KEY POINTS

- Much consideration has been given to the challenges posed by rising life expectancy globally with the population of the People's Republic of China (PRC) also aging rapidly. Limited attention has been paid to an element of this challenge—the longevity risk created by the uncertainty of the future path of this trend.
- Rapid aging and the attendant longevity risk present sustainability challenges for the PRC's pension system. The PRC needs to undertake impactful, widespread, and holistic pension reform.
- Financial markets can offer a partial solution for longevity risk in the PRC by jump-starting a market for longevity risk-sharing transactions in the country. The concept would make use of the diversity in the levels of socioeconomic development between the country's regions, the state's somewhat uniquely powerful policy tools, and the extensive internal migration patterns of the nation's workers.
- This risk-sharing market would aim to strengthen the pension systems of the wealthier provinces by helping them hedge against longevity risk while creating more fiscal space and flexibility for the country's poorer provinces.

A Market-Based Approach to Sharing the Economic Benefits and Consequences of Aging in the People's Republic of China

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The impressive socioeconomic development in the People's Republic of China (PRC) has in part contributed to rapid aging of its population. As in many other countries, rapid aging poses sustainability challenges for the pension system. While much attention has been justifiably paid to the challenges posed by the favorable rising trend of life expectancy, less attention has been paid to the adverse consequences from the uncertainty surrounding this trend; that is, exposure to longevity risk. Exposure to longevity risk grows as life expectancy increases and is greater for older cohorts than younger ones, making it harder to estimate with confidence how much longer people will live. Predicting the remaining life expectancy of future cohorts of the elderly has proven particularly difficult.

Failure to mitigate this longevity risk could threaten the long-term viability of the PRC's pension system. This brief suggests that the financial markets can offer at least a partial solution for longevity risk by jump-starting a market for longevity risk-sharing transactions in the PRC. The concept would make use of the diversity in the levels of socioeconomic development across the PRC, the country's somewhat uniquely powerful policy tools, and the extensive internal migration patterns of its workers. It aims to strengthen the PRC's pension system for the wealthier provinces by helping them hedge against longevity risk and, at the same time, create more fiscal space and increased fiscal flexibility for its poorer provinces.

THE MOUNTING CHALLENGES OF RISING LIFE EXPECTANCY AND LONGEVITY RISK

In 2016, President Xi Jinping described the PRC's elderly population as the world's largest and fastest growing. He called the multiple challenges related to rapid aging in the country the "toughest to cope with" anywhere.¹ People 60 and over accounted for only 12% of the PRC's population in 2010. By 2050, they are projected to make up one-third.² In 2017, due to steady and ongoing rise in life expectancy, the average 65-year-old could expect to live for another 16.5 years, and the average 85-year-old for another 5.5. The social benefits of longer lives come at a price. As the elderly spend more time in retirement and more on day-to-day costs and health care, they risk outliving their financial resources.

Life expectancy is likely to continue to trend upward in the PRC, although at an uncertain pace. While the mean age of death may be ascertained for each cohort age group, the variation around the mean of the actual age of death varies widely. A sense of the size of longevity risk could be ascertained from a United Kingdom (UK) study based on estimates provided by the government's Actuary Department, which states that in 2005, life expectancy for a 65-year-old male cohort lies in a range of 17.7–20.5 years, but by 2040, it could be in a range of 17.2–26.7 years.³ This range has been growing wider over time and is also wider for older cohort age groups than younger ones. This wider range, a measure of longevity risk, should be an important input to the PRC's pension reform process, yet it is not effectively being considered.

Life expectancy for the 65-year-olds of many advanced economies grew by an average of 2 months a year during the first decade of the new millennium. According to the Organisation for Economic Co-operation and Development (OECD), each additional year of life can be expected to add 3%–5% to a nation's current pension liabilities.⁴ Given that uncertainty gaps in projecting future life expectancy for the elderly can be as wide as 10 years, the potential increases in pension costs impacted by longevity risk could be many

times that. This, a rapidly aging population, and a deteriorating worker–pensioner ratio raises sustainability issues for the PRC pension system, which must already deal with growing deficits. These deficits are currently covered by national government subsidies and redistribution schemes,⁵ but a mechanism and market for longevity risk sharing could reduce the need for such support in the future.

