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Long-Term Care: Is There Crowding Out of Informal Care, Private Insurance as Well as Saving?

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Abstract: Publicly provided long-term care (LTC) insurance with means-tested benefits is suspected to crowd out either private LTC insurance (Brown and Finkelstein 2008. The Interaction of Public and Private Insurance: Medicaid and the Long-Term Care Insurance Market. *American Economic Review* 98(3):1083–102), private saving (Gruber and Yelowitz 1999. Public Health Insurance and Private Saving. *Journal of Political Economy* 107(6):1249–74; Sloan and Norton 1997. Adverse Selection, Bequests, Crowding Out, and Private Demand for Insurance: Evidence from the Long-term Care Insurance Market. *Journal of Risk and Uncertainty* 15:201–19), or informal care (Pauly 1990. The Rational Non-purchase of Long-term Care Insurance. *Journal of Political Economy* 95:153–68; Zweifel and Strüwe 1998. Long-term Care Insurance in a Two-generation Model. *Journal of Risk and Insurance* 65(1):13–32). This contribution predicts crowding-out effects for both private LTC insurance and informal care on the one hand and private saving and informal care on the other. These effects result from the interaction of a parent who decides about private LTC insurance before retirement and the amount of saving in retirement and a caregiver who decides about effort devoted to informal care. Some of the predictions are tested using a recent survey from China.

Keywords: long-term care, insurance, saving, crowding out, means testing, China
JEL Classification: D19, H51, J14

1 Introduction and Motivation

Long-term care (LTC) services are costly, causing elderly citizens to face the risk of ending up in poverty unless they receive support from their families or the government. In spite of evidence suggesting an improved degree of control over

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health status also at high age (Schoder and Zweifel 2011), the risk of needing LTC is expected to rise in just about all industrial countries due to increased longevity (Colombo et al. 2011). While several of them integrated LTC into their social insurance schemes, nursing home use continues to be publicly subsidized subject to means testing, making wealthy recipients pay a higher share of its cost. Yet public subsidization (by U.S. Medicaid) has been shown to crowd out private LTC insurance by Brown and Finkelstein (2008). In addition, parent's incentive to save for old age may be weakened, as found by Gruber and Yelowitz (1999), again in the case of U.S. Medicaid.

However, these crowding-out effects are not limited to the behavior of older individuals subject to the risk of needing LTC ("parents" henceforth). They may also characterize the behavior of potential caregivers ("children" henceforth), as argued already by Pauly (1990) and empirically confirmed e.g. by Sloan and Norton (1997). The causal nexus is the bequest, which is preserved if the child makes effort to keep the parent out of the nursing home (Zweifel and Strüwe, 1998). However, this means that crowding-out effects need to be modeled as the outcomes of an interaction between two players, as recognized by Courbage and Zweifel (2011).

The present contribution purports to fill a gap in the existing literature. While crowding out has been studied either with regard to private LTC insurance or saving on the parent side and of informal care on the child side, this paper considers the possibility of a "triple crowding out" induced by means-tested public subsidization of LTC. In addition, it presents some empirical evidence coming from China with its one-child policy, causing it to closely match the theoretical development which is in terms of one parent and one child for simplicity.

The interaction between the parent and the child is modeled as a non-cooperative game. Both parties commit *ex ante*, i.e. before the need for formal LTC services arises. The parent chooses the amount of private LTC coverage rather early in his or her active life. In view of the increasing tendency of private insurers to combine LTC coverage with life or pension insurance (which is contracted at young age), this is a realistic assumption (Banthrope 2013; De Montesquieu 2013). For instance, Schonbee (2013) notes that U.S. life insurance policies often contain so-called riders (provisions for extra coverage), 23% of which currently are for LTC expenditure. When approaching retirement, the parent sets a saving propensity which is not to be changed anymore. This timing is realistic, too since most individuals are able to achieve substantial savings only shortly before retirement, when children have left the household.

However, these decisions are made in view of the child's (expected) effort which serves to reduce the probability of needing formal care, in particular, admission to a nursing home. In turn, the child decides how much informal care

to provide in response to the parent's private LTC coverage and saving, which determine the amount of wealth available for the bequest. Parental altruism is reflected by the fact that final wealth is bequeathed in its entirety; child altruism, by a loss of utility when the parent is in the nursing home. Comparative statics are used to derive the slopes of the reaction functions, whose intersections define a set of Nash equilibria. Exogenous influences displace the equilibrium, permitting to predict changes in outcomes in terms of both LTC insurance and saving on the one hand and informal care on the other hand, providing guidance as to where to expect crowding-out effects.

One crucial finding is a puzzling empirical confirmation of previous theoretical work. Courbage and Zweifel (2011), associating admission to a nursing home with a severing of family ties inducing unstable outcomes, arrived at the prediction that an exogenous increase in parental wealth (a very likely development in China) causes a crowding out of private LTC insurance but a beneficial crowding in of child effort. The present work takes into account that the absence of subsidization of LTC expenditure in China implies the absence of means testing of public LTC provision. It predicts a beneficial crowding in of LTC coverage combined with an ambiguous effect on child effort. Yet, the evidence from China points to a crowding-out effect on LTC coverage combined with a crowding-in effect on child effort, lending support to Courbage and Zweifel (2011). It is silent, however, regarding parents' propensity to save.

The remainder of this paper is structured as follows. The model is presented in Section 2. The Nash equilibria and their displacements caused by four exogenous influences are derived in Section 3. Section 4 considers the displacements of the Nash equilibria in the special case of China. The theoretical predictions are compared to a recent (admittedly partial) survey from China in Section 5. The final section is devoted to a summary and suggestions for policy and future research.

2 The Model

The parent P and the potential caregiver C (a child, but also a spouse, a relative or a friend) are assumed to interact in the guise of non-cooperative game. First, the decision problem of the parent is presented, followed by that of the child.

2.1 The Parent

Long before retirement, the parent decides about the amount of private insurance I at a premium $\bar{\pi}I$ to top up publicly provided LTC insurance benefits.

Increasingly, private life insurance and old-age provision policies (which are contracted at a relatively early age) are sold in combination with LTC coverage (Banthrope 2013). The LTC premium is not risk-rated because the insurer by assumption is unable to predict the actual probability $\pi(e)$ of needing formal LTC, which depends on the effort exerted by the caregiver e . Therefore, $\bar{\pi}I = \pi^e(1 + \lambda)I$, with π^e denoting an expected average value of $\pi(e)$ and λ , a proportional loading for administrative expense and risk bearing.

The parent is assumed to be rich enough to leave a bequest but poor enough to obtain some public support which is means-tested – a likely case in those countries that have introduced mandatory LTC insurance or added a LTC component to their social security. Closer to retirement, he or she opts for a propensity to save s , which determines the size of the bequest available to the caregiver. This separation in time allows the decisions with regard to s and I to be considered separately, greatly simplifying the analysis. The child selects an amount of effort e that serves to reduce the probability π that the parent will enter a nursing home, with $\pi'(e) < 0$ and $\pi''(e) > 0$, indicating decreasing marginal effectiveness of effort. Realistic restrictions are, $\pi(e) < 1 - \pi(e)$ and $|\pi'(e)| < \pi(e)$, i.e. need of formal LTC is a relatively rare event while the marginal effectiveness of child effort is limited throughout.

