

INTRODUCTION/OVERVIEW

Introduction to the 20th Anniversary Special Issue of the *Journal of Pension Economics and Finance*

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Abstract

The papers in this 20th Anniversary Special Issue reflect to a large extent how the fields of pension economics and pension finance have developed in the past two decades, although there remain very clear connections to the research published in the Journal's first issue. While there has been great progress in research on pensions and retirement economics over the last 20 years, there remain important outstanding questions for future study.

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In the first issue of the *Journal of Pension Economics and Finance* in March 2022, editors Jeffrey Brown, Steven Haberman, Moshe Milevsky, and Mike Orszag introduced the *Journal of Pension Economics and Finance* as 'a forum for developing ideas and solutions to pension challenges'. The issue featured papers on controlling the cost of minimum benefit guarantees in public pension conversions (Smetters, 2002), Social Security as a financial asset: gender-specific risks and returns (Baxter, 2002), how China can solve its old-age security problem (James, 2002), and international pension swaps (Bodie and Merton, 2002).

The papers in this 20th Anniversary Special Issue reflect to a large extent how the fields of pension economics and pension finance have developed in the intervening two decades, although there remain very clear connections to the research published in the Journal's first issue.

Old-age Social Security systems around the world continue to be a very active topic of research. The financial challenges facing many of these systems were well-known 20 years ago, with contributing factors including increasing longevity and declining birthrates. As documented by Coile *et al.* (2024) in this issue, the labor force participation rates of older men had fallen dramatically across many countries in the latter part of the 20th century, while the labor force participation of older women had not seen the same increase as that of younger women. The International Social Security (ISS) project undertaken by Coile *et al.* documents that incentive measures built into old-age pension benefit formulas have important effects on retirement behavior. The paper draws on substantive methodological advances in the measurement of pension accruals, some of which predated the first volume of JPEF (the option value framework of Stock and Wise [1990]) and others of which came afterwards (the peak value framework of Coile and Gruber [2007]).

While the funding challenges of old-age Social Security in many countries around the world have hardly been solved, this work provides important evidence of one set of policy tools that can contribute to improving the financial balance of such systems through incentivizing work at older ages. With the US Social Security Trust Fund assets scheduled to be depleted within 10 years of this special issue, some type of reform to the US Social Security system is likely. The ISS project provides

important insights into the labor supply incentives of workers that will be relevant for predicting the likely effects of these reforms.

In a related paper on Social Security, Slavov (2024) examines the evolution of the incentives over the past two decades for claiming versus delaying the receipt of Social Security benefits. While 20 years ago, the timing of when to claim Social Security benefits was roughly actuarially neutral in the range from early retirement at age 62 up to age 70, several factors have substantially increased the gains to delay. These include increased delayed retirement credits, improving longevity, and lower real interest rates. To the extent that the decision to stop working and the decision to claim Social Security are correlated, these incentives might well tilt individuals toward longer working lives. The effects of increasing benefits to claiming on retirement behavior are an important topic for further research. Slavov (2024) also reviews an extensive literature that examines the nature of Social Security as a financial asset that has emerged in the past 20 years, seeing Social Security as a sort of mandatory purchase financial asset with returns linked to the evolution of wages with numerous embedded options. A related literature has examined the financial value of this Social Security asset (Geanakoplos *et al.*, 1999; Geanakoplos and Zeldes, 2010; Blocker *et al.*, 2019). The underlying risk and return characteristics of Social Security inclusive of these options are critical to understand, both from the perspective of evaluating its adequacy as a retirement income program and for the discussion about the extent to which Social Security benefits as a form wealth compress the overall wealth distribution (see Catherine *et al.*, 2023).

The paper in this volume by Brown *et al.* (2024) considers retirement income choices via unique data from participants in the defined contribution plans of the TIAA system. This system serves the employees of colleges, universities, and other non-for-profit entities, and is somewhat unique relative to 401(k) plans offered by private for-profit employers, in both the typical value of accumulated assets and the extent of retirement income choices. For most of TIAA's century-long history, retiree income was generally provided with life annuities. Since 1989, the choice set has expanded so that now employees may take lump-sum distributions, systematic withdrawals, non-life guaranteed income, or other withdrawal options that satisfy the IRS's required minimum distribution (RMD) rules.