A GLOBAL PROBLEM STILL LOOKING FOR ADEQUATE SOLUTIONS

Longevity risk is a worldwide phenomenon. The world's pension systems are already overburdened. One 2016 estimate puts the value of the unfunded or underfunded government pension liabilities in 20 advanced countries at \$78 trillion, a figure approaching twice their current published national debts.⁶ In 2012, the International Monetary Fund in their *Global Stability Report*, Chapter 4: The Financial Impact of Longevity Risk, reported that countries had been consistently underestimating life expectancy by an average of 3 years. They also pointed out the potentially large adverse effects of longevity risk for the stability of the world-wide financial system, citing it as a potential threat to global financial stability.⁷

Much literature describes the growing economic and social importance of the need to cope effectively with the challenge of longevity risk. Issues discussed cover demographic, actuarial, financial, long-term elderly care, and (especially) data concerns. While the severity of the risk is well recognized, radical steps to mitigate concerns have been limited and mostly involved risk transfer transactions. According to Hymans Robertson,⁸ a UK consulting firm, the cumulative value of these pension system transactions through 31 December 2017 reached only \$22 billion in Canada, \$101 billion in longevity swaps and \$128 billion of buy-outs and buy-ins in the UK, and \$115 billion in the United States. These figures are dwarfed by the amount of funded longevity risk exposures for OECD countries, as measured by total pension assets that back future pension obligations.⁹ In 2018, this proxy for the volume of longevity risk was estimated at more than \$16 trillion.

¹ Xinhua News Agency. 2016. Xi Jinping: Promote the Comprehensive, Coordinated and Sustainable Development of the Cause of Aging. 28 May. http://news.xinhuanet.com/politics/2016-05/28/c_1118948763.htm.

² ADB. 2014. Challenges and Opportunities of Population Aging in the People's Republic of China. *Observations and Suggestions*. No. 2014–3. Beijing.

³ UK Pensions Commission. *A New Pension Settlement for the Twenty-First Century – the Second Report of the Pensions Commission*. Appendix E. 2005. London.

⁴ OECD. 2014. *Mortality Assumptions and Longevity Risk, Implication for Pension Funds and Annuity Providers*. Paris.

⁵ F. Tang. 2019. China's State Pension Fund to Run Dry by 2035 as Workforce Shrinks Due to Effects of One-child Policy, Says Study. *South China Morning Post*. 12 April. <https://www.scmp.com/economy/china-economy/article/3005759/chinas-state-pension-fund-run-dry-2035-workforce-shrinks-due>.

⁶ Bass, E. et al. 2016. *The Coming Pensions Crisis*. Citi GPS: Global Perspectives & Solutions. March. http://www.agefi.fr/sites/agefi.fr/files/fichiers/2016/03/citi_retraite_hors_bilan_21_mars_1.pdf.

⁷ International Monetary Fund. 2012. *Global Financial Stability Report*. Washington, DC.

⁸ The Pension's Institute. Blake, D. et al. 2018. *Discussion Paper PI-1804. Still Living with Mortality: The Longevity Risk Transfer Market after One Decade*. Chart on Cumulative Pension Risk Transfer Total by Country and Product. London. p. 59.

⁹ CRO Forum. 2010. *Longevity – CRO briefing – Emerging Risks Initiative – Position Paper*. Amsterdam.

LONGEVITY RISK TRANSFERS EXPENSIVE AND INEFFICIENT

Generally, there are two types of risk transfer transactions involving either reinsurance or the capital markets. Almost all capital market-based attempts to deal with longevity risk so far have involved over-the-counter transfers of risk exposures in whole or in part for a fee—for instance, a large reinsurance company or hedge fund taking on the risk from a defined-benefit pension fund or life annuity provider for an agreed price. Attempts to shift longevity risk to capital markets are based on the use of standardized products linked to a mortality (survivorship) index of general, rather than a specific population. The choice of the index used in such transactions is of utmost importance. Transactions in some countries—the UK, for example—simply transfer the risk by purchasing insurance from an insurance company willing to offer it. Whatever the mechanism, risk transfer transactions reduce or eliminate a pension entity's risk associated with the uncertain longevity of the population it serves.

Aside from their negligible effect on huge pension system longevity risk exposures, risk transfer efforts have had mixed success. Reinsurance companies face regulatory constraints on assuming longevity risk, and the risk transfer trades lack sufficient interested counterparties. Capital markets function best when participants on both sides of a transaction gain through natural hedges of their respective risks. With few entities ready to enter capital markets transactions as natural hedges, and as the longevity risk is simply transferred, it cannot be diversified or hedged, only reinsured. These factors typically raise the price charged by those willing to carry the longevity risk.