The parent is characterized by a risk utility function defined over consumption in the two pre-retirement periods, $u_1(\cdot)$ and $u_2(\cdot)$, and over wealth in a future period, all of unit length.¹ During this post-retirement period, he or she faces the risk of spending the rest of his or her life in a nursing home. Accordingly, the parent's utility function is conditioned on being in [$v^i(\cdot)$] or out of the nursing home [$v^o(\cdot)$]. Utility when out of the nursing home is higher than when in the home, i.e. $v^o > v^i$, reflecting the greater degree of independence in the enjoyment of his or her wealth. This ranking is assumed to hold across the levels of wealth to be considered (wealth when out of the nursing home is higher than when in since the parent must share in the cost of LTC). It also holds for the marginal utility of wealth, i.e. $v^{o'} > v^{i'}$, again across the variation of wealth associated with LTC status. There are three justifications for this assumption. First, it is in accordance with Evans and Viscusi (1991) and Finkelstein, Luttmer, and Notowidigdo (2009), who find empirical evidence

¹ Contrary to the two pre-retirement periods, the post-retirement utility function has wealth and not consumption as its argument in order to model the bequest motive of the elderly while taking into account the fact that the bequest serves as an instrument for influencing child behavior. Introducing second-period consumption as a decision variable would complicate the analysis without producing important insights.

suggesting that bad health goes along not only with reduced wealth but also a reduced marginal utility of wealth. Admission to a nursing home is usually caused by a deterioration of health. Second, relative risk aversion is known to strongly increase with age (Halek and Eisenhauer, 2001). Since admission to a nursing home goes along with a substantial fall in remaining life expectancy (Zweifel et al., 1999), a parent in the home can be said to be older than when continuing to live independently. Denoting $R_R^i := (-u''^i/u^i) \cdot w^i$ as the coefficient of relative risk aversion “when in” and $R_R^o := (-u''^o/u^o) \cdot w^o$ “when out”, respectively, one therefore has $|(u''^o/u^o) \cdot w^o| < |(u''^i/u^i) \cdot w^i|$. This implies $|(u^o/w^o)/u^o| > |(u^i/w^i)/u^i|$ and hence $|u^o/u^i| > 1 = |(u''^o w^o)/(u''^i w^i)|$. This inequality holds unless $u''^o < u''^i$ (for which there is no particular reason) because $w^o > w^i$ in view of parental cost sharing. Third, this separation of insurance and saving decisions in time simplifies the analysis considerably compared e.g. to Dionne and Eeckhoudt (1984) and Meier (1996), who more-
over consider only one decision-maker rather than the interaction of two.

The parent is altruistic in the sense that final wealth becomes a bequest for the child in its entirety. Since the parent is assumed to be retired, there is no labor income that could contribute to his or her wealth. Therefore, final wealth if in the nursing home is given by initial wealth saved $w_0 s$ accrued for interest $(1 + i)$ plus the benefit from private insurance benefit net of premium $I - \bar{\pi}I = I(1 - \bar{\pi})$ minus a share r in LTC expenditure; since time in the nursing home is normalized to one, this expenditure corresponds to the price of LTC p , while $\bar{\pi}$ denotes one-third of the total LTC premium paid. We assume $p > 1$ because nursing homes are expensive compared to the other goods and services that can be financed with wealth. The share $r(\cdot)$ of LTC expenditure is an increasing function of total wealth at the time of admission, reflecting the fact that public LTC benefits are means-tested in most countries, with private LTC benefits not exempted (Brown and Finkelstein 2008).

This function also depends on a parameter α , with $d\alpha > 0$ representing an increased level of cost sharing and $d\alpha < 0$, an increase in subsidization of LTC. If the parent remains out of the nursing home, final wealth is simply given by $w_0 s(1 + i)$. Note that s is set prior to admission to the nursing home, constituting a commitment on the part of a parent who does not change his or her lifestyle anymore. In all, one has for expected utility (EU) of the parent over the current and the future period,

$$\begin{aligned}
 EU &= u_1[w_0 - \bar{\pi}I] + u_2[w_0(1 - s) - \bar{\pi}I] \\
 &\quad + \pi(e)v^i[w_0 s(1 + i) + I(1 - \bar{\pi}) - r(w_0 s(1 + i) + I(1 - \bar{\pi}), \alpha) \cdot p] \\
 &\quad + (1 - \pi(e))v^o[w_0 s(1 + i) - \bar{\pi}I].
 \end{aligned} \tag{1}$$

This formulation assumes that private insurance benefits received $I(1-\bar{\pi})$ are not exempted when the amount of cost sharing is calculated by the public authorities. From eq. [1], one can derive the first-order condition (FOC) for an interior optimum with respect to the parent's purchase of private LTC coverage,

$$\begin{aligned} \frac{dEU}{dI} &= -\bar{\pi}\{u'_1(\cdot) + u'_2(\cdot)\} + \pi(e)\{(1-\bar{\pi}) - r'_w(1-\bar{\pi})p\} \cdot v^i(\cdot) - (1-\pi(e))\bar{\pi} \cdot v^o(\cdot) \\ &= -\bar{\pi}\{u'_1(\cdot) + u'_2(\cdot)\} + \pi(e)(1-\bar{\pi})(1-r'_wp) \cdot v^i(\cdot) - (1-\pi(e))\bar{\pi} \cdot v^o(\cdot) = 0. \end{aligned} \quad [2]$$

The notation using total rather than partial differentials is designed to recall that only one decision is made at a time. Eq. [2] can be interpreted in the following way. In the pre-retirement period, additional coverage has the downside of costing a higher premium according to the (augmented) probability of nursing home admission $\bar{\pi}$, which is valued according to the parent's marginal utility of consumption. It has the additional downside of costing the higher premium also if the parent does not enter the nursing home, which is valued by the marginal utility "when out", v^o . However, with probability $\pi(e)$, the parent is admitted to a nursing home, at which time private insurance pays $(1-\bar{\pi})$ extra for each dollar of extra coverage, which is valued using the marginal utility "when in", v^i . In an optimum, these marginal costs and benefits must balance.

Let this optimum be disturbed by an increase in effort on the part of the child, $de > 0$. Since the FOC is satisfied after the change as well, one has the so-called comparative static equation,

$$\frac{\partial^2 EU}{\partial I^2} dI + \frac{\partial^2 EU}{\partial I \partial e} de = 0 \quad [3]$$

In a maximum, marginal expected utility must decrease, i.e. $\partial^2 EU / \partial I^2 < 0$. Therefore, the sign of dI/de is determined by $\partial^2 EU / \partial I \partial e$,

$$\text{sgn}\left(\frac{dI}{de}\right) = \text{sgn}\left(-\frac{\partial^2 EU / \partial I \partial e}{\partial^2 EU / \partial I^2}\right) = \text{sgn}(\partial^2 EU / \partial I \partial e). \quad [4]$$

However, in view of eqs [2] and [1], one has

$$\begin{aligned} \frac{\partial^2 EU}{\partial I \partial e} &= \pi'(e)(1-\bar{\pi})(1-r'_wp) \cdot v^i(\cdot) + \pi'(e)\bar{\pi} \cdot v^o(\cdot) \\ &= \pi'(e)\{(1-\bar{\pi})(1-r'_wp) \cdot v^i(\cdot) + \bar{\pi} \cdot v^o(\cdot)\}. \end{aligned}$$

Using the FOC of eq. [2] to obtain $(1-\bar{\pi})(1-r'_wp) \cdot v^i(\cdot) = 1/\pi(e)\{\bar{\pi}\{u'_1(\cdot) + u'_2(\cdot)\} + (1-\pi(e))\bar{\pi} \cdot v^o(\cdot)\}$, this can be simplified to become

$$\begin{aligned}
 \frac{\partial^2 EU}{\partial I \partial e} &= \pi'(e)/\pi(e) \{ \bar{\pi} \{ u'_1(\cdot) + u'_2(\cdot) \} + (1 - \pi(e)) \bar{\pi} \cdot v'^o(\cdot) + \pi'(e) \bar{\pi} \cdot v'^o(\cdot) \} \\
 &= \pi'(e)/\pi(e) \{ \bar{\pi} \{ u'_1(\cdot) + u'_2(\cdot) \} + \{ \bar{\pi} - \pi(e) \bar{\pi} + \pi'(e) \bar{\pi} \} \cdot v'^o(\cdot) \} \quad [5] \\
 &= \bar{\pi} \cdot \pi'(e)/\pi(e) \{ \{ u'_1(\cdot) + u'_2(\cdot) \} + \{ 1 - \pi(e) + \pi'(e) \} \cdot v'^o(\cdot) \} \\
 &< 0 \text{ since } \pi'(e) < 0 \text{ while } |\pi'(e)| \text{ is small compared to } 1 - \pi(e).
 \end{aligned}$$

Equation [5] is proportional to the slope dI/de of the parent’s first reaction function [see panel (a) of Figure 1 below]. With $|\pi'(e) \rightarrow 0|$ due to decreasing marginal effectiveness of effort [$\pi''(e) > 0$], this function is concave from below.