Twenty years ago, a key question that the literature was grappling with was why so few participants in defined contribution plans chose to insure against longevity by buying annuities. This empirical question went back to Yaari (1965) who first demonstrated that without a bequest motive, lifecycle consumers should strongly prefer annuitized income. Yet most households do not choose annuities, and this has been difficult to reconcile with rational models of household decision-making. Mitchell *et al.* (1999) showed that the fees and expenses associated with annuities are not large enough to explain the lack of annuitization. Benartzi *et al.* (2011) applied the rationale of behavioral economics, often used to explain lack of participation in defined contributions savings plans such as in Choi *et al.* (2004), to explain a lack of action on annuitization. The literature highlights obstacles including framing, mental accounting, and inertia. In the meantime, the literature has advanced in understanding both the potential and risks of more sophisticated financial products for retirees (Horneff *et al.*, 2010).

The paper by Brown *et al.* (2024) finds that among TIAA participants, the proportion with a life annuity as a component of their payout strategy dropped from 52 percent in 2008 to 31 percent in 2018, while the proportion relying on an RMD payment rose from 16 to 29 percent. They conclude that the RMD structure imposed by the IRS is 'becoming the de facto default distribution option or newly-retired TIAA participants'. This result calls attention to the role of RMD as in some way replacing annuities as a form of lifetime income, albeit one without any longevity insurance and one that in fact depletes assets. Whether RMD policy, in the presence of Social Security, sufficiently ensures retirement income adequacy given accumulated resources remains an important question for further research.

During the pandemic, governments in the US and around the world gave individuals the chance to tap into their retirement savings. For example, in the US, after the passage of the CARES act, individuals were allowed to make penalty-free withdrawals from their IRAs and 401ks if they were deemed

sufficiently under financial duress based on certain criteria. Biggs and Rauh (2020) proposed further that voluntary US stimulus checks might be financed by allowing individuals to borrow against Social Security. Fuentes *et al.* (2024) study the experience of early pension withdrawal in Chile, a country where there is relatively much higher reliance on private retirement savings as opposed to government programs like Social Security. They find that while many factors explain early withdrawals, the fact that a large portion of withdrawals were used for reasons other than retirement suggests that the pension system may require some reform and redesign to achieve adequate asset levels for retirees. The paper also highlights the need to balance offering liquid access to individuals in crises versus protecting retirement asset balances in systems where retirement relies heavily on individual savings.

To determine whether retirement assets are adequate or not requires that they be well measured. Considerable disagreement exists over the question of retirement savings adequacy in the US in particular (see Biggs, 2017). Dushi and Trenkamp (2024) find that for the population 65 or older, supplementing survey data from the Current Population Survey (CPS) Annual Social Economic Supplement (ASEC) with administrative Internal Revenue Service (IRS) tax records and Social Security Administration (SSA) earnings and benefit records leads to an increased pension share of aggregate income, a lower estimated reliance on Social Security, and a lower estimated rate of poverty. The paper demonstrates the importance of using administrative data to accurately reflect all retirement income sources in retirement income calculations, as accuracy of such calculations is essential for assessing retirement income adequacy and analyzing different policy directions in the US retirement landscape.

A related adequacy question is, what constitutes adequate funding of defined benefit (DB) plans? An often-cited summary statistic for the funding quality of a DB plan is the plan's funding ratio, defined as the market value of the plan's assets over the present value of plan liabilities. One strand of literature has focused on the question of the valuation of pension liabilities (Novy-Marx and Rauh, 2011). Yet the argument for fully funding public pensions at 100 percent funding ratios, whether from the perspective of intergenerational welfare or in terms of fiscal sustainability, is not at all unambiguous (Brown *et al.*, 2011). More recently, a focus has emerged that considers whether a given pension funding policy is sustainable, in the sense of achieving stable contribution ratios while not needing to depend on outside funding sources. In one contribution, Lenney *et al.* (2021) posit that policymakers need to only make moderate adjustments to current contribution rates to achieve plan solvency in the form of maintaining a constant long-run debt-to-GDP ratio. However, other researchers have argued that such studies fail to consider whether pension plans could remain solvent for a shorter time horizon with prolonged adverse shocks, or whether the very use of arbitrary assumed investment rates of return itself lends itself to plan unsustainability (Lucas, 2021; Rauh, 2021).

