results on fund returns, our findings agree with the previous literature that different fund and fund manager characteristics may relate to fund flow in mixed ways. Therefore, nuanced analyses by fund objective and nature, like ours, are necessary.

4.3. Relative importance of the explanatory variables

Our analysis above indicates that the regulatory restrictions imposed on TDFs & TRFs all seem to affect their fund outcomes positively. Next, we investigate which explanatory variable shows the strongest predictive power. To assess the relative importance of the additional regulatory requirements on fund risk-adjusted returns (fund flow), we carry out formal model selection by evaluating the relative importance in model adjusted R^2 (Zhang et al., 2018).

In our first model, we only look at the impact of the basic fund characteristics on fund three-factor alpha and fund flow, which includes *FundSize*, *FundAge*, *ExpenseRatio*, *Gender*, and *Degree*. Subsequently, our second, third, and fourth models gradually add *FundFamilySize, LockInPeriod, and Experience* into the model. Finally, the fifth model tests the combined effect of *FundFamilySize*, *LockInPeriod*, and *Experience*. We run five models and display each model's adjusted R2 in Panel A1 of Table 3. Columns (1) and (2) show the results for three-factor alpha, while columns (3) and (4) present the results for fund flow.

Additionally, Panel A2 in Table 3 exhibits the incremental change in adjusted R^2 compared to the baseline regression when considering the outcome variables of three-factor alpha and fund flow, separately. As shown in the first column of Panel B in Table 3, when fund family size, lock-in period and manager experience are all included in the model to explain the risk-adjusted returns, adjusted R^2 improvement increases the most, by 25.33% for TDFs & TRFs compared to the baseline model without these variables. It is noteworthy that the impact of the three factors on TDF & TRF returns is much greater than that on mutual funds. It highlights the significance of the regulatory requirements on pension funds, while the returns of mutual funds could be subject to a more complicated set of determinants. Moreover, when we include the three main explanatory factors only one at a time, for TDFs & TRFs, the most important factors that determine returns are experience, fund family size, and lock-in period in order, as indicated by the average adjusted R^2 improvement increases of 9.22%, 4.18%, and 4.05% respectively.

Furthermore, in the third and fourth columns of Table 3, using the same variables to predict fund flow, we consistently find lock-in period ranks as the most important determinant for TDFs & TRFs. Next, fund family size and manager experience are of similar importance. Further, for both TDFs & TRFs and mutual funds, combining the three main explanatory variables results in a much bigger incremental impact on fund flows (adjusted R^2 improvement of 58.97% and 6.06%) compared to fund returns (adjusted R^2 improvement of 25.33% and −0.22%). That is, imposing these regulatory requirements results in a greater increment in fund flows measured in percentage terms. Note that however, overall, the adjusted R^2 values are higher for fund returns than for fund flows. Finally, to ensure the reliability of the findings, we further calculate the log-likelihood ratio of the competing models (Barron and Ni, 2013) and present the results in Panels B1-B2 of Table 3, overall, the findings remain highly consistent with the adjusted R^2 analysis.

5. Further analysis

5.1. TDFs & TRFs versus mutual funds

In the analysis above, we focus on how the regulatory requirements influence fund performance metrics differently in separate fund groups. In this section, we turn to investigate the differences across the fund groups. It allows us to formally examine whether TDFs & TRFs outperform mutual funds after controlling for the key determinants according to the regulatory requirements.

We introduce a new dummy variable, *TDFTRF*, which takes the value of one for TDFs & TRFs and zero for mutual funds. We include the dummy variable in our baseline regressions for risk-adjusted returns and fund flow and present the results in columns (1) and (3) of Table 4. To further examine the incremental impact of regulatory requirements on the performance of TDFs & TRFs relative to mutual funds, we include three interaction terms between dummy variable *TDFTRF* and *FundFamilySize*, *LockInPeriod* and *Experience* respectively in regression, results are reported in column (2) and column (4).

The results show that TDFs & TRFs outperform mutual funds in general. In columns (1) and (3), the coefficients of *TDFTRF* are 0.0072 and 0.1788 for three-factor alpha and fund flow respectively, both highly significant. These findings indicate that TDFs & TRFs perform better than mutual funds in terms of both fund risk-adjusted returns and fund flows. Moreover, the test of interactions terms in columns (2) and (4) shows that how regulatory requirements shape the relative performance of TDFs & TRFs. The results indicate that larger family size, longer lock-in periods, and greater managerial experience all contribute more positively to the returns of TDFs &

Table 3
Relative importance of the explanatory variables. We compare the adjusted R2 and log-likelihood of the regression model to calculate the relative importance of regulatory requirements on fund performance. The baseline model includes only control variables: fund age, fund size, expense ratio, and managers' gender and degree. The explanatory variables—fund family size, lock-in period, and experience—are added separately and simultaneously to the model. Panel A1 reports the adjusted R2 of each regression, and Panel A2 shows the increment in adjusted R2 for each regression from the baseline model. Panel B1 presents the log-likelihood values of each regression model, and Panel B2 reports the log-likelihood ratio for each regression relative to the baseline model (only controls). *, **, *** indicate levels of statistical significance at 10%, 5%, and 1%, respectively. See Appendix A for more details on variable definitions.

Variables	Three-factor alpha		Fund flow	
	TDFs & TRFs	Mutual funds	TDFs & TRFs	Mutual funds
	(1)	(2)	(3)	(4)
Panel A1: Adjusted R^2				
Control Variables (base)	0.2581	0.0898	0.0078	0.0198
+ FundFamilySize	0.2689	0.0902	0.0087	0.0209
+ LockInPeriod	0.2798	0.0913	0.0118	0.0204
+ Experience	0.2937	0.0877	0.0089	0.0194
+FundFamilySize + LockInPeriod + Experience	0.337	0.0896	0.0124	0.021
Panel A2: Adjusted R^2 improvement				
+ FundFamilySize	4.18%	0.45%	11.54%	5.56%
+ LockInPeriod	4.05%	1.67%	51.28%	3.03%
+ Experience	9.22%	−2.34%	14.10%	−2.02%
+FundFamilySize + LockInPeriod + Experience	25.33%	−0.22%	58.97%	6.06%
Panel B1: Log-likelihood				
Control Variables (base)	3619.04	330526.7	−1059.59	−170144
+ FundFamilySize	3626.23	330,554	−1059.56	−170064
+ LockInPeriod	3657.79	330658.7	−1056.49	−170100
+ Experience	3625.94	330557.7	−1059.16	−170134
+FundFamilySize + LockInPeriod + Experience	3663.18	330,717	−1056.33	−170016
Panel B2: Log-likelihood ratio				
+ FundFamilySize	14.39***	54.46***	0.05	159.54***
+ LockInPeriod	77.50***	263.82***	6.21**	87.98***
+ Experience	13.80***	61.94***	0.85	20.41***
+FundFamilySize + LockInPeriod + Experience	88.28***	380.59***	6.53*	256.58***

TRFs than to those of mutual funds, and that longer lock-in periods also contribute more positively to the flows of TDFs & TRFs than to those of mutual funds. The results lend support to the effectiveness of the regulatory requirements on fund characteristics for TDFs & TRFs in particular. The additional regulatory requirements seem to differentiate TDFs & TRFs from mutual funds (which are not designed for the long-term retirement saving objective), reflected in creating higher returns and attracting more savings (i.e., fund flows) for the investors.

5.2. *Why TDFs & TRFs outperform mutual funds*

In this section, we propose two plausible mechanisms through which TDFs & TRFs may outperform mutual funds. The first concerns whether TDFs & TRFs have better selection skills in selecting high-performing sub-funds for their portfolios (Pool et al., 2016; Chan et al., 2017). The second concerns whether the outperformance is due to stronger flow stability induced by mandatory lock-ins.

5.2.1. *Sub-fund selection*

As discussed previously, TDFs & TRFs are structured as FOFs, with various constituent funds (sub-funds). The outperformance of TDFs & TRFs could be due to fund managers' superior skills in selecting high-performing sub-funds. To test this proposition, we examine what characteristics make sub-funds more likely to be selected using a probit model as follows:

$$ConstituentFund_{i,t} = \beta_0 + \beta_1 ThreeFactorAlpha_{i,t-1} + \beta_2 FundFlow_{i,t-1} + \beta_3 ExpenseRatio_{i,t-1} + Controls + \theta' FundTypeFE + \psi' QuarterFE + \varepsilon_{i,t} \quad (4)$$

where *Constituent Fund* equals one if a fund is selected as a sub-fund for TDFs & TRFs at quarter *t*, and zero otherwise. Independent variables include one quarter lagged values of Fama–French three-factor alpha, fund flow, and expense ratio. Control variables include fund size, turnover ratio, fund family size, and fund age. Fund type and quarter fixed effects are included.