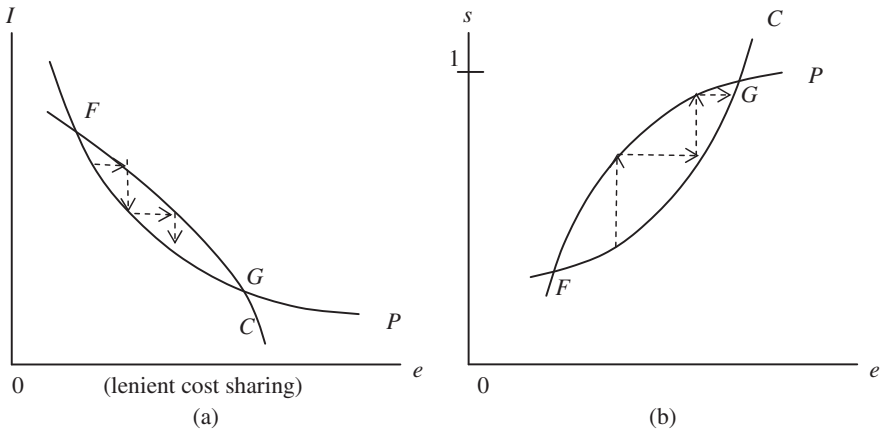


Figure 1: Nash equilibria. (a) in (I, e) -space (b) in (s, e) -space.

As to the parent’s propensity to save (focusing again on interior solutions with $0 < s < 1$),

$$\begin{aligned}
 \frac{dEU}{ds} &= -w_0 u'_2(\cdot) + \pi(e) w_0 \{ (1+i)(1-r'_w p) \} \cdot v'^i(\cdot) + (1 - \pi(e)) w_0 (1+i) \cdot v'^o(\cdot) \\
 &= -u'_2(\cdot) + (1+i) \{ \pi(e)(1-r'_w p) \cdot v'^i(\cdot) + (1 - \pi(e)) \cdot v'^o(\cdot) \} = 0 \quad [6]
 \end{aligned}$$

after division by w_0 , with r'_w denoting the partial derivative of the cost-sharing parameter r with respect to parental wealth. Equation [6] can be interpreted as follows. The first term corresponds to the certain loss of utility caused by forgone consumption. The first term in brackets reflects the probability-weighted marginal benefit of additional saving in terms of wealth in the nursing home. It is positive if $r'_w p < 1$ or $r'_w < 1/p$, respectively (recall that $p > 1$ by assumption), indicating lenient means testing. Conversely, if means testing of LTC is very

stringent (r'_w close to one), this term is negative; the parent will regret to have saved to the detriment of consumption. Note that this may be the unexpected side effect of a policy that makes cost sharing dependent on wealth, disregarding the relative price of LTC. For instance, if LTC is twice as expensive as other goods and services ($p=2$), a value $r'_w > 0.5$ suffices to induce this result. The second term in brackets is unambiguously positive, making an interior solution (which is amenable to comparative-static analysis) always possible.

In full analogy with eq. [3], the sign of the slope ds/de characterizing the parent's second reaction function is proportional to

$$\begin{aligned} \frac{\partial^2 EU}{\partial s \partial e} &= (1+i) \{ \pi'(e)(1-r'_w p) \cdot v^i(\cdot) - \pi'(e) \cdot v^o(\cdot) \} \\ &= (1+i) \pi'(e) \{ -r'_w p \cdot v^i + (v^i - v^o) \} \\ &> 0 \text{ since } v^i < v^o. \end{aligned} \quad [7]$$

The parent's second reaction function therefore has positive slope. Moreover, decreasing marginal effectiveness of effort [$\pi''(e) > 0$] implies $ds/de \rightarrow 0$ for $e \rightarrow \infty$ [see panel (b) of Figure 1 above].

2.2 The Child

The child (considered as the one caregiver here) also derives utility from final wealth. In addition to his or her initial wealth z_0 , he or she can expect a bequest amounting to a share $k(1-t)$ of the parent's final wealth, where t denotes the tax rate on inheritance (which is assumed to be constant for simplicity). The share $r(w_0 s(1+i) + I(1-\bar{\pi}), \alpha) \cdot p$ of LTC expenditure deducted from parental wealth again increases with private insurance benefits received net of premium paid.² During the pre-retirement period, the child is assumed to value his or her effort with an opportunity cost θ per unit of time. For employed individuals, an indicator of θ is the wage rate, which equals the foregone income of time spent providing informal care; for retired individuals, $\theta > 0$ indicates that they could use their time for other activities of value. At the start of the second period, he or she is assumed to enter retirement, with a concomitant drop in θ .

² For simplicity, we abstract from the fact that in some countries (notably Germany), the child may be called upon to contribute to the cost of LTC, resulting in a deduction from Z_0 that depends on Z_0 (means testing) and p . For simplicity again, the model is in terms of one parent and one child; otherwise, the optimal allocation of both bequest and caring effort between the surviving spouse and the children would have to be determined.

For simplicity, $\theta = 0$ is assumed. In the event that the parent stays out of the nursing home, the bequest is larger because there is no share r of the cost of LTC to be paid. Note that effort e is again set during the current period as a commitment and aspect of lifestyle, not to be adjusted anymore in the two future states in and out of the nursing home. Therefore, expected utility of the child ($E\bar{U}$) reads,

$$E\bar{U} = \bar{u}(z_0 - \theta e) + \pi(e)\bar{v}^i[z_0 + k(1-t)\{w_0s(1+i) + I(1-\bar{\pi}) - r(w_0s(1+i) + I(1-\bar{\pi}), \alpha)p\}] + (1-\pi(e))\bar{v}^o[z_0 + k(1-t)\{w_0s(1+i) - \bar{\pi}I\}]. \quad [8]$$

Here, $\bar{u}(\cdot)$ is the utility function of the child in his or her pre-retirement period, while $\bar{v}^i(\cdot)$ symbolizes the risk utility function in the future period given that the parent is in the nursing home and $\bar{v}^o(\cdot)$ otherwise, with $\bar{v}^o > \bar{v}^i$ and $\bar{v}'^o > \bar{v}'^i$. Therefore, the child is altruistic to the extent that he or she derives more utility from a given amount of wealth if the parent is out of the nursing home. His or her marginal utility is also higher, reflecting increased enjoyment of consumption with a parent who is independent (on a vacation, e.g.).

The FOC is given by

$$\frac{dE\bar{U}}{de} = -\theta\bar{u}'(\cdot) + \pi'(e)\{\bar{v}^i(\cdot) - \bar{v}^o(\cdot)\} = 0. \quad [9]$$

This is a well-known necessary condition for optimal prevention. The first term of eq. [9] mirrors the certain utility loss associated with additional effort. It is balanced by the decreased probability of having the parent in the nursing home weighted by the associated utility loss. Note that the boundary optimum $e^* = 0$ obtains if contrary to the assumption, $\bar{v}^o(\cdot) > \bar{v}^i(\cdot)$, i.e. the child does not suffer a loss of utility when the parent lives in the nursing home, reflecting the absence of altruism on his or her part. Conversely, given altruism one has $\bar{v}'^o > \bar{v}'^i$ at the optimum, regardless of the difference in wealth between the two states. In order to maintain this inequality as the child's wealth increases, $\bar{v}'^o > \bar{v}'^i$ is required as well, again regardless of the difference in wealth between the two states.

The slope of the child's first reaction function de/dI is proportional to

$$\begin{aligned} \frac{\partial^2 E\bar{U}}{\partial e \partial I} &= \pi'(e)k(1-t)\{ \{(1-\bar{\pi}) - r'_w(1-\bar{\pi})p\} \cdot \bar{v}^i + \bar{\pi} \cdot \bar{v}'^o \} \\ &= \pi'(e)k(1-t)\{ \{(1-\bar{\pi})(1-r'_wp)\} \cdot \bar{v}^i + \bar{\pi} \cdot \bar{v}'^o \} \end{aligned}$$

> 0 if $r'_wp > 1$ (stringent cost sharing) since $\bar{\pi} < 1 - \bar{\pi}$, $\pi'(e) < 0$ and $\bar{v}^i < \bar{v}'^o$
 < 0 if $r'_wp < 1$ (lenient cost sharing) since $\bar{\pi}(r'_wp) \cdot \bar{v}^i < \bar{\pi}\bar{v}'^o$ with $\bar{v}^i < \bar{v}'^o$.