Costrell and McGee (2024) propose an economic reformulation of funding policy. The basic problem with current DB pension funding policy in the public sector is that these plans depend on policymakers to set adequate taxpayer and member contribution rates as well as expected investment rates of return that cover employees' benefits over the span of their careers. However, it is often the case that these assumptions prove insufficient in generating the necessary amount of funds to cover employees' benefits, and thus this leads to increased pressure on governments to either cut workers' benefits or reallocate a greater share of government spending to cover pensioners. Costrell and McGee (2024) establish a new methodological approach to replace current actuarial funding policy. Like Lenney *et al.* (2021), their approach allows for a role of expected returns on risky assets in setting contribution rates while also using a low-risk discount rate for liabilities, and they also focus on sustainability as opposed to full funding. However, Costrell and McGee (2024) derive contribution adjustment policies necessary for convergence toward a target funding ratio – not necessarily the status quo ratio which may expose pension funds the risks identified by Lucas (2021) and Rauh (2021) – while also introducing an optimization framework in which target portfolio returns and funding ratios are simultaneously determined.

Two additional specific questions arise that are related to the question of retirement benefit adequacy. One is the question of participation – are individuals participating enough in DC plans to build retirement wealth? The other is the question investment – how are the vehicles in which

retirement savers are investing affecting their outcomes and asset markets as a whole? The remaining two papers in this volume address these issues.

Beshears *et al.* (2024) study one UK-based company that had a significantly default employee contribution rate of 12 percent to the firm's defined contribution plan that is significantly higher than the rates of 1–6 percent by typical firms studied in prior research. While the default rate was 12 percent, employees could choose to opt out and remain part of the plan by contributing at least 4 percent. The authors find that by 12 months of tenure, 75 percent of employees had chosen to opt out of the 12 percent default contribution rate. Those that remained had salaries one-third less than those who had chosen to opt out. The authors conclude that higher default contribution rates may be useful from a policymaking perspective. Those who do decide to opt out may have a better sense of what rate best satisfies their future goals, while those who decide to remain at the higher contribution rate will be less likely to fail to meet their retirement needs.

Parker and Sun (2024) address alternative investor retirement strategies' impact on the market through the study of target date funds (TDFs). TDFs are funds which invest in mixes of different investment assets (e.g., stocks, bonds, etc.) that aim to help investors retire on specific target dates. Thus, depending on the performance of the fund, portfolio managers will adjust the mix of investments to best ensure that investors remain on track to retire by that date. The authors of the paper find that because TDFs trade against market returns to maintain exposure (i.e., buying stocks when the market declines and selling stocks when the market performs well) and because TDFs have become very prevalent as they now represent about one-quarter of all 401(k) assets, TDFs inadvertently have proven to have a stabilizing impact on the market.

What issues are still unresolved in the pensions and retirement landscape? While there has been great progress in research on pensions and retirement economics over the last 20 years, there remain important, outstanding questions that require future study.

First, one area that has become increasingly relevant has been the proliferation of 'Environmental, Social, and Governance' (ESG) funds that supposedly consider both financial and non-financial factors when considering areas in which to invest. Pension funds currently maintain large investments in ESG funds, and thus it is of ever-increasing importance to study whether there is a financial tradeoff associated with considering 'non-financial' factors particularly when noting that pension funds currently have unfunded liabilities of \$5.1 trillion based on market valuation standards (Giesecke and Rauh, 2024).

Second, while Parker and Sun (2024) show that there are market stabilizing benefits associated with TDFs, evidence is mixed on their usefulness as a retirement strategy. Matching existing TDF quarterly holdings to highly correlated ETFs and then using those matched ETFs to reconstruct TDFs into what the authors refer to as 'Replicating Funds' (RFs), Brown and Davies (2020) find that existing TDFs significantly underperform constructed RFs primarily due to high fund fees as well as poor fund selection, which account for 55 and 40 percent of fund underperformance, respectively. However, other research has shown that a TDF's management structure matters significantly in how these funds perform. Mao and Wong (2022) find that managers who themselves invest in TDFs exhibit less risk-taking behavior in their investment choices when managing TDFs. Further, Shoven and Walton (2021) find that higher-cost, actively managed TDFs perform worse than alternative passive TDFs. The rebalancing of TDFs toward fixed income securities as individuals approach retirement has in some cases proven not robust for individuals expecting or targeting a lump sum on a retirement date, as increases in interest rates have hurt fixed income assets of longer duration, which it turns out are strongly represented in the fixed income portfolios of many TDFs. TDFs may of course also play a role in stabilizing fixed income markets. Furthermore, TDFs are generally designed as a one-size-fits-all strategy and may be adopted by individuals with vastly different levels and composition of background wealth. Further research is necessary to fully understand the optimal design of TDFs, their usefulness as a retirement savings vehicle, and their impact on asset markets.