In Panel A of Table 5, we report Probit regression results on the likelihood of a fund being selected as a TDF or TRF constituent, conditional on lagged characteristics. Results show that sub-funds being selected to TDFs & TRFs exhibit inferior return performance and lower expense ratio, evidence contradicts the argument of superior sub-fund selection skills.

Additionally, Pool et al. (2016) demonstrate that 401(k) plan sponsors who design their investment menus tend to prefer in-house funds, despite their inferior performance. Similarly, Chan et al. (2017) observe that U.S. fund families often include affiliated sub-funds in TDFs that have exhibited weaker past performance or higher expense ratios, raising concerns about potential conflicts of interest. Motivated by this literature, we further supplement our analysis above, by examining whether such favouritism towards affiliated

Table 4
TDFs & TRFs versus mutual funds. This table investigates whether TDFs & TRFs outperform mutual funds after controlling for regulatory requirements during the period 2004–2022. The dependent variables are measured by Fama-French three-factor alpha and fund flow in columns (1)-(2) and (3)-(4), respectively. A dummy variable, *TDFTRF*, takes the value of one if the observation is for TDFs & TRFs and zero if it is for mutual funds. We then add *TDFTRF* to the baseline model and include the same set of control variables as in the baseline model in columns (1) and (3). Next, we include the interaction terms between *TDFTRF* and *FundFamilySize*, *LockInPeriod* and *Experience* in regression to better understand the effect of regulatory requirements on TRFs & TDFs. The results of these interaction regressions are reported in columns (2) and (4). Control variables include fund size, fund age, expense ratio, and managers' gender and degree. We also control for fund type and quarter fixed effects, and robust standard errors are applied in all regressions. The p-values of regression coefficients are reported in parentheses, and *, **, *** indicate levels of statistical significance at 10%, 5%, and 1%, respectively. See Appendix A for more details on variable definitions.

Variables	Three-factor alpha		Fund flow	
	(1)	(2)	(3)	(4)
FundFamilySize	0.0004***	0.0004***	−0.0211***	−0.0213***
	(0.00)	(0.00)	(0.00)	(0.00)
FundFamilySize × TDFTRF		0.0007*		0.0255
		(0.09)		(0.36)
LockInPeriod	−0.0003***	−0.0004***	−0.0052***	−0.0087***
	(0.00)	(0.00)	(0.00)	(0.00)
LockInPeriod × TDFTRF		0.0006***		0.0133***
		(0.00)		(0.00)
Experience	−0.0001***	−0.0001***	−0.0020***	−0.0020***
	(0.00)	(0.00)	(0.00)	(0.00)
Experience × TDFTRF		0.0004***		0.0076
		(0.00)		(0.36)
FundSize	0.0006***	0.0006***	0.0368***	0.0375***
	(0.00)	(0.00)	(0.00)	(0.00)
FundAge	−0.0002***	−0.0003***	−0.0065***	−0.0068***
	(0.00)	(0.00)	(0.00)	(0.00)
ExpenseRatio	0.0046***	0.0045***	−0.1044***	−0.1051***
	(0.00)	(0.00)	(0.00)	(0.00)
Gender	0.0003*	0.0003*	0.0143**	0.0144**
	(0.06)	(0.06)	(0.02)	(0.02)
Degree	−0.000005	0.000009	0.0050	0.0053
	(0.97)	(0.96)	(0.36)	(0.33)
TDFTRF	0.0072***	−0.0295***	0.1788***	−0.9068
	(0.00)	(0.01)	(0.00)	(0.23)
Constant	−0.0305***	−0.0309***	−0.2239***	−0.2319***
	(0.00)	(0.00)	(0.00)	(0.00)
Observations	149,183	149,183	141,268	141,268
Adjusted R-squared	0.0891	0.0898	0.0205	0.0208
Fund Type fixed effects	YES	YES	YES	YES
Quarter fixed effects	YES	YES	YES	YES

funds exists in the sub-fund selection in the Chinese context.

Table 5 Panel B1 illustrates the yearly frequency of affiliated (in-house) versus non-affiliated sub-funds being selected into TDFs & TRFs by year. Overall, affiliated sub-funds account for a smaller proportion in TDFs & TRFs than non-affiliated sub-funds. However, affiliated sub-funds that are selected into TDFs & TRFs tend to have weaker past returns, lower fund flows and higher expense ratio compared to non-affiliated sub-funds, characteristics consistent with agency problems documented by Pool et al. (2016) and Chan et al. (2017). The regression results in Panel B2 corroborate this preliminary finding. In this new model, the dependent variable *Affiliated*, equals one for affiliated sub-funds of TDFs & TRFs, and zero for non-affiliated sub-funds of TDFs & TRFs at quarter *t*. Our results show that affiliated sub-funds exhibit lower return performance and higher expense ratios, suggesting fund family's favouritism towards adding poor-performing affiliated funds to TDFs & TRFs. The findings lend additional support to rule out superior fund selection skills as an explanation of the outperformance of TDFs & TRFs.

5.2.2. Flow stability

In this section, we consider an alternative mechanism: TDFs & TRFs may benefit from more stable fund flows compared with mutual funds due to their mandatory lock-in requirements. To test this hypothesis, we introduce a new variable, *FundFlowStability*, which captures the stability of a fund's quarterly flows, and examine whether it correlates with the performance of TDFs & TRFs. *FundFlowStability* is defined as the negative of the standard deviation of a fund's quarterly fund flows over the past four quarters following Rakowski (2010), so that higher values indicate greater stability. We also include an interaction term, *FundFlowStability* × *TDFTRF*, along with standard control variables. This framework allows us to assess whether flow stability of TDFs & TRFs contributes more positively to performance, compared to other mutual funds.

$$ThreeFactorAlpha_{i,t} = a_i + \beta_1 FundFlowStability_{i,t-1} + \beta_2 TDFTRF_{i,t} + \beta_3 FundFlowStability_{i,t-1} \times TDFTRF_{i,t} + \theta' FundTypeFE + \psi' QuarterFE + \varepsilon_{i,t} \quad (5)$$

Table 5
Sub-fund selection. This table estimate the sub-fund selection within TDFs & TRFs. In Panel A, we investigate the likelihood of a fund is selected as a TDF or TRF constituent. The dependent variable, *Constituent*, equals one if a fund is selected as a sub-fund for TDFs or TRFs. and zero otherwise. In Panel B1, we display the yearly frequency of affiliated versus non-affiliated sub-funds being selected into TDFs & TRFs by year. Affiliated sub-funds are sub-funds of TDFs and TRFs from the same fund family, while non-affiliated sub-funds are from other families. Furthermore, Panel B2 tests for the factors that influence affiliated sub-funds are selected by a TDF & TRF. Here, the dependent variable, *Affiliated*, equals one for affiliated sub-funds and zero for non-affiliated sub-funds. In both regressions, independent variables include one quarter lagged value of Fama–French three-factor alpha, fund flow, expense ratio, fund size, turnover ratio, fund family size, and fund age. We also control for fund type and quarter fixed effects, and robust standard errors are applied in all regressions. The p-values of regression coefficients are reported in parentheses, and *, **, *** indicate levels of statistical significance at 10%, 5%, and 1%, respectively. See Appendix A for more details on variable definitions.

Panel A: Probit model of the likelihood of a fund is selected as a TDF or TRF constituent

Variables	Constituent fund
	(1)
L.ThreeFactorAlpha	−1.7463**
	(0.02)
L.FundFlow	0.0133
	(0.66)
L.ExpenseRatio	−0.2777***
	(0.00)
L.FundSize	0.1513***
	(0.00)
L.TurnoverRatio	0.00004
	(0.15)
L.FundFamilySize	−0.0068
	(0.76)
L.FundAge	0.0066
	(0.33)
Constant	−3.0035***
	(0.00)
Observations	5,544
Pseudo R-squared	0.319
Fund type fixed effects	YES
Quarter fixed effects	YES

Panel B1: Affiliated vs. non-affiliated sub-funds

	Affiliated sub-funds	Non-affiliated sub-funds	Affiliated sub-funds	Non-affiliated sub-funds	Affiliated sub-funds	Non-affiliated sub-funds	Affiliated sub-funds	Non-affiliated sub-funds
Year	Past return		Past fund flow		Past expense ratio			
							Number of observations	
2018	−0.0046	−0.0115	−0.0794	0.1098	0.8500	0.8750	14	30
2019	0.0041	0.0049	0.1308	0.3363	1.1358	1.0034	248	304
2020	0.0120	0.0144	0.1947	0.2892	1.1605	1.1228	531	569
2021	0.0191	0.0212	0.1429	0.2564	1.1479	1.0287	556	795
2022	0.0108	0.0149	0.1055	0.1923	0.9514	0.9568	476	870

The results are presented in Table 6. The interaction term is positive and significant, indicating that compared to standard mutual funds, fund flow stability contributes positively to the performance of TDFs & TRFs. In other words, these findings support the view that fund flow stability, as a result of mandatory lock-in periods, is likely the driver of the outperformance of TDFs & TRFs.