[10]

The slope of the child's first reaction decreases in absolute value because $|\pi'(e) \rightarrow 0|$ in view of $\pi''(e) > 0$ [see panel (a) of Figure 1 for the case of lenient cost sharing]. As to the child's second reaction function with slope de/ds , one obtains from eqs [9] and [8],

$$\begin{aligned} \frac{\partial^2 E\bar{U}}{\partial e \partial s} &= \pi'(e)k(1-t) \{ \{w_0(1+i) - r'_w w_0(1+i)p\} \cdot \bar{v}^i - w_0(1+i) \cdot \bar{v}^o \} \\ &= \pi'(e)k(1-t)w_0(1+i) \{ \bar{v}^i - \bar{v}^o - r'_w p \cdot \bar{v}^i \}. \end{aligned}$$

Using the FOC in eq. [9] to obtain $\bar{v}^i(\cdot) - \bar{v}^o(\cdot) = \theta \bar{u}'(\cdot) / \pi'(e)$, this becomes

$$\begin{aligned} \frac{\partial^2 E\bar{U}}{\partial e \partial s} &= \pi'(e)k(1-t)w_0(1+i) \{ \theta \bar{u}'(\cdot) / \pi'(e) - r'_w p \cdot \bar{v}^i \} = \\ &= k(1-t)w_0(1+i) \{ \theta \bar{u}'(\cdot) - \pi'(e) \cdot r'_w p \cdot \bar{v}^i \} \\ &> 0. \end{aligned} \quad [11]$$

Therefore, the slope de/ds of the child's second reaction function is positive but decreasing with e , as depicted in panel (b) of Figure 1. Panels (a) and (b) show that apart from an unlikely tangency Nash equilibrium, there are two equilibria (where the two reaction functions intersect), only one of which is stable (G).

3 Nash Equilibria and their Displacement in the Case of China

In this section, three institutional details characterizing China are introduced to arrive at specific predictions using the results of comparative-static analysis developed in the Appendix.

- (1) In contradistinction with Courbage and Zweifel (2011) who studied unstable outcomes with reference to industrial countries, focus this time is on stable equilibria because in China, becoming an LTC case does not usually entail a breakup of family ties (Xu and Zweifel 2014).
- (2) Formal LTC services are not subsidized in China at present [$r(\cdot) = 1$]. Therefore, the share of LTC expenditure borne by the parent does not vary with wealth at all, implying $r'_w = r''_w = 0$.
- (3) Parental propensity to save s is high in China (Tao Young, Zhang and Zhous 2011) such that $w_0 s(1+i) > \bar{\pi}I$, i.e. the savings achieved during retirement exceed the pro-rata premium for private LTC insurance.

3.1 Higher Initial Wealth of the Parent in the Case of China ($dw_0 > 0$)

The displacement of the parent's first reaction function is given by eq. (A.1),

$$\begin{aligned} \frac{\partial^2 EU}{\partial I \partial w_0} &= -\bar{\pi} \{u_1''(\cdot) + (1-s)u_2''(\cdot)\} \\ &\quad + (1+i) \left\{ \pi(e)(1-\bar{\pi}) \left\{ (-r''_w p) \cdot v^i + (1-r'_w p)^2 \cdot v''^i(\cdot) \right\} - (1-\pi(e))\bar{\pi} \cdot v''^o(\cdot) \right\} \\ &\quad \begin{matrix} \geq \\ < \end{matrix} 0. \end{aligned}$$

However, due to characteristic No. 2 cited above, the shift of the parent's first reaction function simplifies to become

$$\begin{aligned} \frac{\partial^2 EU}{\partial I \partial w_0} &= -\bar{\pi} \{u_1''(\cdot) + (1+s)u_2''(\cdot)\} + s(1+i) \{ \pi(e)(1-\bar{\pi}) \cdot v''^i(\cdot) - (1-\pi(e))\bar{\pi} \cdot v''^o(\cdot) \} \\ &> 0 \quad (\text{see text below}). \end{aligned}$$

[12]

The crucial expression in brackets is approximately equal to $\pi(e)(1-\bar{\pi}) \cdot \{v''^i(\cdot) - v''^o(\cdot)\} < g \{v''^i(\cdot) - v''^o(\cdot)\}$, with $0 < g < 1$, provided $\pi(e)$ and $\bar{\pi}$ do not differ too much (on average, $\bar{\pi}$ differs from $\pi(e)$ only by the loading. In that event, the first term of eq. [12], involving the sum $u_1''(\cdot) + (1+s)u_2''(\cdot)$, is almost certain to dominate the second term involving the difference $v''^i(\cdot) - v''^o(\cdot)$ because there is no reason to assume major divergences between $u_1''(\cdot)$, $u_2''(\cdot)$, $v''^i(\cdot)$, and $v''^o(\cdot)$. This implies an upward displacement of the parent's first reaction function in panel (a) of Figure 2.

The displacement of the parent's second reaction function is given by eq. (A.2),

$$\begin{aligned} \frac{\partial^2 EU}{\partial s \partial w_0} &= - (1-s)u_2''(\cdot) + (1+i) \left\{ \pi(e) \left\{ -r''_w p \cdot v^i(\cdot) + s(1+i)(1-r'_w p)^2 \cdot v''^i \right\} \right. \\ &\quad \left. + (1-\pi(e)) \cdot v''^o \right\} \begin{matrix} \geq \\ < \end{matrix} 0. \end{aligned}$$

In view of characteristic No. 2 once again, it becomes

$$\begin{aligned} \frac{\partial^2 EU}{\partial s \partial w_0} &= - (1-s)u_2''(\cdot) + (1+i) \left\{ \pi(e) \left\{ -r''_w p \cdot v^i(\cdot) + s(1+i)(1-r'_w p)^2 \cdot v''^i \right\} \right. \\ &\quad \left. + (1-\pi(e)) \cdot v''^o \right\} \\ &= - (1-s)u_2''(\cdot) + (1+i) \left\{ \pi(e)s(1+i)v''^i + (1-\pi(e)) \cdot v''^o \right\} \\ &< 0 \end{aligned}$$

[13]

since risk aversion increases strongly with retirement (Halek and Eisenhauer, 2001), implying $v''^i > u_2''(\cdot)$ and $v''^o > u_2''(\cdot)$. The reaction function thus shifts downward [see panel (b) of Figure 2].

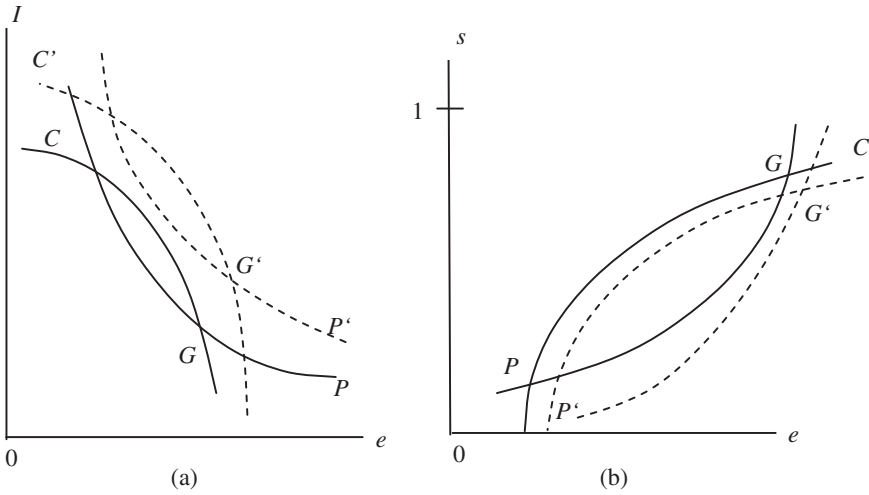


Figure 2: Increase in parental wealth ($dw_0 > 0$). (a) Displacement in (l, e) -space, (b) Displacement in (s, e) -space.