Third, the past two decades have seen a strong resurgence of research and interest in pension fund governance and how pension boards affect investment decisions, performance, and funding outcomes. Useem and Mitchell (2000) show that public sector governance policies – investment restriction

criteria, how investment performance is assessed, a board's purview, and finally a board's size and composition – all have a substantial influence on a retirement system's investment performance. Mitchell and Hsin (1999) relatedly find that public pension systems' board composition in particular had important implications for fund performance, as systems with boards that included current employees or retirees generally were associated as being more poorly funded while systems with boards that force members to carry liability insurance, or which have more in-house actuaries are associated with being better funded. Mitchell and Yang (2005) support these results, finding that an increased proportion of representation of retired and/or active employees generally worsens investment performance and stock funding while the inclusion of experts generally ameliorates investment performance. Studies have also shown the presence of state officials on retirement system boards is also associated with worse investment performance of state retirement systems as well as increased risk-taking behavior and the use of higher discount rates (Andonov *et al.*, 2017; Andonov *et al.*, 2018). In general, as Clark (2004) finds, most pension fund managers lack a basic understanding of advanced financial instruments, hindering funds' efforts to optimize investment performance. Research has also shown that beyond investment performance, board composition can influence how federal monies directed toward pension funds are allocated. Clemens *et al.* (2024) find that in allocating money from federal rescue packages, states where the trustees of pension funds were more heavily composed of plan members as opposed to politicians and independent members of the public were able to direct more funds to pension contributions.

Finally, with entitlements like Social Security and many public employee DB pension plans facing financial distress over the coming decades, further development of funding frameworks that can make these systems sustainable remains an important area of research. Recent research has found that individuals may not value some types of DBs as highly as their cost to systems or employers, due to constraints that some traditional benefits place on liquidity and portability (Giesecke and Rauh, 2023). The Netherlands is offering a national experiment in shifting from primarily DB to primarily collective DC plans (i.e., 'Direct Ambition' [DA] plans), as it implements significant changes in benefit structures for its occupational pension plans. Bovenberg *et al.* (2014) considered the applicability of the Dutch DA plans to US retirement systems, finding that a hybrid scheme could be proved to be optimal where the system would use a DC structure while employees accumulate benefits and a DA structure as the benefits are paid out. Collective defined contribution plans are plans that pool assets but where benefits to plan participants will vary in some way based on asset performance. Ponds and van Riel (2009), Cui *et al.* (2011), and Novy-Marx and Rauh (2014) all analyze the distributions of outcomes for various hybrid types of strategies introduced in pension reforms. Understanding what reforms will achieve fiscal sustainability despite substantial program shortfalls and overall budget deficits that are much greater than they were 20 years ago, while also preventing old-age poverty, remains a vital area for future study.

References

- Andonov A, Bauer RMM and Martijn Cremers KJ (2017) Pension fund asset allocation and liability discount rates. *The Review of Financial Studies* 30, 2555–2595.
- Andonov A, Hochberg YV and Rauh JD (2018) Political representation and governance: evidence from the investment decisions of public pension funds. *The Journal of Finance* 73, 2041–2086.
- Baxter M (2002) Social security as a financial asset: gender-specific risks and returns. *Journal of Pension Economics and Finance* 1, 35–52.
- Benartzi S, Previtero A and Thaler RH (2011) Annuitization puzzles. *Journal of Economic Perspectives* 25, 143–164.
- Beshears J, Guo R, Laibson D, Madrian B and Choi J (2024) Automatic enrollment with a 12% default contribution rate. *Journal of Pension Economics and Finance* 24, 152–182.
- Biggs AG (2017) The life cycle model, replacement rates, and retirement income adequacy. *The Journal of Retirement* 4, 96–110.
- Biggs AG and Rauh J (2020) Funding direct payments to Americans through social security deferral. *Social Science Research Network (SSRN)*, 3580533, 1–16.
- Blocker AW, Kotlikoff LJ, Ross SA and Vallenas SV (2019) The true cost of social security. *Tax Policy and the Economy* 33, 131–163.