5.3. Survival analysis on ongoing constituent funds

In this section, we further extend our mechanism analysis by performing survival analysis to assess TDF & TRF sub-funds' likelihood of remaining in the portfolio (Chan et al., 2017). This analysis allows us to identify characteristics of sub-funds which are more likely to be replaced, providing insights for ongoing discipline. Detailed methodology is presented in Appendix B to save space.

As shown in Table 7, we find that both *Avg_ExpenseRatio* and *Avg_FundFlow* are positively and significantly related to fund survival probabilities, suggesting that sub-funds with higher expenses and larger inflows are more likely to be replaced, while fund performance (*Avg_ThreeFactorAlpha)* and fund age (*Avg_FundAge)* are statistically insignificant. The results are consistent with our findings in the mechanism analysis that sub-fund superior performance is unlikely related to its inclusion in TDFs & TRFs.

5.4. TDF & TRF issuers versus other issuers

Prior literature widely documents that funds under the same issuing firm share information and fund management expertise, leading to a positive cross-fund correlation (Gaspar et al., 2006; Bessler et al., 2016). Alternatively, another strand of literature argues that funds under the same management compete for resources so a negative correlation in fund returns is observed (Kempf and Ruenzi, 2008). In our context, on the one hand, investors could view those issuing companies that successfully obtain licenses to operate in the

Table 6
Flow stability. This table examines whether TDFs & TRFs may benefit from more stable fund flows compared with mutual funds due to their mandatory lock-in requirements. The dependent variable is the Fama–French three-factor alpha, which measures fund risk-adjusted returns. We introduce a new variable, *FundFlowStability*, capturing the stability of a fund's quarterly flows and investigate whether it correlates with the performance of TDFs and TRFs. We also include an interaction term, *FundFlowStability* × *TDFTRF* in the model. Control variables include fund size, fund age, expense ratio, and managers' gender and degree. We also control for fund type and quarter fixed effects, and robust standard errors are applied in all regressions. The p-values of regression coefficients are reported in parentheses, and *, **, *** indicate levels of statistical significance at 10%, 5%, and 1%, respectively. See Appendix A for more details on variable definitions.

Variables	Three-factor alpha
	(1)
L.FundFlowStability	−0.0041***
	(0.00)
L.FundFlowStability × TDFTRF	0.0045*
	(0.05)
TDFTRF	0.0059***
	(0.00)
FundFamilySize	0.0006***
	(0.00)
LockInPeriod	−0.0002***
	(0.00)
Experience	−0.0001***
	(0.00)
FundSize	0.0009***
	(0.00)
FundAge	−0.0005***
	(0.00)
ExpenseRatio	0.0069***
	(0.00)
Gender	0.0003
	(0.12)
Degree	0.0001
	(0.67)
Constant	−0.0293***
	(0.00)
Observations	125,503
Adjusted R-squared	0.1431
Fund type fixed effects	YES
Quarter fixed effects	YES

Panel B2: Probit model of the likelihood of an affiliated sub-fund is selected in a TDF or TRF

Variables	Affiliated sub-fund
	(1)
L.ThreeFactorAlpha	−5.2733***
	(0.00)
L.FundFlow	−0.0254
	(0.59)
L.ExpenseRatio	0.1472*
	(0.07)
L.FundSize	−0.3106***
	(0.00)
L.TurnoverRatio	0.0001
	(0.38)
L.FundFamilySize	0.3568***
	(0.00)
L.FundAge	0.0200**
	(0.05)
Constant	−3.2162***
	(0.00)
Observations	2,083
Pseudo R-squared	0.127
Fund type fixed effects	YES
Quarter fixed effects	YES

Table 7
Survival test on ongoing constituent funds. This table examines the factors influencing whether constituent funds of TDFs & TRFs remain in the portfolio during 2018–2022. We employ a proportional hazards model, with the dependent variable defined as the hazard rate. A higher hazard rate indicates a lower probability of survival. Independent variables include the constituent funds' average expense ratio, three-factor alpha, fund age, fund flow, and turnover ratio. The p-values of regression coefficients are reported in parentheses, and *, **, *** indicate levels of statistical significance at 10%, 5%, and 1%, respectively. See Appendix A for more details on variable definitions.

Variables	Hazard rate
	(1)
Avg_ExpenseRatio	0.3645*
	(0.07)
Avg_ThreeFactorAlpha	−0.2070
	(0.96)
Avg_FundAge	−0.0298
	(0.24)
Avg_FundFlow	0.5148**
	(0.04)
Avg_Turnover	−0.0001
	(0.79)
Observations	246
Pseudo R-squared	0.00745
Log Likelihood	−685.65518
Prob > Chi-squared	0.0672

Table 8
TDF & TRF issuers versus other issuers. This table compares whether funds from TDF &TRF issuing companies outperform their counterparts that do not issue TDFs or TRFs. The dependent variables are measured by Fama-French three-factor alpha and fund flow in columns (1) and (2), respectively. We construct a dummy variable, *TDFTRFCOMPANY*, which equals one for funds whose issuers also manage a TDF or TRF at the same time, and zero otherwise. We then add *TDFTRFCOMPANY* to the baseline regression and include the same set of control variables as in the baseline model. We also control for fund type and quarter fixed effects, and robust standard errors are applied in all regressions. The p-values of regression coefficients are reported in parentheses, and *, **, *** indicate levels of statistical significance at 10%, 5%, and 1%, respectively. See Appendix A for more details on variable definitions.

Variables	Three-factor alpha	Fund flow
	(1)	(2)
TDFTRFCOMPANY	−0.0022***	0.0035
	(0.00)	(0.67)
FundFamilySize	0.0008***	−0.0213***
	(0.00)	(0.00)
LockInPeriod	−0.0002***	−0.0024***
	(0.00)	(0.00)
Experience	−0.0001***	−0.0020***
	(0.00)	(0.00)
FundSize	0.0005***	0.0364***
	(0.00)	(0.00)
FundAge	−0.0002***	−0.0063***
	(0.00)	(0.00)
ExpenseRatio	0.0045***	−0.1064***
	(0.00)	(0.00)
Gender	0.0003*	0.0142**
	(0.07)	(0.02)
Degree	0.00002	0.0053
	(0.89)	(0.33)
Constant	−0.0385***	−0.2071***
	(0.00)	(0.00)
Observations	149,183	141,268
Adjusted R-squared	0.0893	0.0203
Fund Type fixed effects	YES	YES
Quarter fixed effects	YES	YES

growing TDF & TRF sector as more reliable and reputable, especially in the early stage of the industry. On the other hand, however, when a fund company needs to meet stricter rules surrounding transparency, disclosure and experience to obtain its license to enter the TDF & TRF fund industry, it may also be exposed to the risk of sharing private information with other funds, and higher regulatory and compliance costs, hence losing competitive edges (Parida and Teo, 2018).

We therefore extend our analysis to compare whether funds under TDF & TRF issuing companies outperform their counterparts that do not issue TDFs or TRFs. There is no a priori based on the arguments above. We construct a dummy variable, namely *TDFTRFCOMPANY*. This variable takes a value of one for funds whose issuers also manage a TDF & TRF concurrently, and zero otherwise. We then run the baseline regressions with *TDFTRFCOMPANY* added to the model. The results are in Table 8.

As indicated by the first column, the coefficient of *TDFTRFCOMPANY* is negative and significant. It suggests that overall, funds under the management of TDF & TRF issuers underperform funds from non-TDF & TRF issuers. This aligns with the argument that higher compliance and regulatory costs could set constraints that prevent managers from allocating resources to maximize returns. For example, funds from TDF & TRF issuers may attract more investors and regulatory attention, but they are also more followed and 'copycat' by industry peers, leading to a negative impact on fund returns. Moreover, fund managers may carry over their conservative practices when managing TDFs & TRFs, which could extend to those non-TDFs & TRFs managed within the same fund company, resulting in underinvestment.