The displacement of the child’s reaction function is given by eq. (A.3),

$$\frac{\partial^2 E\bar{U}}{\partial e \partial w_0} = \pi'(e)s(1+i) \{ (k(1-t)(\bar{v}^i - \bar{v}^o) - r'_w p \cdot \bar{v}^i) \} > 0 \text{ since } \bar{v}^i < \bar{v}^o.$$

Due to characteristic No. 2, this simplifies to

$$\frac{\partial^2 E\bar{U}}{\partial e \partial w_0} = \pi'(e)s(1+i)k(1-t) \{ \bar{v}^i - \bar{v}^o \} > 0. \tag{14}$$

Therefore, the child’s reaction curve moves out when parental wealth increases, which by itself creates scope for more informal care. However, Figure 2 results in

Prediction 1 ($dw_0 > 0$):

A higher initial wealth on the part of the parent has a positive effect on his or her demand for private LTC coverage combined with an ambiguous effect on the amount of informal care provided by the child. It decreases the saving propensity of the parent combined with an increase in child effort. This renders the overall effect on child effort ambiguous.

4.2 Increase in Cost Sharing in the Case of China ($d\alpha > 0$, $\partial r/\partial\alpha > 0$)

Here, “increase” is to be understood in terms of a comparison between industrial countries (with limited cost sharing) and China (with 100% cost sharing as it were). From eq. (A.4), one has for the first parental reaction function,

$$\begin{aligned} \frac{\partial^2 EU}{\partial I \partial \alpha} &= -\pi(e)(1-\bar{\pi})(1-r'_w p)(r'_a p) \cdot v''^i(\cdot) \\ &< 0 \text{ if } r'_w p > 1 \text{ (string ent means testing)} \\ &> 0 \text{ if } r'_w p < 1 \text{ (lenient means testing)}. \end{aligned}$$

While China is certainly characterized by stringent means testing as it were, it is also true that $r'_w = 0$ while $r'_a > 0$ compared to industrial countries. Therefore, one obtains

$$\frac{\partial^2 EU}{\partial I \partial \alpha} = -\pi(e)(1-\bar{\pi})(r'_a p) \cdot v''^i(\cdot) > 0, \tag{15}$$

indicating an upward shift in the first parental reaction function [see panel (a) of Figure 3; note that the shift from G to G' could conceivably entail a reduction in e]. As to the second reaction function, characteristic No. 2 modifies eq. [16] to become

$$\begin{aligned} \frac{\partial^2 EU}{\partial s \partial \alpha} &= -(1+i)\{\pi(e)(1-r'_w p)(r'_a p) \cdot v''^i(\cdot)\} \\ &= -(1+i)\{\pi(e)r'_a p \cdot v''^i(\cdot)\} \\ &> 0, \end{aligned} \tag{16}$$

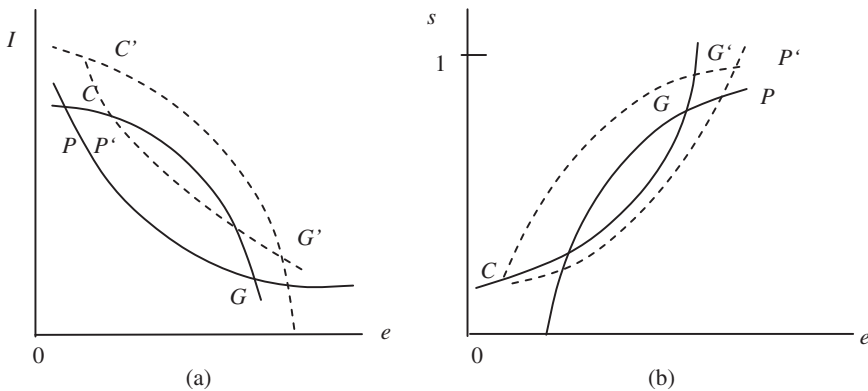


Figure 3: Increase in cost sharing ($d\alpha > 0$, $\partial r/\partial\alpha > 0$). (a) Displacement in (I, e) -space, (b) Displacement in (s, e) -space.

indicating an upward shift [see panel (b) of Figure 3]. The impact on child effort is given by eq. (A.6),

$$\frac{\partial^2 E\bar{U}}{\partial e \partial \alpha} = \pi'(e)k(1-t)(-r'_\alpha p) \cdot \bar{v}^i > 0. \tag{17}$$

This equation needs no modification; it indicates an outward shift [see panel (b) of Figure 3].

Therefore, the interaction of the two players gives rise to

Prediction 2 ($d\alpha > 0, \partial r/\partial \alpha > 0$):

In response to an increased cost sharing in LTC expenditure, parental demand for private LTC insurance is predicted to increase combined with an ambiguous effect on the amount of informal care provided by the child. The predicted change in the parent’s propensity to save is positive combined with an increase in child effort. Therefore, the overall effect on child effort is ambiguous.

Now the two exogenous changes on the child’s side are considered for the Chinese case.

4.3 Increased Opportunity Cost of the Child in the Case of China ($d\theta > 0$)

According to eq. (A.7), the parent is not affected, while eq. (A.8) unambiguously indicates an inward shift of the child’s reaction functions. Therefore, Figure 4 yields

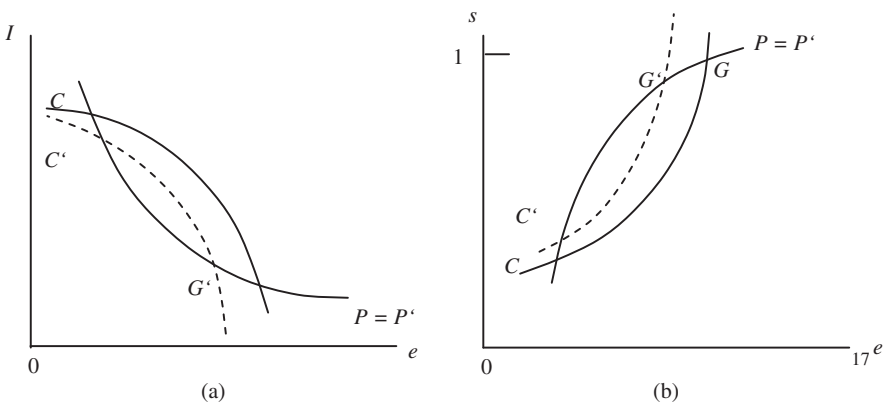


Figure 4: Higher opportunity cost of the child ($d\theta > 0$). (a) Displacement in (I, e) -space, (b) Displacement in (s, e) -space.

Prediction 3 ($d\theta > 0$):

A higher wage rate (or more generally, opportunity cost of time) on the part of the child is predicted to increase parental demand for private LTC insurance combined with less informal care provided by the child. The prediction with respect to the parent’s propensity to save is a decrease, again combined with less informal care. Thus, there is a crowding-out effect on both parental saving and child effort.