The lack of interest in a longevity bond announced for the UK pension market in 2004 illustrated the difficulties of finding a market for and establishing confidence in such products. Developed by a partnership that included PartnerRe and the European Union's lending arm, the European Investment Bank, the bond, supported by BNP Paribas, was to make payments linked to a cohort survival index based on the realized mortality rates of men aged 65 in 2003 in England and Wales.¹⁰ Among the bond issue's problems, according to reports, were a failure to cover the risk of people living past 90 and uncertainty about longevity projections themselves.¹¹ The upfront capital cost was also considered by some to be high for the degree of hedging the bond would provide.¹²

Better management of the longevity risk confronting pension systems will require solutions that are more efficient and less expensive than those based on risk transfer. Buy-out and buy-in

transactions, fixed versus variable longevity swaps, and other over-the-counter risk transfer mechanisms have shown only nominal growth in value that is minuscule when compared, for example, with the estimated \$16 trillion longevity risk exposure of OECD country pension systems in 2018. Financial market transactions based on the principle of longevity risk sharing rather than risk transfer are better placed to help mitigate longevity risk.

INTEGRATING LONGEVITY RISK SHARING INTO THE PEOPLE'S REPUBLIC OF CHINA PENSION REFORMS

It may be more effective to use the capital markets to share longevity risk rather than transfer it. There is scope for applying this approach on a global scale, but the PRC offers the fundamental conditions and a suitable environment for longevity risk sharing all on its own. It is also in need and in the process of reforms to counteract the stresses its rapidly aging population will place on its pension systems and overall fiscal position.

Fertility rates are low, and the dependency ratio is rising quickly. By 2040, about every five workers will have an elderly person to support.¹³ The challenge is great, and these reforms must be impactful, widespread, and holistic. They will likely affect local government fiscal positions, current transfer policies for redistributing wealth between provinces, and the PRC's residence point system. The country's approach to long-term care and pension regulation will probably change, as will the institutional and structural arrangements for meeting the needs of the elderly. The PRC might also need to raise the minimum retirement age and link it to actual or projected mortality rates.

However far-reaching these PRC reforms may become, they will be insufficient alone to fully address longevity risk. That would require dealing with the uncertainty in estimating life expectancy, which is stochastic and varies over time and between ages in elderly cohorts. Longevity risk has been overlooked within solutions to deal with the PRC's aging population. Fortunately, the PRC's great size, the government's potent policy and incentive tools, and the regional diversity in current levels of economic development present an opportunity to create a market to at least reduce longevity risk by sharing it.

Such a market requires parties willing to hold mutually advantageous positions that reflect the opposite sides of this risk. In this case, the PRC's better-off provinces face the downside risk of higher pension and other costs if their elderly cohorts live longer than projected. Many of the country's economically

¹⁰ P. Antolin and H. Blommestein. 2007. Governments and the Market for Longevity-Indexed Bonds. *OECD Working Papers on Insurance and Private Pensions*. No. 4. OECD.

¹¹ M. Foster. 2005. Paribas' longevity bonds fall flat. *Financial News*. 5 December.

¹² *Investment Week*. 2006. Gearing offers secret to longevity bond market sales. 16 January. <https://www.investmentweek.co.uk/investment-week/news/1387366/gearing-offers-secret-longevity-bond-market-sales>.

¹³ A. Hagiwara, D. Park, and H. Van Rijn. 2018. Three Features of Aging in the Peoples Republic of China and Implications for Development Agenda. *ADB Briefs*. No. 103. Manila: Asian Development Bank.

less developed provinces, on the other hand, can in at least one way expect to benefit as the population ages. Their fiscal space can likely improve through the growing revenue earned off the remittances sent home by their migrant elderly care workers (ECW). These ECWs are already serving elderly cohorts in the PRC's better-off provinces and would be needed for longer times and in greater numbers as the PRC's elderly population continues to grow and live longer.

HOW THE LONGEVITY RISK-SHARING MARKET WOULD WORK

A longevity risk-sharing market would be created in the PRC with the issuance of bonds by the home provinces of migrant ECWs with coupons linked to an indicator of the fiscal effects of increases in ECW remittance-based revenues. This exploits the structural form of provinces in the PRC which are naturally diverse across socioeconomic status. The growing demand for ECW by pensioners in the PRC's wealthier provinces, together with the fact that many of the ECWs come from the PRC's poorer provinces and remit part of their earnings back to their home provinces, would be used for the mutual benefit of both types of provinces and support creation of the market. These bonds would be purchased by a consortium of the PRC's largest state-owned commercial banks (SOCBs), which would then back the issuance of bonds of identical maturity, but with variable rate coupons linked to the actual survivorship rates of elderly cohorts in the respective wealthier provinces. The pension funds in these wealthier provinces would, in turn, purchase the consortium bonds linked to their elderly cohorts to hedge their exposure to longevity risk. The SOCBs would assume the small basis risk between the two transactions.