Moreover, in terms of fund flow, we do not observe a significant difference between funds from TDF & TRF issuers and non-issuers, as indicated by the insignificant sign of *TDFTRFCOMPANY*. That is, investors do not seem to favor TDF & TRF issuers for their ability and effort to obtain a TDF & TRF issuers' license. Our results suggest that non-TDFs & TRFs operated under TDF & TRF issuers do not seem to benefit by meeting the additional regulatory and compliance costs. Rather, issuing TDF & TRF could be a sign of higher costs, lower flexibility, and not profit-oriented.

Furthermore, we employ the propensity score matching (PSM) based difference-in-differences (DiD) test to investigate the impact of issuing TDF & TRF on the overall performance of fund companies. DiD approach is used to test the influence of an exogenous shock that could alter the relationship between fund returns (fund flows) and explanatory variables (Bertrand et al., 2004; Beck et al., 2010).

Specifically, we take the first instance of TDF & TRF issuance in a fund family as a shock and investigate the impact of such a shock

Table 9

PSM-DiD. This table reports our robustness check using PSM-DiD to examine the external shock effect on fund performance from 2004 to 2022. We use the earliest inception date of TDF & TRF within one fund company as a time shock, DiD equals one if the fund's fund company first time issued TDF & TRF, and zero otherwise. We report the Average Treatment Effect (ATT) of the PSM. In Panel B, columns (1), and (3) are the DiD without considering PSM, and columns (2), and (4) include the results of PSM. We include the same set of control variables as in the baseline model. We also control for fund type and quarter fixed effects, and robust standard errors are applied in all regression. The p-value of regression coefficients is reported in parentheses, and *, **, *** indicate the level of statistical significance at 10%, 5%, and 1% respectively. See Appendix A for more details of variable definition.

Panel A: Average treatment effect				
Outcome variable	ATT	Standard Errors	T-statistics	
Three-factor alpha	−0.0064***	0.0010	−6.35	
Fund flow	−0.0434***	0.0340	−1.27	
Panel B: PSM-DiD regression results				
Variables	Three-factor alpha	Fund flow		
	(1)	(2)	(3)	(4)
DiD	−0.0022***	−0.0013***	−0.0040	0.0162
	(0.00)	(0.00)	(0.63)	(0.18)
FundFamilySize	0.0008***	0.0012***	−0.0207***	−0.0257***
	(0.00)	(0.00)	(0.00)	(0.00)
LockInPeriod	−0.0002***	−0.0003***	−0.0086***	−0.0081***
	(0.00)	(0.00)	(0.00)	(0.00)
Experience	−0.0001***	−0.00002	−0.0020***	−0.0018**
	(0.00)	(0.47)	(0.00)	(0.04)
FundSize	0.0005***	0.0007***	0.0376***	0.0425***
	(0.00)	(0.00)	(0.00)	(0.00)
FundAge	−0.0002***	−0.0005***	−0.0068***	−0.0055***
	(0.00)	(0.00)	(0.00)	(0.00)
ExpenseRatio	0.0045***	0.0026***	−0.1051***	−0.1159***
	(0.00)	(0.00)	(0.00)	(0.00)
Gender	0.0003*	0.0005*	0.0140**	0.0006
	(0.07)	(0.06)	(0.02)	(0.95)
Degree	0.00003	0.0008***	0.0062	0.0090
	(0.86)	(0.00)	(0.26)	(0.31)
Constant	−0.0390***	−0.0506***	−0.2532***	−0.2231*
	(0.00)	(0.00)	(0.00)	(0.07)
Observations	149,183	62,837	140,246	59,282
Adjusted R-squared	0.0894	0.1083	0.0210	0.0236
PSM	NO	YES	NO	YES
Fund Type fixed effects	YES	YES	YES	YES
Quarter fixed effects	YES	YES	YES	YES

on fund performance metrics. To validate the suitability of utilizing DiD in our specific context, we conduct parallel trend testing as a prerequisite. The outcomes of this test provide confirmation that the treated and control groups within our sample meet the necessary criteria. Specifically, the results demonstrate that in the absence of treatment, the disparity in fund performance between these groups remains constant over time. Subsequently, we proceed to perform the official DiD test using the following model:

$$Y_{i,t} = \alpha + \beta_1 DiD_{i,t} + \beta_2 FundFamilySize_{i,t} + \beta_3 LockInPeriod_{i,t} + \beta_4 Experience_{i,t} + Controls + \theta' FundTypeFE + \psi' QuarterFE + \varepsilon_{i,t} \quad (6)$$

where $DiD_{i,t}$ is a binary variable that takes the value of one for all years following the first-time disclosure of TDF & TRF by fund i's family, and zero otherwise. Our DiD specification resembles Beck et al. (2010). In this setting, $DiD_{i,t}$ captures the differential effect of the main explanatory variables on fund company i's fund performance, specifically in the context of the first-time issuance of TDFs & TRFs by the fund company. All other variables retain the same definitions as the primary model. We report the average treatment effect (ATT) of the PSM in Panel A of Table 9. From Panel B, the results demonstrate that the coefficient of $DiD_{i,t}$ is negatively significant indicating disclosure of TDFs & TRFs decreases fund risk-adjusted returns. The results support our findings documented earlier in this section and with endogeneity addressed. We then use a calliper nearest neighbor matching PSM and illustrate results in column (2) of Table 9. Similar process is conducted for fund flow in columns (3) and (4), but with insignificant results documented.

Our results imply that TDF & TRF family companies may incur higher costs of producing and distributing holding-related information when issuing TDFs & TRFs for the first time, which in turn deteriorates the overall performance of all funds managed under the same family companies. This result is in line with Shi (2017), who find a negative relationship between portfolio disclosure and hedge fund performance when observing the policy debate over optimal portfolio disclosure. More frequent disclosure decreases the performance of mutual funds, especially those holding illiquid assets (Parida and Teo, 2018).

Furthermore, to strengthen the robustness of our results, we perform a placebo analysis following Zhou et al. (2023), and report results in Exhibit 1. In this test, the timing of the regulatory shock is randomly assigned across funds, and the pseudo-treatment variable is reconstructed accordingly. We then re-estimate the DiD specification in Eq. (6) using these simulated values. If the placebo treatment does not predict fund performance, this would indicate that our baseline findings are unlikely to be driven by random variation. We repeat the randomization 1000 times and summarize the distribution of coefficients and p-values in Exhibit 1. The average coefficient estimates for the placebo treatment are close to zero and far smaller than those from the actual regression. Moreover, most of the associated p-values are above 0.10, suggesting an absence of statistical significance. Taken together, this evidence reinforces that the identified effect of the shock on fund performance is not a spurious outcome.

Table 10
Non-TDF & TRF issuers. We estimate the effect of non-TDF & TRF issuers on fund performance for the period 2004–2022. We add a dummy variable, *Over20*, which takes the value of one if the fund company's total assets are over 20 billion RMB and it does not issue TDFs or TRFs, and zero if the total assets of a fund company exceed 20 billion RMB and it does issue TDFs or TRFs. We then run the baseline regression after adding *Over20* and include the same set of control variables as in the baseline model. We also control for fund type and quarter fixed effects, and robust standard errors are applied in all regressions. The p-values of regression coefficients are reported in parentheses, and *, **, *** indicate levels of statistical significance at 10%, 5%, and 1%, respectively. See Appendix A for more details on variable definitions.

Variables	Three-factor alpha	Fund flow
	(1)	(2)
Over20	0.0011***	−0.0069
	(0.00)	(0.44)
FundFamilySize	0.0002***	−0.0196***
	(0.01)	(0.00)
LockInPeriod	−0.0002***	−0.0021***
	(0.00)	(0.00)
Experience	−0.0002***	−0.0021***
	(0.00)	(0.00)
FundSize	0.0005***	0.0339***
	(0.00)	(0.00)
FundAge	−0.0002***	−0.0063***
	(0.00)	(0.00)
ExpenseRatio	0.0050***	−0.0989***
	(0.00)	(0.00)
Gender	0.0004**	0.0098
	(0.01)	(0.12)
Degree	0.0002	0.0055
	(0.30)	(0.32)
Constant	−0.0193***	−0.1473
	(0.00)	(0.14)
Observations	134,364	127,540
Adjusted R-squared	0.0830	0.0191
Fund Type fixed effects	YES	YES
Quarter fixed effects	YES	YES

5.5. Non-TDF & TRF issuers

According to the regulation governing the issuance of TDFs & TRFs, fund companies must meet specific requirements in size, having a total asset of over 20 million RMB. As a further extension to Section 5.4, we are particularly interested in examining why those funds that meet the threshold do not choose to become TDF & TRF issuers. Naturally, bigger funds in general should be more attracted to expansion opportunities, especially when there is a threshold that restricts many others from entering the market. Is it because of the potential negative impact of the additional regulatory and compliance costs?