- Bodie Z and Merton RC** (2002) International pension swaps. *Journal of Pension Economics and Finance* **1**, 77–83.
- Bovenberg L, Mehlkopf R and Nijman T** (2014) The promise of defined ambition plans: lessons for the United States. In Mitchell OS and Shea RC (eds), *Reimagining Pensions: The Next 40 Years*. Oxford: Oxford University Press, pp. 215–246.
- Brown DC and Davies S** (2020) Off target: on the underperformance of target-date funds. *Social Science Research Network* (SSRN), 3707755, 1–73.
- Brown JR, Clark R and Rauh J** (2011) The economics of state and local pensions. *Journal of Pension Economics and Finance* **10**, 161–172.
- Brown JR, Poterba JM and Richardson DP** (2024) Trends in retirement and retirement income choices by TIAA participants: 2000–2018. *Journal of Pension Economics and Finance* **24**, 47–68.
- Catherine S, Miller M and Sarin N** (2023) Social security trends in wealth inequality. *Social Science Research Network* (SSRN) (*Jacobs Levy Equity Management Center for Quantitative Financial Research*), 3546668, 1–68.
- Choi J, Laibson D, Madrian B and Metrick A** (2004) For better or for worse: default effects and 401(k) savings behavior. In Wise DA (ed), *Perspectives on the Economics of Aging*. Chicago, IL: University of Chicago Press, pp. 81–121.
- Clark GL** (2004) Pension fund governance: expertise and organizational form. *Journal of Pension Economics and Finance* **3**, 233–253.
- Clemens J, Giesecke O, Rauh J and Veuger S** (2024) Where did pandemic-era fiscal aid to states land? Paper presented at *Longer-Term Health and Economic Effects of COVID-19: Spring 2024*, Cambridge, MA, February 2, 2024. Available at https://conference.nber.org/conf_papers/f193951.pdf
- Coile C and Gruber J** (2007) Future social security entitlements and the retirement decision. *The Review of Economics and Statistics* **89**, 234–246.
- Coile C, Wise D, Börsch-Supan A, Gruber J, Milligan K, Woodbury R, Baker M, Banks J, Behaghel L, Ben Salem M, Bingley P, Blanchet D, Blundell R, Boldrín M, Bozio A, Brugiavini A, Bucher-Konen T, Buia R, Caroli E, Debrand T, Dellis A, Desmet R, de Vos K, Diamond P, Emmerson C, Ferrari I, Fraikin A, Fujii M, García-Gómez P, García-Mandico S, Goll N, Gupta N, Jiménez-Martín S, Johansson P, Johnson P, Jørgensen M, Jousten A, Jürges H, Kallestrup-Lamb M, Kalwij A, Kapteyn A, Kohnz S, Laun L, Lefebvre M, Mahieu R, Mastrobuoni G, Meghir C, Oishi A, Oshio T, Palme M, Pasini G, Pedersen P, Pelé L-P, Peracchi F, Perelman S, Pestieau P, Prost C, Rabaté S, Rausch J, Roger M, Schirle T, Schnabel R, Schuth M, Shimizutani S, Smith S, Stijns J-P, Sturrock D, Svensson I, Tetlow G, Thiel L, Tô M, Tréguier J, Usui E, Vall-Castelló J, Walraet E, Weber G and Yashiro N** (2024) Social security and retirement around the world. *Journal of Pension Economics and Finance* **24**, 8–30.
- Costrell R and McGee J** (2024) Toward an economic reformulation of public pension funding. *Journal of Pension Economics and Finance* **24**, 123–151.
- Cui J, De Jong F and Ponds E** (2011) Intergenerational risk sharing within funded pension schemes. *Journal of Pension Economics and Finance* **10**, 1–29.
- Dushi I and Trenkamp B** (2024) Measuring income of the aged in household surveys: evidence from linked administrative records. *Journal of Pension Economics and Finance* **24**, 95–122.
- Fuentes OS, Mitchell OS and Villatoro F** (2024) Early pension withdrawals in Chile during the pandemic. *Journal of Pension Economics and Finance* **24**, 69–94.
- Geanakoplos J and Zeldes SP** (2010) Market valuation of accrued social security benefits. In Lucas D (ed), *Measuring and Managing Federal Financial Risk*. Chicago, Illinois: The University of Chicago Press, pp. 213–233.
- Geanakoplos J, Mitchell OS and Zeldes S** (1999) Social security money's worth. In Mitchell OS, Myers RJ and Young H (eds), *Prospects for Social Security Reform*. Philadelphia, PA: University of Pennsylvania Press, pp. 79–151.
- Giesecke O and Rauh JD** (2023) How much do public employees value defined benefit versus defined contribution retirement benefits? *Social Science Research Network* (SSRN), 4308471, 1–68.
- Giesecke O and Rauh JD** (2024) Trends in state and local pension funds. *Social Science Research Network*, 1–40.
- Horneff WJ, Maurer RH, Mitchell OS and Stamos MZ** (2010) Variable payout annuities and dynamic portfolio choice in retirement. *Journal of Pension Economics and Finance* **9**, 163–183.
- James E** (2002) How can China solve its old-age security problem? The interaction between pension, state enterprise and financial market reform. *Journal of Pension Economics and Finance* **1**, 53–75.
- Lenney J, Lutz B, Schuele F and Sheiner L** (2021) The sustainability of state and local pensions: a public finance approach. *Brookings Papers on Economic Activity* **52**, 1–63.
- Lucas D** (2021) Comment on 'The sustainability of state and local pensions: a public finance approach'. *Brookings Papers on Economic Activity* **52**, 49–57.
- Mao MQ and Wong CH** (2022) Managerial commitment and heterogeneity in target-date funds. *Journal of Empirical Finance* **68**, 1–19.
- Mitchell OS and Hsin P-L** (1999) Public pension governance and performance. In Valdes-Prieto S (ed), *The Economics of Pensions: Principles, Policies, and International Experience*. Cambridge: Cambridge University Press, 92–126.
- Mitchell OS and Yang T** (2005) Public pension governance, funding, and performance: a longitudinal appraisal. In Evans J, Orszag M and Piggott J (eds), *Pension Fund Governance: A Global Perspective on Financial Regulation*. Cheltenham: Edward Elgar Publishing, pp. 179–199.