Assumptions

The concept's viability rests on several assumptions. One is widely accepted—that rates of survival among the PRC's elderly will continue to rise. It is also assumed that demand for ECWs will correlate closely with this rise, as it has under similar conditions elsewhere in the world.¹⁴ Elderly care that relies only on the personal attention of families and the tradition of “filial piety” has become unsustainable in a country where massive numbers of the young have migrated away from birthplaces to live and work, and aged parents outnumber their adult children, who themselves may often come to outnumber their own offspring.¹⁵ The government is now actively promoting the substitution of care by ECWs for traditional family care of the country's elders, and of home care in place of institutionalized care.

Remittances to their home provinces by migrants working elsewhere in the PRC accounted for 18% of all rural income in 2003.¹⁶ The third assumption is that remittances by ECWs are in line with those of other migrant workers, and that higher demand in wealthier areas of the PRC for ECWs, who come primarily from poorer provinces, would lead to similar increases in the flow of remittances to, and added income for, those provinces.

It is also assumed that this will lead to more fiscal flexibility and improved fiscal positions in these poorer provinces. The share of remittances in total household income in the PRC is estimated at 30%–50%.¹⁷ Purchases and payments by families of migrant workers are subject to local taxation and only some of the resulting revenue is shared with the national government. The more ECWs remit funds to home provinces, the more revenue provincial governments earn from value-added taxes, personal and corporate income tax, taxes on deeds, land appreciation taxes, and an urban land tax. Budget savings can also result. More money in their pockets can enable residents to rely less on public services and more on privately provided ones or allow local governments to charge higher services fees or co-payments.

Setting the Coupon Rates

The coupon rates on the ECW-provider provincial bonds need to be linked to a proxy for the contribution of increased ECW remittances to any improvement in the fiscal positions of issuing provinces. Determining this proxy is challenging. It is somewhat difficult to separate the role ECW remittances might play in fiscal strengthening (or weakening) from those of other possible factors. Considering current data availability, the best way at the moment—and the way this brief proposes—is to link the coupon rate to the ratio of a province's annual incoming ECW remittances to the amount it receives each year in transfers from the national government (ECW annual remittances/annual national government transfers). A rise in this ratio, other things being equal, would be an indication of the part ECW remittances play in improving this fiscal condition. The proxy would be refined further as more detailed fiscal and remittance data are developed and as the level of remittances of ECWs serving different age cohorts is identified.

Considering current data availability, this brief proposes that the first provincial bond issued would mature in 5 years, corresponding roughly to the current average remaining life expectancy of the 85-year-old cohort in the PRC (footnote 2). The SOCB consortium, the financial intermediary, would purchase this provincial bond and issue one of its own with the identical maturity. The coupon rate on the consortium bond would be linked to an index of the annual actual percentage change in mortality

¹⁴ International Labour Organization and Organisation for Economic Co-operation and Development. 2019. *New Job Opportunities in an Ageing Society*. Tokyo; J. Ha and S. Lee. 2018. Population Aging and the Possibility of a Middle-Income Trap in Asia. *ADB Economics Working Paper Series*. No. 536. Manila: Asian Development Bank.

¹⁵ E.E. Glinskaya and Z. Feng. 2018. *Options for Aged Care in China*. Washington, DC: World Bank Group.

¹⁶ P. Huang and S. Zahn. 2009. *Migrant's Workers Remittances Rural Development in China*. Beijing: Chinese Academy of Social Sciences.

¹⁷ Hua, Y. Munich Personal RePEc Archive. 2014. *Migration Decision and Rural Income Inequality in North Western China*. Munich.

(survivorship) of the 85-year-old cohort. The pension fund of the wealthier province would purchase the bonds as a hedge against its longevity risk exposure. As experience with these longevity risk-sharing transactions accumulates, bonds with longer maturities could be issued to reflect the longer life expectancies of the younger pension-age cohorts.