To investigate this, we introduce a dummy variable called *Over20*. It takes the value of one if the total assets of a fund company exceed 20 billion RMB on average, but the fund company does not issue TDFs & TRFs, and zero if the total assets of a fund company exceed 20 billion RMB and issue TDFs & TRFs. Upon analyzing the results in Table 10, our results suggest that fund companies meeting the size requirement but do not issue TDFs & TRFs exhibit better performance than those TDF & TRF issuing companies. This finding is consistent with the previous results and further corroborates the implied regulatory and compliance costs with TDF & TRF issuance.

Viewed collectively, results from sections 5.4 and 5.5 imply that issuing TDFs & TRFs appear to weaken the performance of other funds managed by the same family. We propose several plausible attributes to this finding. First, we argue that the additional compliance and disclosure obligations of managing TDFs & TRFs can inadvertently weaken the performance of non-TDFs & TRFs within the same family. Issuing these pension products raises operational costs, limits managerial flexibility, and diverts attention from profit maximization. Stricter reporting requirements not only add costs but may also erode shareholder returns if external investors reverse-engineer disclosures to infer investment strategies, constraining managers' ability to exploit proprietary research (Wermers, 2001). Resources may therefore be reallocated toward TDFs & TRFs to ensure regulatory compliance, leaving fewer resources for other funds.

Beyond compliance costs, strategic considerations can further tilt fund families toward prioritizing pension products. Because TDFs & TRFs are new and rapidly expanding in China's financial market, obtaining approval to issue them can enhance a fund company's reputation, strengthen long-term client relationships, foster collaboration with the regulators, and position it for future growth in the pension sector. These incentives make fund families more likely to channel resources and marketing support to TDFs & TRFs once approval is secured. Consistent with the literature on cross-fund subsidization, fund families may transfer performance or resources across member funds to maximize overall revenue (Gaspar et al., 2006; Bhattacharya et al., 2013; Wang, 2024). For example, Gaspar et al. (2006) show that families use IPO allocations or coordinated trading to benefit strategically important funds, while Wang (2024) documents targeted subsidies and marketing support for star funds. In the Chinese context, pension funds can become the new "star products," receiving preferential treatment through internal performance transfers, research support, or promotional budgets. Such strategic reallocation may further disadvantage non-pension funds managed by the same company, compounding the performance drag created by higher compliance and disclosure costs.[16]

6. Robustness checks

In this section, we carry out various robustness checks. First, we perform an endogeneity test following the placebo test approach of Zhou et al. (2023). To examine whether the observed effects of fund family size, lock-in period, and manager experience on fund performance could arise by chance, we randomly shuffle these characteristics across funds and then re-estimate the main model (Eq. (3)) using these pseudo values. We repeat this randomization 1000 times and plot the estimated coefficients and corresponding p-values in Exhibit 2. The resulting average coefficients for fund family size, lock-in period, and manager experience are all near zero and substantially smaller than the baseline estimates. Furthermore, the majority of p-values exceed 0.10, indicating no statistical significance. Collectively, these results confirm that the effects documented in the baseline regressions are unlikely to be due to random variation, hence further safeguard our results against endogeneity.

Additionally, we separately test the effects of *FundFamilySize*, *LockInPeriod* and *Experience* on fund return to test the robustness of our results. As shown in Panel A1 of Table 11, when investigating the effects of these three regulatory requirements individually, the coefficients of fund family size, lock-in period, and experience are all positive and statistically significant for TDFs & TRFs. Similar results are also observed in general when we estimate the fund flow of all funds in Panel A2.

Next, instead of assets under management, we utilize the number of funds held by the fund company as an alternative measure of fund family size, namely *NumFund*. The joint effects of *NumFund*, *LockInPeriod*, and *Experience* on three-factor alpha and fund flow are documented in Panel B of Table 11, and the results are largely consistent with our main results. Moreover, previous research point out that Fama-French three factor model may not best capture risk-adjusted returns in a Chinese context (Guo et al., 2017; Wang and Zhu, 2024). To address these concerns, we employ Jensen's alpha (Yan, 2008; Rao et al., 2020) and Fama-French five-factor alpha (Fama and French, 2015) as our alternative measures for fund return. Further details of the methodology can be found in Appendix C. We rerun our main analysis and present the results in columns (1)-(4) of Panel C in Table 11. The results are highly consistent with our baseline model results.

[16] A formal analysis using fund-level marketing or investor attention metrics would provide the most rigorous test of this proposition. We acknowledge the limitation that such data are not available for our sample, and note that this offers an interesting avenue for future research.

Table 11
Robustness checks. This table reports our various robustness checks. In Panel A1-A2, we gradually add fund family size, lock-in period, and manager experience to the model in columns (1)-(6) to examine the effect of these factors on fund performance. In Panel B, the number of funds held by the fund company (*NumFund*) is used as an alternative measure of fund family size. We employ Jensen's alpha and Fama-French five-factor alpha as alternative performance measures, and utilize net flow as an alternative metric for fund flow in Panel C. We include the mutual funds sample from 2018 onward, covering the TDFs & TRFs period in Panel D. We include the same set of control variables as in the baseline model. We also control for fund type and quarter fixed effects, and robust standard errors are applied in all regressions. The p-values of regression coefficients are reported in parentheses, and *, **, *** indicate levels of statistical significance at 10%, 5%, and 1%, respectively. See Appendix A for more details on variable definitions.

Panel A1: The effect of regulatory requirements on fund return

Variables	TDFs & TRFs	Mutual funds	TDFs & TRFs	Mutual funds	TDFs & TRFs	Mutual funds
	(1)	(2)	(3)	(4)	(5)	(6)
FundFamilySize	0.0016***	0.0004***	0.0014***	0.0004***	0.0014***	0.0004***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LockInPeriod			0.0001***	−0.0004***		
			(0.00)	(0.00)		
Experience					0.0003***	−0.0002***
					(0.00)	(0.00)
Observations	1,372	153,759	1,372	153,759	1,147	148,036
Adjusted R-squared	0.2689	0.0902	0.2875	0.0917	0.3017	0.0881
Controls	YES	YES	YES	YES	YES	YES
Fund Type fixed effects	YES	YES	YES	YES	YES	YES
Quarter fixed effects	YES	YES	YES	YES	YES	YES

Panel A2: The effect of regulatory requirements on fund flow

Variables	TDFs & TRFs	Mutuals funds	TDFs & TRFs	Mutual funds	TDFs & TRFs	Mutual funds
	(1)	(2)	(3)	(4)	(5)	(6)
FundFamilySize	0.0332*	−0.0217***	0.0269	−0.0216***	0.0060	−0.0215***
	(0.09)	(0.00)	(0.17)	(0.00)	(0.83)	(0.00)
LockInPeriod			0.0033***	−0.0087***		
			(0.00)	(0.00)		
Experience					0.0060	−0.0022***
					(0.46)	(0.00)
Observations	1,216	145,520	1,216	145,520	1,022	140,246
Adjusted R-squared	0.0087	0.0209	0.0121	0.0215	0.0080	0.0204
Controls	YES	YES	YES	YES	YES	YES
Fund Type fixed effects	YES	YES	YES	YES	YES	YES
Quarter fixed effects	YES	YES	YES	YES	YES	YES

Panel B: Alternative measurement of fund family size

Variables	Three-factor alpha	Fund flow		
	TDFs & TRFs	Mutual funds	TDFs & TRFs	Mutual funds
	(1)	(2)	(3)	(4)
NumFund	0.0011*	0.0004***	−0.0232	−0.0292***
	(0.07)	(0.00)	(0.63)	(0.00)
LockInPeriod	0.0002***	−0.0004***	0.0042***	−0.0087***
	(0.00)	(0.00)	(0.00)	(0.00)
Experience	0.0002**	−0.0001***	0.0033	−0.0020***
	(0.02)	(0.00)	(0.69)	(0.00)
Observations	1,147	148,036	1,022	140,246
Adjusted R-squared	0.3360	0.0893	0.0126	0.0207
Controls	YES	YES	YES	YES
Fund Type fixed effects	YES	YES	YES	YES
Quarter fixed effects	YES	YES	YES	YES

