Health care and social care: complements, substitutes and attributes

Wildman, John and McMeekin, Peter

Economics, Newcastle University, IHS, Newcastle University

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Peter McMeekin[1] and John Wildman[2*]

[1] IHS, Newcastle University, Newcastle upon Tyne, UK, peter.mcmeekin@ncl.ac.uk

[2*] Economics, Newcastle University, Newcastle upon Tyne, UK. Corresponding author: john.wildman@ncl.ac.uk

Abstract

Ageing populations are a major challenge for most developed countries, where social security systems were developed in the post war period. It has been suggested that the costs of caring for the ageing population places a considerable strain on individuals, as well as on the public purse, and many countries are looking for ways to reduce costs. One of the major issues is the relationship between health care and social care. This paper considers health care and social care as complements and substitutes through a household production framework. We demonstrate how health care and social care are attributes that are valued by individuals and how in the presence of a perfect market individuals would choose combinations of these attributes. We highlight how, even with technical efficiency, sub-optimal combinations of health and social care may be chosen. We also show, through the introduction of a new good, how there may be opportunities to alleviate the costs of the ageing population.

Keywords:

Ageing population, health production, attributes, complements and substitutes, market failure

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Introduction

The ageing population is a major global challenge, with developed countries struggling as the proportion of elderly in their populations increase. Many countries have social security systems that were developed after the war and were put in place to aid needy populations and are not well equipped to deal with an ageing population. One question that countries need to answer is 'what do we want for our ageing population?' There are equity and efficiency objectives that underpin views towards the elderly, however, in general there is a desire for individuals to have long, healthy, active and independent lives. Underlying these goals are issues of costs, where individuals and the state, operating within their budget constraints (and with fixed budgets), wish to allocate resources to the ageing process or, more specifically, altering and adapting to the way that health and functioning vary with age. In the background to all of these issues often lies the (health) objective of equal access for equal need, although, as Hauck et al. (2002) demonstrate resource allocation that tries to accommodate alternative aims can lead to the mis-allocation of resources. These debates are further complicated by the increasing use, and cost of, technologies that are also increasing health care expenditures (Breyer et al., 2010). [1] [2]

State resources, be it pensions, or contributions to long-term care, or some other form of state support, are being placed under pressure and the proportion of individuals over 65 increases. Individual budgets are under pressure because individuals live longer and work, proportionately, for a shorter period of their lives. Further, there can be incentives for individuals and institutions to behave in a way that is not optimal for society, trying to shift costs onto other individuals or institutions, leading to free-riding and inefficiency, and so increasing the costs of care and ageing.

The costs of caring for the ageing population are expected to rise considerably in the coming years. The U.S. Administration on Aging predicts people in the 65+ age cohort will grow from about 13% of the population in 2010 to about 20% of the population by 2030. This will affect the social security fund that, at current rates, is predicted to move from surplus to deficit in 2023 and be exhausted by 2036 (OASDI Trustees Report, 2011). Medicare provides community care through its home health care scheme and in the 2011 trustees report it was predicted that the fund would begin to run out of money in 2024. Further, Hall and Jones (2007) suggest that the optimal share of health spending should rise from 15.4% of GDP in 2000, to over 30% by the middle of the century. In the UK, the Dilnot Commission suggested that under the current funding system the cost of the ageing population to the tax payer would rise from £14.6 billion in 2010/11 to £23 billion by 2025/26. It is vital for decision-makers to find ways of funding care which are equitable and efficient. However, many of the figures relating to costs need to be treated carefully because changes in epidemiology are often not accounted for when predicting costs.

The optimal way of funding and dealing with the problem of the ageing population is facing considerable scrutiny. Wittenberg et al. (2002) outline a range of issues and options for funding the care of the elderly. Fernandez and Forder (2012) compare the experiences of the UK, France, Germany and Japan in reforming their longer term care financing arrangements with those of the US. The former group have sought to develop partnerships between individuals and their states to 'share, efficiently and equitably, the responsibilities associated with paying for the care of

[1] There is a body of work that suggests that health care expenditures are not related to age once other factors have been controlled for (Zweifel et al., 1999, Shang and Goldman 2008). This is known as the "red herring" hypothesis. The results of Breyer et al. (2010) do confirm the existence of a weak red-herring hypothesis and find that population ageing accounts for a 0.5% growth rate in health expenditures. Also, see Payne et al. (2007) for a review.