The Consortium, the Basis Risk, and Potent Government Tools

The national government's creation of a consortium of the five largest SOCBs to jump-start a market for longevity risk sharing would align with its recent moves to bolster the country's pension funds and deal with the overall challenge of an aging population. In 2019, for instance, the Ministry of Finance transferred \$16 billion worth of its shares held in the Industrial and Commercial Bank of China and Agricultural Bank of China to help cover pension shortfalls in the National Council for Social Security Fund.¹⁸ These SOCBs could see this risk-sharing market as an interest spread opportunity. As the consortium would be the sole intermediary, it might be able to pay lower interest rates on the bonds issued and sold to the pension funds than it would earn from the coupons on the provincial government bonds it acquires.

The consortium SOCBs would be exposed to basis risk in this transaction. This arises from the lack of perfect correlation between the changes in the indexes used for the coupon payments between the bonds bought by the consortium from the provinces and those that they issue to the pension funds. However, it is expected that the level of basis risk would not be large. Furthermore, due to the PRC's size, diversity, and internal migration policy, and conditions not present in other countries, unique policy responses are available that can be used that will effectively increase the correlation, reducing basis risk and improving the effectiveness of the longevity risk hedge. The PRC's unique position to strengthen this correlation can also increase and stabilize the demand for and the supply of ECW. Through the government's *hukou* system regulating residency permits and internal migration, the PRC is equipped to increase correlation through steps to affect the demand, supply, and flow of ECW migration. Demand growth is already supported through the current five-year plan for developing elderly care services. ECW supply can be increased through incentives under the residential permit point system that awards higher scores to aspiring migrants with professional ECW training.

HOW TO PILOT TEST LONGEVITY RISK-SHARING MARKET

This concept requires a pilot test, ideally involving two provinces particularly representative of the opposite sides of a longevity risk-sharing transaction. One should be comparatively well-off, a destination for the PRC's migrant workers, and face future funding uncertainties related to the actual life expectancy of its old-age pensioners. The other, in terms of revenue growth and improvement in a perhaps challenging fiscal position, should stand to gain through an increase in its provision of migrant ECWs as longevity among the country's elderly increases. To make the concept and the test workable, both would need significant data capacity. Two candidates stand out as suitable for the pilot test.

Guizhou Province: A Relatively Poorer, but High-Tech Provider of Migrant Workers

Guizhou's per capita income is only 56% of the national average. The provincial ratio of direct debt relative to fiscal revenue, estimated at 227.5%, is the highest in the country.¹⁹ Research has also been conducted in the role migrant worker remittances play in the provincial economy.²⁰ Importantly, Guizhou's robust digital economy and growing big data-related industries—which accounted for more than 20% of its economic growth in 2019—offer the synergies necessary to pilot test the longevity risk-sharing concept successfully.²¹ It leads the PRC's provinces in adopting big data applications for areas such as poverty reduction, support for the real economy, social governance, and rural revitalization, in addition to improving government management and administration.²² Its data-sharing cloud network—which was the first such provincial system to connect to the national platform and central government departments—links all provincial government units. This would facilitate the gathering of detailed data about incoming migrant ECW remittances and their contribution to the province's fiscal position. This data is critical to further developing the proxy on which to base the coupon rates of a bond to launch the risk-sharing mechanism. Central government limits on Guizhou's debt issuance volume, rates, and terms and conditions could be an obstacle to the functioning of a risk-sharing market, but these restrictions could be eased based on the progress the province makes in reliably assessing remittance contributions to improving its fiscal position.

¹⁸ Caixin. 2019. *Finance Ministry to Transfer \$16 Billion in Equities to Pension-Short Fall Fund*. Beijing. <http://en.caixin.com/2019-09-26/101466718.html>.

¹⁹ Dagong Global Credit Rating (Hong Kong) Co., Ltd. 2017. *An Overview of China's Local and Regional Governments – Provincial Governments, Credit Handbook*. Hong Kong, China.

²⁰ Z. Liang, J. Li, and Z. Ma. 2013. Migration and Remittances: Evidence from a Poor Province in China. *Asian Population Studies*. 9 (2). pp. 124–141. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4486665>.

²¹ T. Xinyu. 2019. Big Data Driving Digital Economy Boom in Guizhou. *China Daily Online*. 24 June. <http://www.chinadaily.com.cn/a/201906/24/WS5d1099a9a3103dbf14329ed2.html>.

²² China.org. 2017. *Guizhou Creates Model on Big Data Development*. http://p.china.org.cn/2017-09/30/content_50029752.htm.