Panel C: Alternative measurement of dependent variables

Variables	Jensen's alpha	Five-factor alpha	Net flow			
	TDFs & TRFs	Mutual funds	TDFs & TRFs	Mutual funds	TDFs & TRFs	Mutual funds
	(1)	(2)	(3)	(4)	(5)	(6)
FundFamilySize	0.0016***	0.0004***	0.0006*	0.0004***	0.0068	−0.0055***
	(0.00)	(0.00)	(0.08)	(0.00)	(0.86)	(0.00)
LockInPeriod	0.0003***	−0.0005***	0.0002***	−0.0005***	−0.0036	−0.0147***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.26)	(0.00)
Experience	0.0002***	−0.0002***	0.0002*	−0.0001***	0.0032	−0.0022***
	(0.01)	(0.00)	(0.09)	(0.00)	(0.62)	(0.00)

(*continued on next page*)

Table 11 (*continued*)

Panel A2: The effect of regulatory requirements on fund flow						
Observations	1,147	148,036	1,147	148,036	344	130,326
Adjusted R-squared	0.5712	0.1696	0.2413	0.0730	0.1475	0.0695
Controls	YES	YES	YES	YES	YES	YES
Fund Type fixed effects	YES	YES	YES	YES	YES	YES
Quarter fixed effects	YES	YES	YES	YES	YES	YES
Panel D: Alternative sample: 2018 – 2022						
Variables	Three-factor alpha	Fund flow				
	(1)	(2)				
FundFamilySize	0.0001**	−0.0186***				
	(0.05)	(0.00)				
LockInPeriod	−0.0005***	−0.0081***				
	(0.00)	(0.00)				
Experience	−0.0002***	−0.0023***				
	(0.00)	(0.00)				
Observations	104,543	99,491				
Adjusted R-squared	0.0902	0.0160				
Controls	YES	YES				
Fund Type fixed effects	YES	YES				
Quarter fixed effects	YES	YES				

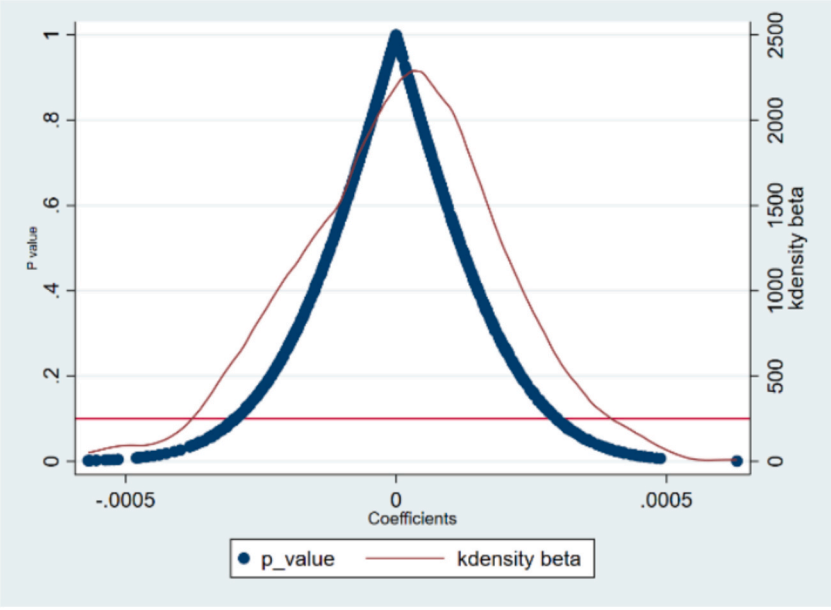

Fig. 1. External shock effect on fund return.

Furthermore, we use the net flow[17] as one alternative measure of fund flow (Ivković and Weisbenner, 2009) to provide a warrant for our main analysis. In columns (5)-(6) of Panel C in Table 11, we present the results which again remain similar to the main analysis. To ensure a more balanced comparison, we compare the performance of TDFs & TRFs with standard mutual funds after 2018 only, when TDFs & TRFs were first introduced. The results, presented in Panel D, align with our main findings in Table 2 and further support our conclusions.

7. Conclusions

In this study, we find that extra regulatory requirements imposed on fund characteristics for TDFs & TRFs, namely fund family size, lock-in period, and fund manager experience, improve the returns and net flows of these funds significantly. In contrast, we discover

[17] Estimated NetFlow is calculated as follows: $InFlow_{i,t} = New\ Sales_{i,t}/TNA_{i,t}$; $OutFlow_{i,t} = Redeemed\ Cash_{i,t}/TNA_{i,t}$; $NetFlow_{i,t} = InFlow_{i,t}$-$OutFlow_{i,t}$. TNA is the total net assets of the fund i in month t. $New\ Sales_{i,t}$ and $Redeemed\ Cash_{i,t}$ are the total number of individual investors' purchases and sales for fund i in month t, respectively.

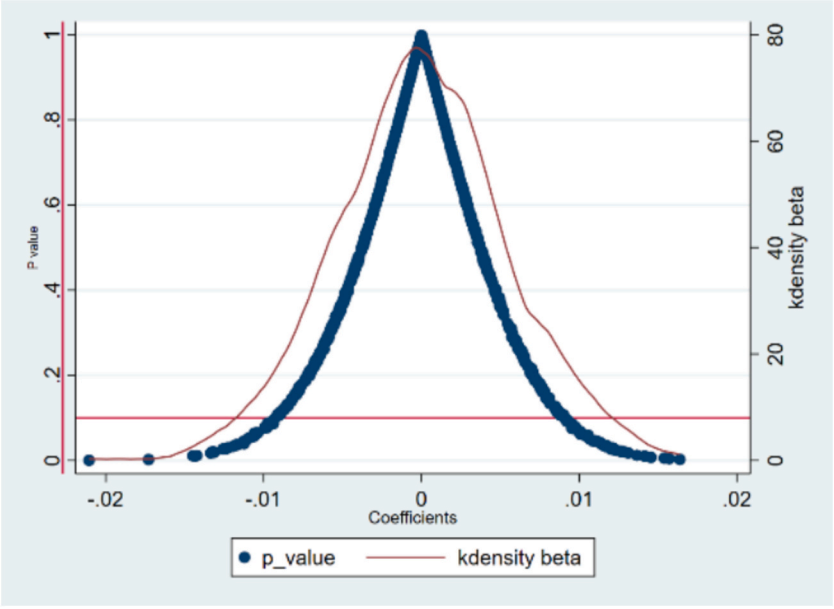

Fig. 2. External shock effect on fund flow.

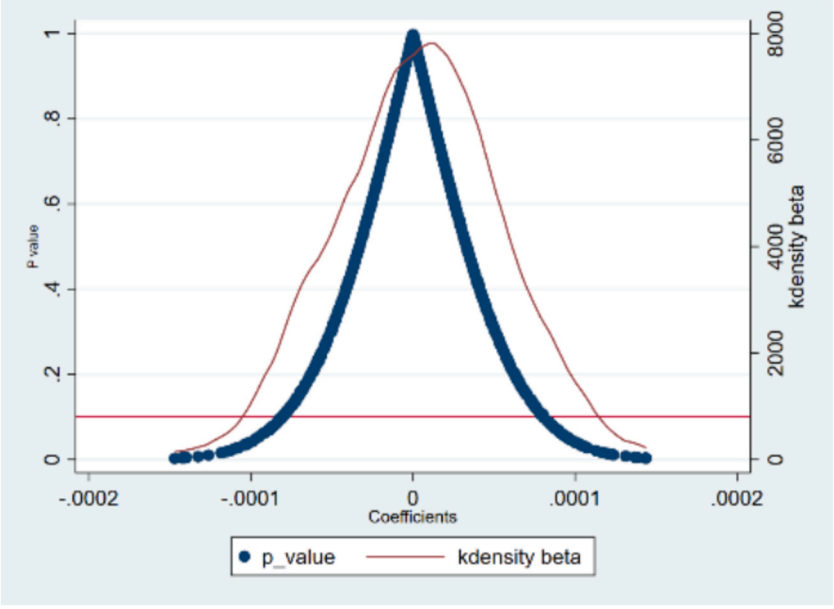

Fig. 3. Fund family size on fund return.