4.4 Increased Taxation of Inheritance in the Case of China ($dt > 0$)

According to eq. (A.9), the parent is not affected. As to the child, eq. (A.10) indicates in inward shift of the reaction function because of characteristics No. 2 and 3,

$$\begin{aligned} \frac{\partial^2 E\bar{U}}{\partial e \partial t} &= -\pi'(e)k\{\{w_0s(1+i) - \bar{\pi}I\} \cdot \theta\bar{u}'(\cdot)/\pi'(e) - \{I - r(\cdot)p\} \cdot \bar{v}^i\} \\ &= -k\{\theta\{w_0s(1+i) - \bar{\pi}I\} \cdot \bar{u}'(\cdot) - \pi'(e)I \cdot \bar{v}^i\} \\ &< 0 \text{ since } w_0s(1+i) > \bar{\pi}I. \end{aligned} \tag{18}$$

In view of $\pi''(e) > 0$, the displacement (in absolute value) is relatively small in for high values of e . Figure 5 thus results in

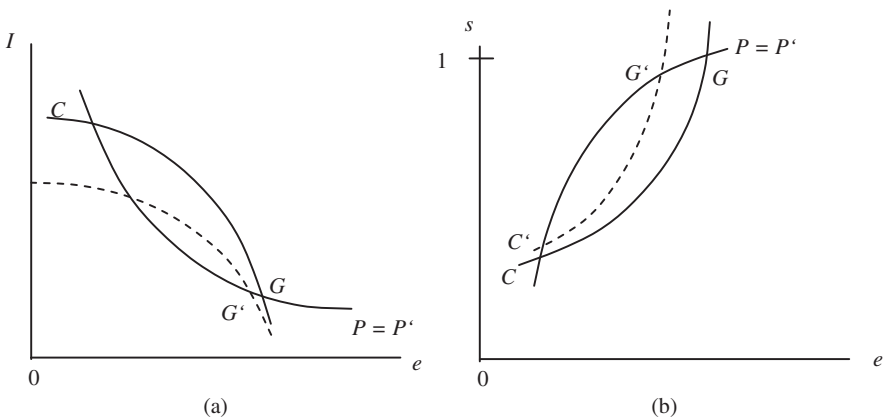


Figure 5: Increased inheritance taxation ($dt > 0$). (a) Displacement in (l, e) -space, (b) Displacement in (s, e) -space.

Prediction 4 ($dt > 0$):

A higher tax rate on the bequest received by the child is predicted to increase parental demand for private LTC insurance combined with a reduced amount of informal caregiving provided by the child. It has a depressing the parent's propensity to save, combined again with less child effort. These adjustments amount to a double crowding-out effect.

5 Comparison with Evidence from China

In 2012, a mailed survey was conducted in Shanghai City, involving 584 persons between ages 30 and 60 who were representative of the Chinese urban population. Note that it permits only a partial testing of the predictions, having been designed to test the theoretical work by Courbage and Zweifel (2011), which does not consider parental saving. Participants were asked to first wear the hat of a parent who might be in need of LTC and then to adopt the view of a child who considers providing informal care. In this latter role, more than 61% wished for their parents to live independently but with frequent visits, justifying the assumption that (contrary to the situation common in the West), family ties in China remain intact in the advent of entry into a nursing home. Hence emphasis in the present work is on stable outcomes of the interaction between the two players, in contradistinction with Courbage and Zweifel (2011). Moreover, since most of the respondents are single children, reflecting China's one-child policy, the sample fits the two-player model expounded in the previous sections very closely. Responses were of two types. The first was, "If as the parent I knew that my child would provide more/the same/less effort, I would increase/keep constant/decrease my private LTC insurance coverage". The second response was of the type, "If as the child I knew that my parent would have more/the same/less LTC insurance coverage, I would provide more/the same/less informal care". For the analysis of "parental" responses e.g., the ordered probit regression equation read,

$$\Delta InsurP = \gamma_0 + \gamma_1 \Delta EffortC + \gamma_2 (\Delta EffortC \cdot \Delta WealthP) + \gamma_3 (\Delta EffortC \cdot \Delta HealthP) + \gamma_4 \\ + (\Delta EffortC \cdot \Delta OpportcoC) + \gamma_5 (\Delta EffortC \cdot \Delta InheritC) + (socioec. char.) + \varepsilon,$$

with "P" denoting parent and "C", child; the variable labels are self-explanatory. The survey did not contain any questions about a change in subsidization of LTC expenditure, which is unknown in China, in order to avoid an excess of hypothetical items. Therefore, entry No. 2 of Table 1 below, "Increased cost sharing", is to be understood in comparison with a typical industrial country.

In a first step, the predictions by Courbage and Zweifel (“CZ” in Table 1) are compared with those of the present paper (“ZC”). While they correspond closely in three out of four cases, they contradict each other with regard to the effect of higher initial parental wealth. Whereas CZ predicted that private demand for private LTC coverage would fall in combination with a beneficial effect on child effort, the model presented in this paper (ZC) leads to the prediction of an increase in LTC insurance combined with an ambiguous effect on child effort. Therefore, whether admission to a nursing home is seen as a shakeup of family ties (as in CZ) or not (as here) does matter.

Turning to the evidence from China, the column “XZ” of Table 1, referring to Xu and Zweifel (2014), shows but partial confirmation of theoretical predictions. With regard to the effect of higher parental wealth (exogenous change No. 1), it points to a reduction in private LTC insurance (col. 3), thus

Table 1: Overview of predictions and empirical evidence from China.

Exogenous change	Decreased parental demand for private LTC insurance?			Decreased parental propensity to save?			Decreased informal care provided by child?		
	CZ (1)	ZC (2)	XZ (3)	CZ (4)	ZC (5)	XZ (6)	CZ (7)	ZC (8)	XZ (9)
Parent									
1. Higher wealth $dw_0 > 0$	yes	no ^d	yes	n.a.	yes	no ^d	no ^d	?	no effect
2. Increased cost sharing, $da > 0$	no ^{a,d}	no ^d	no ^{c,d}	n.a.	no ^d	yes ^a	yes ^a	no ^d	no ^{c,d}
Child									
3. Increased opportunity cost, $d\theta > 0$	no effect	no ^d	no effect	n.a.	yes	yes	yes	yes	yes
4. Increased taxation of inheritance, $dt > 0$	no effect	no ^d	no effect	n.a.	yes	? ^e	yes ^b	yes	yes

Notes: CZ: Courbage and Zweifel (2011); ZC: the present paper; XC: Xu and Zweifel (2014).

^aThe change actually examined is a change in the amount of subsidy; ^bThe change actually examined is a changed share in the bequest; ^cChina does not currently subsidize LTC expenditure, which is equivalent to an extreme increase of cost sharing compared to most western countries; ^dBeneficial crowding-in effect; ^eAn unambiguous prediction obtains only if the child’s share in the bequest is low initially, which does not apply to China with its one-child families.

supporting CZ (col. 1) rather than the “crowding-in” prediction of ZC (col. 2). Possibly respondents to the ZX survey, considering their future as parents, feared that their children’s high degree of mobility might induce them to reduce their informal care (in the limit to zero, as in CZ). Yet when wearing the hat of the child, their responses fail to suggest a reduction in the amount of informal care (see col. 9).

Compared to most industrial countries, China imposes an extremely high degree of cost sharing in LTC expenditure by not subsidizing it at all (change No. 3 of Table 1). The fact that a full 81% of respondents in the XZ survey expressed interest in private LTC insurance supports the prediction of a beneficial “crowding-in” effect by both CZ and ZC (see cols. 1, 2, and 3 of Table 1). In addition CZ predicted a crowding out of informal care provided by the child if LTC subsidization were to be stepped up (equivalent to a decrease in cost sharing) and hence a crowding-in effect if subsidization were to be reduced (possibly to zero). Indeed, the XZ survey finds that 34% of the respondents acting as children were prepared to host an elderly frail parent in their crowded Shanghai apartment. In comparison, among respondents representative of German rural communities, only 7% state they would provide LTC themselves on all conditions, while 17% would tend towards providing LTC (Blinkert and Klie 2004). The high degree of willingness to provide informal care in China can be interpreted as a response to the fact that parents would have to come up for the full cost of formal LTC services (another reason could be gratefulness for the investment in education many parents undertake in favor of their children, which could be modeled as a particularly high difference $\bar{v}^o - \bar{v}^i$ in eq. [9], resulting in a high value of optimal effort e^*).

Turning to an increase in the child’s opportunity cost of providing care (No. 3 in Table 1), CZ predicted “no change” in parental demand for private LTC coverage (col. 1) and ZC, a beneficial crowding-in effect (col. 2). On this score, the XZ survey (col. 3) supports CZ because it does not suggest a significant effect. However, both theoretical approaches lead to the prediction of a reduced amount of informal care provided by the child, which is confirmed by the survey (cols. 7, 8, and 9).