Beijing Municipality: A Comparatively High-Income Jurisdiction with Lengthening Life Expectancy

The surplus of Beijing's pension system offers resilience to any risks involved in the pilot test.²³ The remaining life expectancy of 65-year-old Beijing males is about 2 years longer than for 65-year-old males in the PRC on average, and also higher than that of all other provinces, except for Shanghai Municipality.²⁴ It is assumed that for cohort age groups older than 65 in Beijing (such as 85-year-old cohorts) that their remaining life expectancy is also longer than the average of comparable cohort age groups in the PRC. Although official life expectancy or mortality data for the comparatively wealthy national capital itself is limited, some additional required data can be inferred from empirical studies.²⁵ International evidence indicates that variation from the mean in the eventual ages of death gets greater as a cohort gets older—i.e., this variation will be larger for individuals who have reached 65 than for younger cohorts, and wider for those who reach 85 than it is for those only 65.²⁶ For Beijing, that the remaining life expectancy for its older cohorts is longer than the PRC average, and as the uncertainty around the actual remaining life spans of older elderly cohorts is higher, Beijing's pension fund is more exposed to longevity risk than in other provinces. The pilot test would be tailored to address the longevity risks linked to the 85-year-old cohort in Beijing's population, who at present are projected to live approximately 5 more years on average (footnote 2).

The pilot test for this concept would involve the following:

- i) Guizhou Province would issue a bond with a 5-year maturity and a coupon rate linked to a calculation of the contribution to its overall fiscal position being made by remittances from its migrant ECWs caring for 85-year-old pensioners in Beijing.
- ii) The consortium of the five largest SOCBs would purchase these bonds and use them to back issuance of a 5-year bond with coupon linked to an index of the annual actual percentage change in mortality (survivorship) of the 85-year-old cohort.
- iii) Beijing's pension system would purchase the consortium bonds.
- iv) The PRC pension regulators would consider the hedging value provided by these bonds in determining the Beijing pension system's risk reserve requirements.

INVESTMENTS NEEDED FOR BROAD LONGEVITY RISK SHARING, BUT BENEFITS PROFOUND

Implementing this concept more widely across the PRC would benefit from further investment. Requirements would include improved data infrastructure and statistical capacity in the wealthier provinces to determine the survivorship rates of pensioners more accurately. Poorer provinces would need precise data on the remittances of their migrant workers overall and of migrant ECW remittances differentiated by the ages of the elderly cohorts they serve. This would enable them to more reliably compute the relationship between these remittances and total fiscal revenues. The central government would also have to remove the current de facto upper limits on the interest rates provincial governments offer on their bonds, allowing for market-based differentiation of yields based on true credit risk.

If successful, the longevity risk-sharing mechanism would generate profound benefits. The PRC's poorer provinces participating in the risk-sharing mechanism could reduce the interest they pay on their debt. This is because there would be a transparent and structured link to rising ECW remittance-related revenue and the fiscal positions of provinces involved in the risk-sharing mechanism. This clarity would specifically support that coupon rates on the longevity risk-sharing bonds would be lower than on a province's other bond issues. Guizhou, for instance, due to its low credit rating, must now pay at the upper end of the de facto limits on interest rates of 25–40 basis points above the central government bond rate for the same maturity. When the sources of improvement to the fiscal position of Guizhou become more reliable and measurable, investors have stronger confidence assessing the province's repayment capacity and would be more willing to purchase their longevity risk-sharing bonds. The increased transparency of fiscal obligations will also support development and marketization of their basic local government bonds as investors would gain confidence overall in fiscal management. Fiscal pressures would also be eased in wealthier provinces where the hedging provided by the new mechanism would likely reduce risk capital requirements needed to sustain the viability of their old-age pension systems.

²³ Gruat, J.-V. EU–China Social Protection Reform Project. 2017. *Some Striking Features of the Chinese Pension System*.

²⁴ J. Li. 2012. Regional Differences in Life Expectancy in Mainland China. Undergraduate thesis. University of New South Wales.

²⁵ H. Caswell. 2014. A matrix approach to the statistics of longevity in heterogeneous frailty models. *Demographic Research*. 31 (19). pp. 553–592.

²⁶ M. Engelmann, H. Caswell, and E. M. Agree. 2014. Why do lifespan variability trends for the young and old diverge? A perturbation analysis. *Demographic Research*. 30 (48). pp. 1367–1396.

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