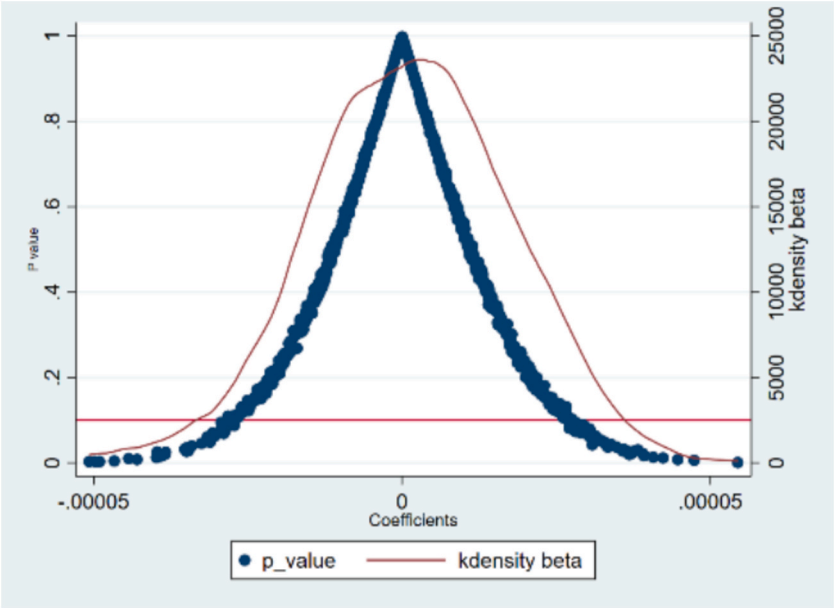

Fig. 4. Lock-in period on fund return.

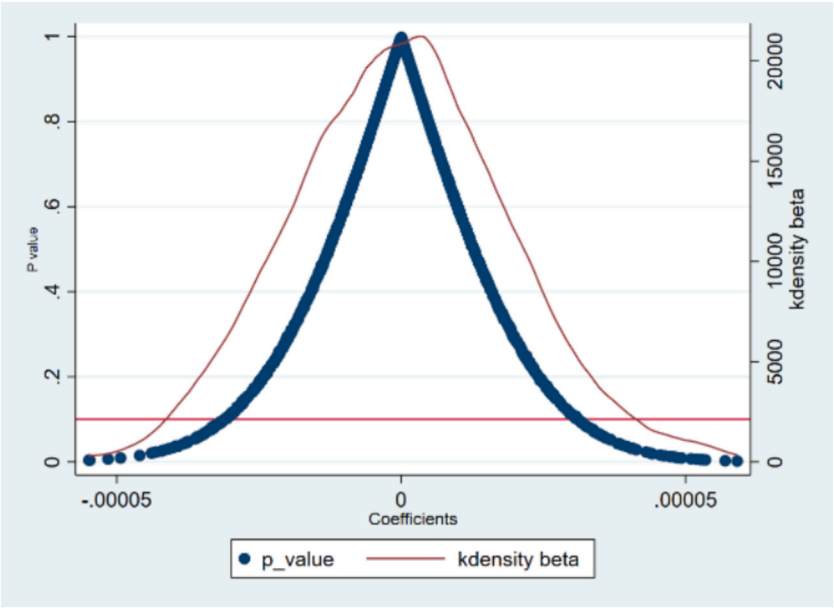

Fig. 5. Manager experience on fund return.

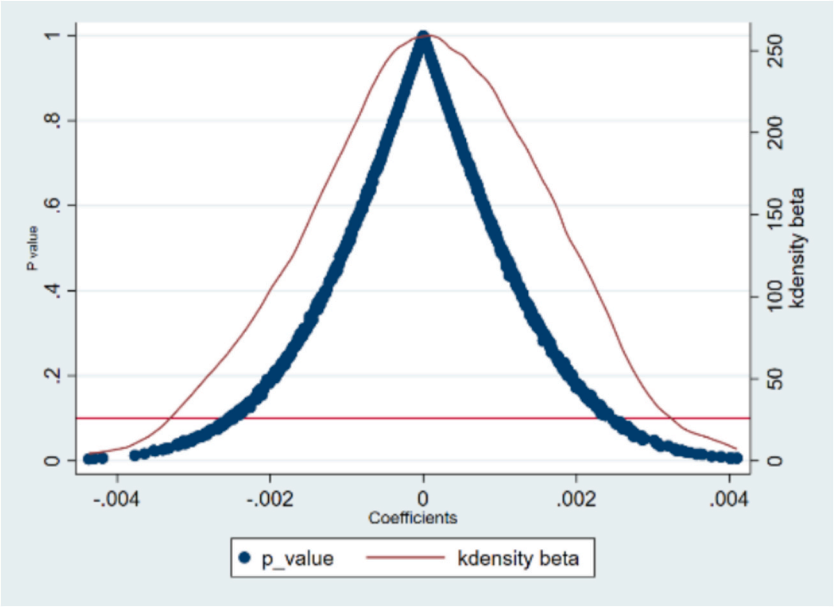

Fig. 6. Fund family size on fund flow.

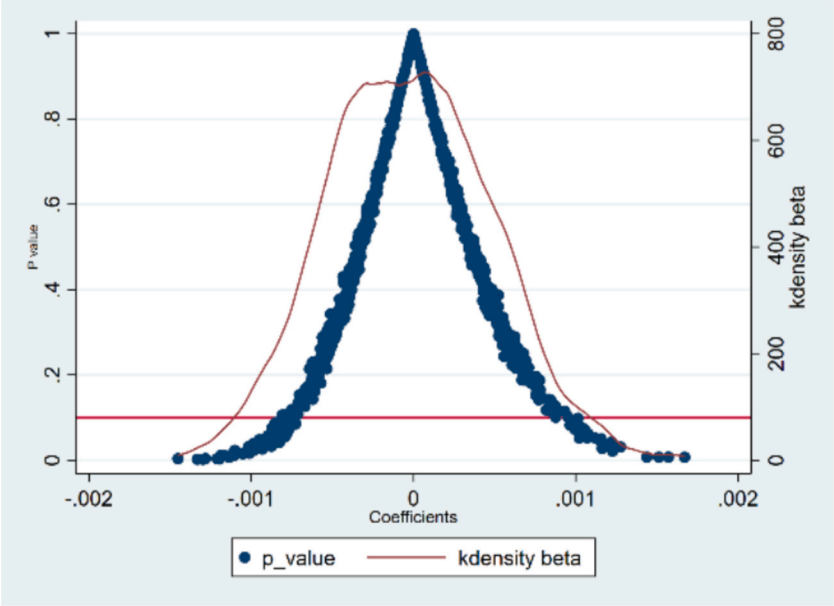

Fig. 7. Lock-in period on fund flow.

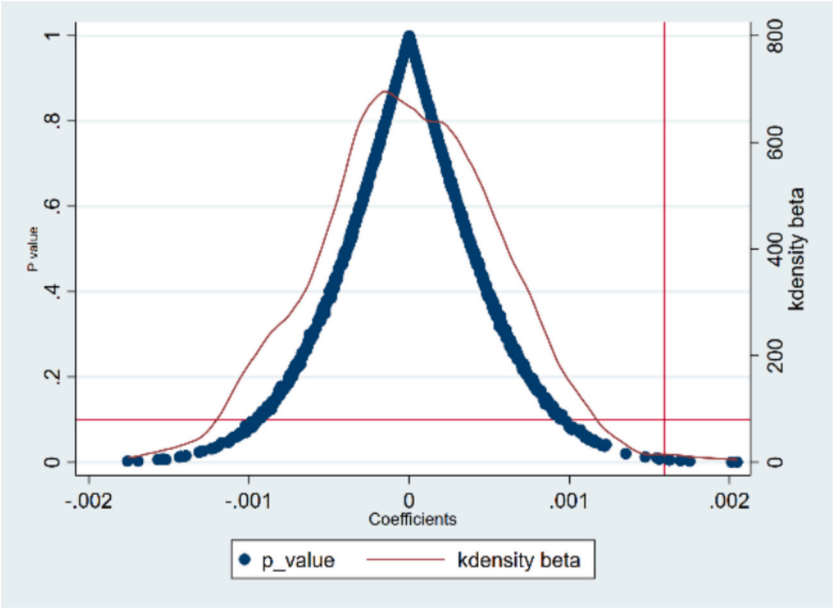

Fig. 8. Manager experience on fund flow.

these regulatory requirements for TDFs & TRFs have a limited effect on mutual fund returns, and a negative effect on mutual fund flows. Our mechanism test shows that TDFs & TRFs have greater fund flow stability, which contributes to their superior performance over mutual funds. Results from further analyses imply a negative spillover to the performance of other non-pension funds managed under the same fund family, which can be attributed to the extra regulatory disclosure and compliance burden as well as the fund family's strategic reasons.