[2] Most studies consider elements of health care, social care, pension costs etc. Generally when referring to increasing costs we are considering all of these elements. OECD projections of public health and long-term care expenditures range from 3.5% - 6% for the period 2005-2050 (Martins et al., 2006)

dependent people'. The debate in the US is centred more on market provision of long term care where the 'implication is that for the foreseeable future there is little chance that a social insurance approach would be politically viable in the United States' (Frank, 2012). In both circumstances, why the market may lead to an inefficient allocation of resources in social care is a key issue for policy makers.

The rate at which healthy life expectancy (the years spent in good health) matches total life expectancy is a key issue in determining the costs of the ageing population. Healthy life-expectancy is important because the longer people remain healthy, the longer they are independent, stay out of hospital and stay out of long term care. There are three (simplified) ways that life-expectancy and health life-expectancy could interact. Firstly, as life-expectancy increases, healthy life-expectancy shows larger absolute increases. Secondly, life expectancy and health life-expectancy move together by the same amount. Thirdly, life expectancy increases more (in absolute terms) than healthy life-expectancy. In all three scenarios individuals live longer, but in scenario one it is possible to delay retirement for longer because of increasing health life-expectancy, providing opportunities to save more to fund retirement. The second scenario may be neutral in the sense that the period in which individuals are unable to work is unchanged. However, if individuals become unhealthy at a later age then ageing may be more severe and there may be increasing costs. Finally, there are increased costs because although individuals live longer, the time which they are not working is increasing at a faster rate than the opportunities to work and save. In the US Spillman (2000) estimated that health care costs increased at an accelerating rate as the number of years spent in a reduced health state increased as a proportion of total life expectancy. This was in contrast to their findings about acute medical costs which increased at a decreasing rate. In the UK the Office for Nation Statistics (ONS) suggests that the situation will be the same for Great Britain. The ONS figures suggest, with some uncertainty, that the gap between life expectancy and healthy life expectancy will be 11.5 years in 2025, compared to 9.75 years in 2005 (Mayhew et al., 2010). These figures suggest that the costs will increase all other things being equal.

This paper uses household production frameworks (Lancaster, 1966 and Grossman, 1972) to investigate the relationship between health care and social care as complements and substitutes. In the Lancaster framework we consider the role of attributes. In the Grossman framework we use the standard goods framework. We show that both frameworks can be used to demonstrate important concerns for the care of the elderly. We show how, even in the presence of technical efficiency, it is possible for individuals to consume sub-optimal combinations of health and social care. We also consider the introduction of a new product that is designed to assist ageing. Assisted living technologies (ALTs) are increasingly being seen as a mechanism for addressing the problems of ageing. We show that their uptake will depend on the relationship between health care and social care, and the valuation of the attributes that ALTs provide.

Health and Social Care: Substitutes and complements

The model of Lancaster (1966) provides an ideal framework for considering the relationship between health care and social care. In this framework goods contain a bundle of attributes and for simplicity we consider two goods, a health good and a care good, and two attributes, health care and social care. Both goods provide both attributes but in different quantities. Health goods, for example a hospital stay, provide the attributes of health care - individuals can be monitored and treated during their stay and this provides them with health care. Health goods also provide the attribute social care - a hospital stay includes social care aspects such as meals and easy access to facilities. Likewise care goods provide both the attributes of social care, the care component, and health care, including monitoring or recovery. It would be expected that health goods provide more of the health care attribute, while care goods provide more of the social care attribute.

In this model consumer preferences are defined in terms of the attributes and the demand for the goods is a derived demand, ie goods are inputs into a production process, where the production process involves extracting attributes from the goods. Individuals purchase the health good and the care good in order to obtain the health care and social care attributes, which in turn, according to Grossman (1972), are also derived demands.