The fourth exogenous change examined is an increase in inheritance taxation (No. 4 of Table 1), which is considered equivalent to a reduced share in the bequest (as in CZ). According to both CZ and ZC (cols. 1 and 2, this should boost parental demand for private LTC insurance, yet the XZ survey suggests no effect (col. 3). However, it does suggest a decrease in the amount of informal care provided by the child (col. 9), which is predicted by ZC (col. 8) while CZ is ambiguous (col. 7).

The XZ survey does not address changes in the parental saving propensity, where the present paper predicts reductions in three out of four cases (see col. 5 of Table 1). Therefore, the double crowding-out effect predicted by ZC (less saving combined with less child effort) cannot be pitted against empirical evidence yet.

6 Conclusion and Outlook

Subsidization of LTC expenditure has been suspected of crowding out private LTC insurance (Brown and Finkelstein 2008), private saving (Gruber and Yellowitz 1999; Sloan and Norton 1997) as well as informal LTC (Pauly 1990; Zweifel and Strüwe 1998). However, these contributions do not show that a crowding out may be the simultaneous outcome of the interaction of the two players. They also neglect the fact that public LTC benefits typically are means-tested. The purpose of this paper is to fill these gaps by modeling a parent who decides about his or her demand for private LTC coverage and propensity to save in response to the child's amount of caregiving, and a child who decides about his or her caregiving in response to the parent's decisions which affects the size of the bequest.

Four exogenous changes impinging on the interaction between parent and child are considered in this paper; two of them characterize the two agents, while the other two reflect public policy. Predictions generally do not differ between the modeling approaches of Courbage and Zweifel (2011) (CZ), where the need for formal LTC (in particular, admission to a nursing home) is associated with a breakup of family ties, and the present paper (ZC), where it is not. The one exception is that CZ predicted that an exogenous increase in parental wealth (change No. 1 in Table 1) decreases the parent's demand for private LTC insurance combined with a positive effect on child effort. By way of contrast, ZC now predict an increase in LTC coverage combined with an ambiguous effect on child effort. However, this is intuitive because ZC, referring to China specifically, is not based on a breakup of family ties, contrary to CZ.

The empirical evidence comes from a survey performed in Shanghai City in 2013; it points to a crowding out of private LTC insurance in response to a (hypothetical) increase in parental wealth combined with a crowding in of child effort, thus confirming CZ (change No. 1 in Table 1). On the child's side, an increase in his or her opportunity cost was examined (change No. 3 in Table 1). While CZ predicted no change in the demand for LTC insurance combined with a reduction of child effort, ZC now predict an increase in insurance demand, again combined with less child effort. The empirical evidence suggests no effect on the demand for LTC insurance but a crowding out of child effort. Overall, developments beyond the control of public policy may well have crowding-out effects especially on the amount of informal care provided by children.

Turning to public policy, one change that may be considered by governments under budgetary pressure is stepping up the degree of cost sharing to be borne by persons in need of formal LTC (change No. 2 in Table 1). The modelling

approach adopted by CZ led to the prediction, “Increased demand for LTC coverage combined with less child effort”, the present one, “Increased demand for LTC coverage combined with an ambiguous effect on child effort”. The survey responses suggest the conclusion, “More LTC insurance, more child effort”. Therefore, the crowding-out effect of increased cost sharing on child effort found by CZ does not seem to apply to China with its (still) strong family ties. However, the XZ survey indicates that popular opinion in China is strongly in favor of LTC becoming a part of social insurance, which amounts to its subsidization, i.e. a decrease rather than an increase in cost sharing. Both theoretical approaches predict a crowding out of private LTC insurance, likely combined with an ambiguous effect on informal care provided by the child, while the survey confirms the first prediction but points to a crowding out of informal care as well. The other policy change considered is an increase in inheritance taxation (change No. 4 in Table 1). According to CZ, this would boost parents’ demand for LTC coverage, with an ambiguous effect on the amount of informal care provided by their children. The present work agrees with respect to LTC insurance but predicts a crowd-out of child effort. The empirical evidence combines “no effect” for LTC insurance with a crowding out of child effort. In sum, increased taxation of bequests is not devoid of a crowding-out effect either.

The present work also generates predictions concerning the parental propensity to save in combination with child effort. For the two exogenous changes affecting the child (increased opportunity cost, increased inheritance taxation), it finds a double crowding-out effect. For one of the changes affecting the parent (higher initial wealth), it finds a crowding out of parental saving combined with an ambiguous effect on child effort; for the other (increased cost sharing), a beneficial crowding-in effect on parental saving combined with an ambiguous one on child effort. The survey does not provide empirical evidence in this regards because it was designed to test the earlier predictions formulated by CZ.

There are several limitations to this work that need to be pointed out. First, the two players may be more altruistic than modeled here. For instance, the parent could suffer a utility loss from the opportunity cost of caring borne by the child, while the child could also derive utility from being with the parent. Specifically, this would cause the marginal utilities [u'_1 and u'_2 of eq. (2)] to depend negatively on opportunity cost, resulting in a positive value of $\partial^2 EU / \partial I \partial \theta$ in eq. [18] and hence an upward shift in the parent’s reaction function [see panel (a) of Figure 4 again]. As to the child, eq. [9] would contain an additional positive term involving marginal utilities $\bar{v}^i(\cdot)$ and $\bar{v}^o(\cdot)$ which however would have to depend on opportunity cost θ to make a difference in eq. (A.8). Barring such a complication, an upward shift of the parent’s reaction

function would combine with no shift on the child's side. This would imply that higher opportunity cost borne by the child results in a more marked increase in the parental demand for LTC insurance combined with a more marked reduction of child effort than predicted on the basis of panel (a) of Figure 4.

Second, the model may be extended to comprise three generations, with ambiguous effects however. On the one hand, the child may also anticipate his or her own old age, which would be a cause for weakening any crowding-out effect with respect to effort. On the other hand, the caregiver may have children of his or her own, causing his or her opportunity cost of time to be particularly high. This would reinforce crowding-out effects on child effort according to eq. (A.8) and Figure 4. Another potential shortcoming is that all decision variables are fixed prior to the possible admission to the nursing home. A more refined analysis would introduce parental saving before and after admission and a level of child effort before and after admission on the part of the caregiver. In the latter case, the two variables could be interpreted in different ways, i.e. actual effort designed to keep the parent out of the nursing home and simply time spent with him or her.

Also, both the objectives and functional relationships may have to be specified differently, depending on whether the caregiver is a child, the spouse, or a friend, all of whom have inheritance prospects that are subject to differing legal norms. As a first approximation, these norms are reflected in the parameter k , with consequences similar to those emanating from a change in the taxation of inheritance (see Prediction 4). Finally, the empirical evidence has its weaknesses because participants made hypothetical statements in response to hypothetical changes rather than actual decisions in response to actual changes. Moreover, they had to act first as parents and then as children, which may have taxed their power of imagination (although being between ages 30 and 60, they were familiar with both roles).

The empirical evidence also has its weaknesses. Especially when acting as the child, respondents were likely to be subject to a “warm glow” effect (Andreoni 1990), causing them to state an immutable willingness to provide informal care to their parents. Filial piety is a highly respected social norm deeply rooted in Confucianism (Chang and Kalmanson 2010). This norm may be responsible for predicted moral hazard (and hence crowding-out effects not to be confirmed in some instances).

In spite of these limitations, some of the insights of this research are likely to be robust. One is that for establishing crowding-out effects (single, double, or even triple), the interaction between the beneficiary and the caregiver needs to be studied. Another insight is that the stringency as well as the progressiveness of cost sharing is of crucial importance when trying to predict the crowding-out effects especially of an increase in parental wealth and of public policy designed to relieve the budget by making persons in need of formal care pay a greater share of LTC expenditure.

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Appendix: Four exogenous changes and their impact on the reaction functions

In this appendix, the model is subjected first to two exogenous changes on the parent’s side, viz. an increase in his or her initial wealth ($dw_0 > 0$) and an increase in the degree of cost sharing in LTC expenditure ($da > 0, \partial r / \partial \alpha > 0$). Two more changes relate to the child, viz. an increase in his or her opportunity cost of caregiving ($d\theta > 0$) and a lower amount of inheritance (this is thought to be caused by an increase in its taxation ($dt > 0$)).