We supplement the literature on pension funds and give a first glance at the characteristics and performance of TDFs & TRFs in the Chinese market. While prior studies have examined extensively how fund size, flows, and managerial quality influence performance (Chen et al., 2004; Agarwal et al., 2009; Ding and Wermers, 2012), our setting is unique in that these characteristics are mandated by regulation for newly established TDFs & TRFs in China, rather than chosen strategically by fund families. By showing that regulatory thresholds on fund family size, lock-in periods, and managerial experience significantly shape fund outcomes, our findings imply how regulation itself can serve as an effective channel to enhance retirement saving effectiveness. This not only advances the literature on fund performance by shifting the focus from discretionary characteristics to regulatory design, but also provides timely policy insights for China and other aging economies seeking to strengthen private pension systems.

While our analysis focuses on the national-level effects of regulatory requirements on TDFs & TRFs, we recognize that heterogeneity in investor behavior, occupation, and demographic characteristics may also influence household participation and fund outcomes. At present, such household-level subscription data are not available. We therefore leave this as a promising direction for future research, which could provide more nuanced insights into how different groups engage with target pension funds.

Exhibit 1: Placebo test of external shock

Figs. 1 and 2 plot the distributions of regression coefficients from placebo tests, where pseudo external shock is randomly assigned to assess their effects on fund performance.

Exhibit 2: Placebo test of baseline model

Figs. 3–8 plot the distributions of regression coefficients from placebo tests, where pseudo fund family size, lock-in period, and manager experience are randomly assigned to funds to assess their effects on performance.

CRediT authorship contribution statement

Yuruo Feng: Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation. **Martin Robert Young:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Jiali Fang:** Writing – review & editing, Validation, Supervision, Project administration, Conceptualization. **Wei Hao:** Writing – review & editing, Supervision, Project administration, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. . Variable definition

Variables	Definition
ThreeFactorAlpha	The abnormal returns generated by the Fama-French three-factor model.
FundFlow	The net growth in fund assets beyond reinvested dividends. $\text{Flow}_{i,t} = \frac{\text{TNA}_{i,t} - \text{TNA}_{i,t-1} \times (1 + r_{i,t})}{\text{TNA}_{i,t-1}}$
FundFamilySize	The natural logarithm of the total assets under management of the fund's family
LockInPeriod	The minimum holding period required by the fund.
Experience	The fund managers' experience in the fund management industry measured in number of years
FundSize	The natural logarithm of the total net assets of the fund.
FundAge	The number of years in which the fund was established.
ExpenseRatio	The ratio of a fund's management fee and custodian fee to the total net assets of funds.
Gender	Takes the value of one if the fund management team includes at least one male manager, and zero otherwise
Degree	The highest education attainment of a fund management team (Degree ranges from 1 to 4 for no tertiary qualification, Undergraduate, Master and MBA/EMBA, and Doctorate, respectively)
TDFTRF	Takes the value of one if the fund is TDFs or TRFs, and zero for mutual funds.
TurnoverRatio	Defined as the greater of total purchases or total sales of securities during the reporting period, divided by the fund's average net assets over the same period.
FundFlowStability	Defined as the negative of the standard deviation of a fund's quarterly fund flows over the past four quarters.
Avg_ExpenseRatio	Represents the average expense ratio of constituent funds during their holding period within TDFs or TRFs.
Avg_ThreeFactorAlpha	Represents the average Fama–French three-factor alpha of constituent funds during their holding period within TDFs or TRFs.
Avg_FundAge	Measures the average age of constituent funds throughout their holding period within TDFs or TRFs.
Avg_FundFlow	Represents the average fund flow of constituent funds during their holding period within TDFs or TRFs.
Avg_Turnover	Represents the average turnover ratio of constituent funds during their holding period within TDFs or TRFs.
TDFTRFCOMPANY	Takes the value of one if the funds' issuers also manage a TDF or TRF at the same time, and zero otherwise.
Over20	Takes the value of one if the fund company's total assets are over 20 billion RMB and it does not issue TDFs or TRFs, and zero if the total assets of a fund company exceed 20 billion RMB and it does issue TDFs or TRFs.
NumFund	The number of funds held by the fund company.
Jensen's alpha	Captures the risk-adjusted return based on the CAPM model.
FiveFactorAlpha	Captures the abnormal return based on the Fama-French five-factor model.
NetFlow	The net monthly fund flow, calculated as the difference between purchases and redemptions by individual investors, scaled by the fund's total net assets.

Appendix B. . Survival analysis

Following Cox (1972), we use the proportional hazards model to investigate the survival probability of TDFs & TRFs' sub-funds. The central focus is the hazard function, $h(t)$, which can be interpreted as the conditional probability that a constituent fund is terminated from a TDF or TRF at time t. T denotes the duration a sub-fund remains within a TDF or TRF, the hazard function can be defined as follows:

$$h(t) = \lim_{\delta \to 0^+} \left(\frac{Pr[t \ll T < t + \delta | T \gg t|}{\delta} \right) \tag{1}$$

The hazard function is specified as:

$$h(t, z; \beta, h_0) = e^{z'\beta} h_0(t) \tag{2}$$

where t is measured in calendar quarters, and z is a vector of explanatory variables that may influence how long a sub-fund remains in a TDF or TRF. We can also express Eq. (2) as the following model:

$$\begin{aligned} \log h(t, z; \beta, h_0) &= \beta_1 Avg\_ExpenseRatio_i^{constituent\ fund} + \beta_2 Avg\_ThreeFactorAlpha_i^{constituent\ fund} \\ &+ \beta_3 Avg\_FundAge_i^{constituent\ fund} + Controls + \log h_0(t) \end{aligned} \tag{3}$$

where *Avg_ExpenseRatio* denotes the average expense ratio of constituent fund i during its holding period within a TDF or TRF, while *Avg_ThreeFactorAlpha* represents its Fama–French three-factor alpha over the same period. *Avg_FundAge* measures the average age of fund i throughout its holding period. In addition, we include the average fund inflows and turnover ratios of each constituent fund, along with other control variables.

Appendix C. . Alphas

We employ Jensen's alpha (Yan, 2008; Rao et al., 2020) and Fama-French five-factor alpha (Fama and French, 2015) as our alternative measures for fund return. Jensen's alpha measures the risk-adjusted return relative to the Capital Asset Pricing Model (CAPM). The Fama–French five-factor alpha measures the abnormal return after controlling for market risk, size, book-to-market value, profitability, and investment factors. The two regression models are shown below:

$$r_{i,t} - r_{f,t} = a_i + \beta_{1,i} \times \left(r_{m,t} - r_{f,t} \right) + \varepsilon_{i,t} \tag{4}$$

$$r_{i,t} - r_{f,t} = a_i + \beta_{1,i} \times \left(r_{m,t} - r_{f,t}\right) + \beta_{2,i} \times SMB_{i,t} + \beta_{3,i} \times HML_{i,t} + \beta_{4,i} \times RMW_{i,t} + \beta_{5,i} \times CMA_{i,t} + \varepsilon_{i,t} \quad (5)$$

where $r_{i,t}$ is the return of fund i at month t, and $r_{m,t}$ represents the return of the corresponding Shanghai Stock Exchange-Shenzhen Stock Exchange (SSE-SZSE) index returns. The risk-free rate $r_{f,t}$ is the monthly interest rate of the official one-year term deposit (Chen et al., 2018). $r_{m,t} - r_{f,t}$ is the excess return of funds. $SMB_{i,t}$ (small minus big) is the average return on small-capitalization portfolios minus the average return on large-capitalization portfolios. $HML_{i,t}$(high minus low) is the average return on high book-to-market portfolios minus the average return on low book-to-market portfolios. $RMW_{i,t}$(robust minus weak) is the average return on robust profitability portfolios minus the average return on weak profitability portfolios. $CMA_{i,t}$(conservative minus aggressive) is the average return on conservative investment strategies portfolios minus the average return on aggressive investment strategies portfolios. To calculate quarterly alphas, we use a rolling window of 24 months to obtain monthly fund returns, and then aggregate them into quarterly returns (Amihud and Goyenko, 2013).

Appendix D. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.intfin.2026.102290.

Data availability

Data will be made available on request.

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