- Mitchell OS, Poterba JM, Warshawsky MJ and Brown JR** (1999) New evidence on the money's worth of individual annuities. *American Economic Review* **89**, 1299–1318.
- Novy-Marx R and Rauh J** (2011) Public pension promises: how big are they and what are they worth. *The Journal of Finance* **66**, 1211–1249.
- Novy-Marx R and Rauh JD** (2014) Linking benefits to investment performance in US public pension systems. *Journal of Public Economics* **116**, 47–61.
- Parker J and Sun Y** (2024) Target date funds as asset market stabilizers: evidence from the pandemic. *Journal of Pension Economics and Finance* **24**, 183–208.
- Ponds EHM and van Riel B** (2009) Sharing risk: the Netherlands' new approach to pensions. *Journal of Pension Economics and Finance* **8**, 91–105.
- Rauh J** (2021) Comment on 'The sustainability of state and local pensions: a public finance approach'. *Brookings Papers on Economic Activity* **52**, 57–61.
- Shoven J and Walton D** (2021) An analysis of the performance of target date funds. *The Journal of Retirement* **8**, 43–65.
- Slavov S** (2024) Two decades of social security claiming. *Journal of Pension Economics and Finance* **24**, 31–46.
- Smetters K** (2002) Controlling the cost of minimum benefit guarantees in public pension conversions. *Journal of Pension Economics and Finance* **1**, 9–33.
- Stock JH and Wise DA** (1990) Pensions, the option value of work, and retirement. *Econometrica* **58**, 1151–1180.
- Useem M and Mitchell OS** (2000) Holders of the purse strings: governance and performance of public retirement systems. *Social Science Quarterly* **8**, 489–506.
- Yaari ME** (1965) Uncertain lifetime, life insurance, and the theory of the consumer. *The Review of Economic Studies* **32**, 137–150.