(1) Higher initial wealth of the parent ($dw_0 > 0$)

From eqs [2] and [1], the crucial mixed derivative determining the first parental reaction function is given by

$$\begin{aligned}
 \frac{\partial^2 EU}{\partial I \partial w_0} &= -\bar{\pi} \{u_1''(\cdot) + (1-s)u_2''(\cdot)\} \\
 &\quad + \pi(e)(1-\bar{\pi}) \left\{ -r_w'' s(1+i)p \cdot v^i + (1-r_w' p)^2 s(1+i) \cdot v''^i(\cdot) \right\} \\
 &\quad - (1-\pi(e))\bar{\pi}s(1+i) \cdot v''^o(\cdot) \\
 &= -\bar{\pi} \{u_1''(\cdot) + (1-s)u_2''(\cdot)\} \\
 &\quad + s(1+i) \left\{ \pi(e)(1-\bar{\pi}) \left\{ (-r_w'' p) \cdot v^i + (1-r_w' p)^2 \cdot v''^i(\cdot) \right\} - (1-\pi(e))\bar{\pi} \cdot v''^o(\cdot) \right\} \\
 &\quad > 0.
 \end{aligned}
 \tag{A.1}$$

As to the parent's second reaction function, eqs [6] and [1] imply

$$\begin{aligned}
 \frac{\partial^2 EU}{\partial s \partial w_0} &= -(1-s)u_2''(\cdot) + (1+i) \\
 &\quad \{ -\pi(e)(r_w''p) \cdot v^i(\cdot) + \pi(e)(1-r_w'p) \{ s(1+i) - r_w's(1+i)p \} \\
 &\quad \cdot v''^i + (1-\pi(e)) \cdot v''^o(\cdot) \} \\
 &= -(1-s)u_2''(\cdot) + (1+i) \left\{ \pi(e) \left\{ -r_w''p \cdot v^i(\cdot) + s(1+i)(1-r_w'p)^2 \cdot v''^i \right\} \right. \\
 &\quad \left. + (1-\pi(e)) \cdot v''^o \right\} \\
 &\geq 0.
 \end{aligned} \tag{A.2}$$

For the child, one has from eqs. (9) and (8)

$$\begin{aligned}
 \frac{\partial^2 E\bar{U}}{\partial e \partial w_0} &= \pi'(e) \{ \{ k(1-t)s(1+i) - r_w's(1+i)p \} \cdot \bar{v}^i - k(1-t)s(1+i) \cdot \bar{v}^o \} \\
 &= \pi'(e)s(1+i) \{ (k(1-t) - r_w'p) \cdot \bar{v}^i - (k(1-t)\bar{v}^o) \} \\
 &= \pi'(e)s(1+i) \{ (k(1-t)(\bar{v}^i - \bar{v}^o) - r_w'p \cdot \bar{v}^i \} \\
 &> 0 \text{ since } \bar{v}^i < \bar{v}^o.
 \end{aligned} \tag{A.3}$$

(2) Increase in cost sharing ($d\alpha > 0$, $\partial r / \partial \alpha > 0$)

An increase in cost sharing is equivalent to an increase in α causing a change in the function $r(w_0s(1+i), \alpha)$ such that $\partial \frac{r(w_0s(1+i), \alpha)}{\partial \alpha} = r'_\alpha > 0$. To make this a pure upward shift of the cost-sharing schedule without a change in its progressiveness, $r''_{\alpha w} = r''_{w\alpha} = 0$ is imposed.

On the parent's side, an exogenous change $d\alpha > 0$ affects the FOC given by eq. [2], resulting in a shift of his or her first reaction function as follows [see also eq. (1)],

$$\begin{aligned}
 \frac{\partial^2 EU}{\partial l \partial \alpha} &= \pi(e)(1-\bar{\pi}) \{ (-r''_{w\alpha}p) \cdot v^i(\cdot) + (1-r_w'p)(-r'_\alpha p) \cdot v''^i(\cdot) \} \\
 &= -\pi(e)(1-\bar{\pi})(1-r_w'p)(r'_\alpha p) \cdot v''^i(\cdot) \\
 &< 0 \text{ if } r_w'p > 1 (\text{stringent meanstesting}) \\
 &> 0 \text{ if } r_w'p < 1 (\text{lenient meanstesting}).
 \end{aligned} \tag{A.4}$$

To determine the displacement of the second parental reaction function, one has from eqs [6] and [1],

$$\begin{aligned}
\frac{\partial^2 EU}{\partial s \partial \alpha} &= (1+i) \{ \pi(e) \{ (-r''_{wa} p) \cdot v^i(\cdot) + (1-r'_{wp})(-r'_{\alpha} p) \cdot v''^i(\cdot) \} \} \\
&= -(1+i) \{ \pi(e) (1-r'_{wp})(r'_{\alpha} p) \cdot v''^i(\cdot) \} \quad (\text{A.5}) \\
&< 0 \text{ if } r'_{wp} > 1 (\text{stringent meanstesting}) \text{ since } r''_{wa} = 0 \\
&> 0 \text{ if } r'_{wp} < 1 (\text{lenient meanstesting}) \text{ since } r''_{wa} = 0.
\end{aligned}$$

With regard to the child, the direction of the displacement is given by [see eqs. (9) and (8)],

$$\frac{\partial^2 E\bar{U}}{\partial e \partial \alpha} = \pi'(e) k(1-t)(-r'_{\alpha} p) \cdot \bar{v}^i > 0. \quad (\text{A.6})$$

Now two exogenous changes on the child's side are considered.

(3) Increased opportunity cost of the child ($d\theta > 0$)

From eqs. (2), (6), and (1), it is evident that the parent is not affected, hence

$$\frac{\partial^2 EU}{\partial I \partial \theta} = 0, \quad \frac{\partial^2 EU}{\partial s \partial \theta} = 0. \quad (\text{A.7})$$

As to the child, eqs. (9) and (8) yield

$$\frac{\partial^2 E\bar{U}}{\partial e \partial \theta} = -\bar{u}'(\cdot) + e\theta \cdot \bar{u}''(\cdot) < 0, \quad (\text{A.8})$$

indicating an inward movement of the reaction curve which becomes more pronounced for higher values of e .

(4) Increased taxation of inheritance ($dt > 0$)

An increased rate of taxation ($dt > 0$) has the effect of reducing the net share of the caregiver in the bequest. According to eqs. (2), (6) and (1), this does not affect optimization on the part of the parent, thus

$$\frac{\partial^2 EU}{\partial I \partial t} = 0, \quad \frac{\partial^2 EU}{\partial s \partial t} = 0 \quad (\text{A.9})$$

Therefore, there again is no displacement of the parental reaction functions. Concerning the child's reaction function, one obtains from eqs. (9) and (8),

$$\begin{aligned} \frac{\partial^2 E\bar{U}}{\partial e \partial t} &= \pi'(e) \{ -k\{w_0s(1+i) + I(1-\bar{\pi}) - r(\cdot)p\} \cdot \bar{v}^i + k\{w_0s(1+i) - \bar{\pi}I\} \cdot \bar{v}'^o \} \\ &= -k\{\pi'(e)\{w_0s(1+i) - \bar{\pi}I\} \cdot (\bar{v}^i - \bar{v}'^o) - \pi'(e)\{I - r(\cdot)p\} \cdot \bar{v}^i\}. \end{aligned}$$

Using $\pi'(e)\{\bar{v}^i(\cdot) - \bar{v}'^o(\cdot)\} = \theta\bar{u}'(\cdot)$ from the FOC of eq. (9), this boils down to

$$\begin{aligned} \frac{\partial^2 E\bar{U}}{\partial e \partial t} &= -k\{\{w_0s(1+i) - \bar{\pi}I\} \cdot \theta\bar{u}'(\cdot) - \pi'(e)\{I - r(\cdot)p\} \cdot \bar{v}^i\} \\ &\geq 0. \end{aligned} \tag{A.10}$$

In sum, several comparative-static results are ambiguous, precluding predictions concerning the displacement of Nash equilibria. However, they prepare the ground for analyzing the case of China in greater detail.