In our simple model with two goods, x_1 (health good) and x_2 (care good), and two attributes, a_1 (health care) and a_2 (social care) we suggest that each good x_j yields a vector of attributes $\alpha_j = (\alpha_{1j}, a_{2j})$ where each $\alpha_{ij} \geq 0$. We assume that the amount of attribute *i* yielded by one unit of good *j* is fixed regardless of the level of consumption.

The amount of attribute *i* that can be obtained from the two goods is:

$$a_i = \alpha_{i1}x_1 + \alpha_{i2}x_2 \qquad i = 1,2$$

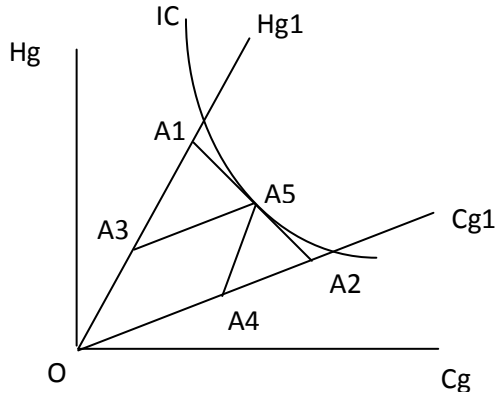
Utility is represented on the basis of attributes (rather than goods). This gives the following optimization problem:

$$\max u(a_1, a_2) \qquad s.t. \qquad i) \sum_j p_j x_j \leq M$$

$$ii)\ a_i = \sum_j a_{ij}x_j$$

$$iii)\ x_j \geq 0$$

Figure 1: model in attribute space



The attributes are measured on the axes. Purchasing a unit of *Hg* (health goods) will produce α_{11} of attribute *1* (health care) and α_{21} of attribute *2* (social care). The ray *OHg1* shows the combinations of health care and social care produced when the individual buys only *Hg*. Ray *OCg2* shows similar combination for *Cg*. If all income is spent on *Hg* then the individual will be at *A1* on *OHg1*. If all income is spent on *Cg* the individual will be at *A2 on OCg1*. Individuals may choose to consume combinations of goods, and so all the points in the area *OA1A2* are feasible, with the line *A1A2* the efficiency frontier. Individuals would choose combinations along *A1A2* in order to maximise utility, points inside the frontier are not efficient - consumers can be made better off by choosing a different combination of goods. If an individual bought O*A3* units of *Hg* and O*A4* units of *Cg* then they would be at point *A5* on the efficient frontier. If the individual has preferences shown by the indifference curve *IC* then point *A5* will be their optimal combination of health goods and care goods.

Using this analysis we can think of the implicit prices of the attributes, rather than the prices of the goods. Solving the model yields:

$$p_1\left(\frac{a_1\alpha_{22}-a_2\alpha_{12}}{\alpha_{11}\alpha_{22}-\alpha_{21}\alpha_{12}}\right)+p_2\left(\frac{a_2\alpha_{11}-a_1\alpha_{21}}{\alpha_{11}\alpha_{22}-\alpha_{21}\alpha_{12}}\right)=M$$

rearranging gives:

$$a_1\left(\frac{p_1\alpha_{22}-p_2\alpha_{21}}{\alpha_{11}\alpha_{22}-\alpha_{21}\alpha_{12}}\right)+a_2\left(\frac{p_2\alpha_{11}-p_1\alpha_{21}}{\alpha_{11}\alpha_{22}-\alpha_{21}\alpha_{12}}\right)=M$$

simplifying notation gives:

$$\pi_1 a_1+\pi_2 a_2=M$$

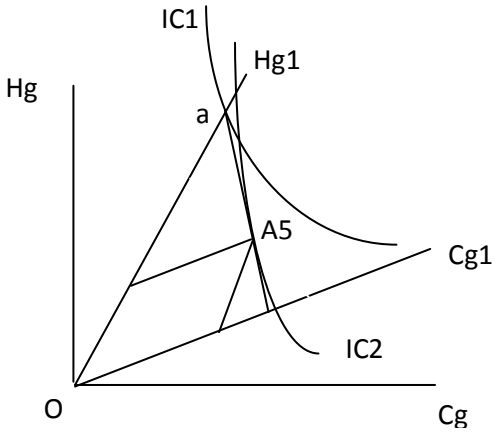
Where *π1* and *π2* can be considered as the implicit prices of the attributes, where their ratio is equal to the slope of the budget line. We can also consider the valuation equations:

$$\pi_1\alpha_{11}+\pi_2 a_{21}=p_1$$
$$\pi_1\alpha_{12}+\pi_2 a_{22}=p_2$$

The left-hand side gives the value of the bundle of characteristics contained in one unit of each good. This highlights the relationship between attributes and price. The price of a good is equal to the value placed on the characteristics. In our example we can think of the price of care being equated to the value placed on the social care attribute and the health care attribute that makes up a unit of care.

From this type of analysis it is possible to consider the association between attributes and goods and individual behaviour. In systems where the health good is provided centrally through national insurance or general taxation schemes and is free at the point of delivery (or involves only small co-payments), then its price is low relative to the care good (many more aspects of care goods are paid for by the individuals compared to health care). In this case individuals can consume many units of health care and obtain high levels of the attributes health care and social care (Figure 2).

Figure 2: Relatively inexpensive health good and corner solutions

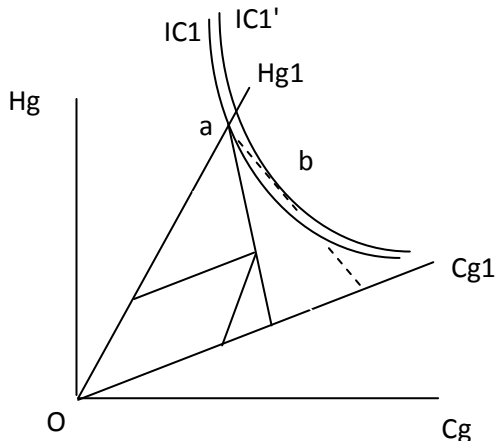


In this case the budget constraint is almost vertical and if the individual has preferences shown by the indifference curve *IC1,* they will choose the corner solution *a*. With this choice the individual can obtain almost as much of the attribute social care by consuming the health care good, rather than consuming the care good. Only if the individual has preferences that are strongly in favour of the

social care attribute (as illustrated by the steeper indifference curve *IC2*) would the individual purchase both the health good and the care good.

Such a scenario could be considered from a decision maker's view-point. If the health good and the care good budgets are separate then it may be in the interest of the (health) care provider to encourage individuals to consume more of the health good (care good) rather than provide care goods. In this case the individual gains social care attributes through the consumption of the health good *Hg* but the social care provider incurs no cost.

Figure 3: Social decision maker



Adapting our figure (Figure 3) it is possible to demonstrate the issues surrounding health and care goods as complements. The unbroken line gives the constraint faced by the social decision maker. The dashed constraint is the constraint that the individual would face if health and social care were provided in a private market.[3] The indifference curve *IC1* is that of the individual's and in a private market they would choose the point *b*. The social decision maker chooses point *a*, which only purchases the health good on behalf of the individual. In this case the individual needs/wants more social care, with *b* on a higher indifference curve. Here health care is acting as a substitute for social care. The individual would choose a combination of health and social care where they are acting as complements, increasing overall utility to the individual. Point *a* is on the efficient frontier; however it is not an optimal point given individual preferences.

Ageing and health and social care production

Maintaining the production function approach it is possible to reframe this problem based on the production models of Becker (1965) and Grossman (1972). In this approach we move away from the 'attributes' space and back towards the more traditional 'goods' space.

In this model the individual gains utility from the health good and the care good. We assume that there are diminishing returns to both the health good (*Hg*) and care good (*Cg*). As an illustration we assume that the utility function is:

$$U = Hg^{\alpha} + Cg^{\beta} \qquad (1)$$

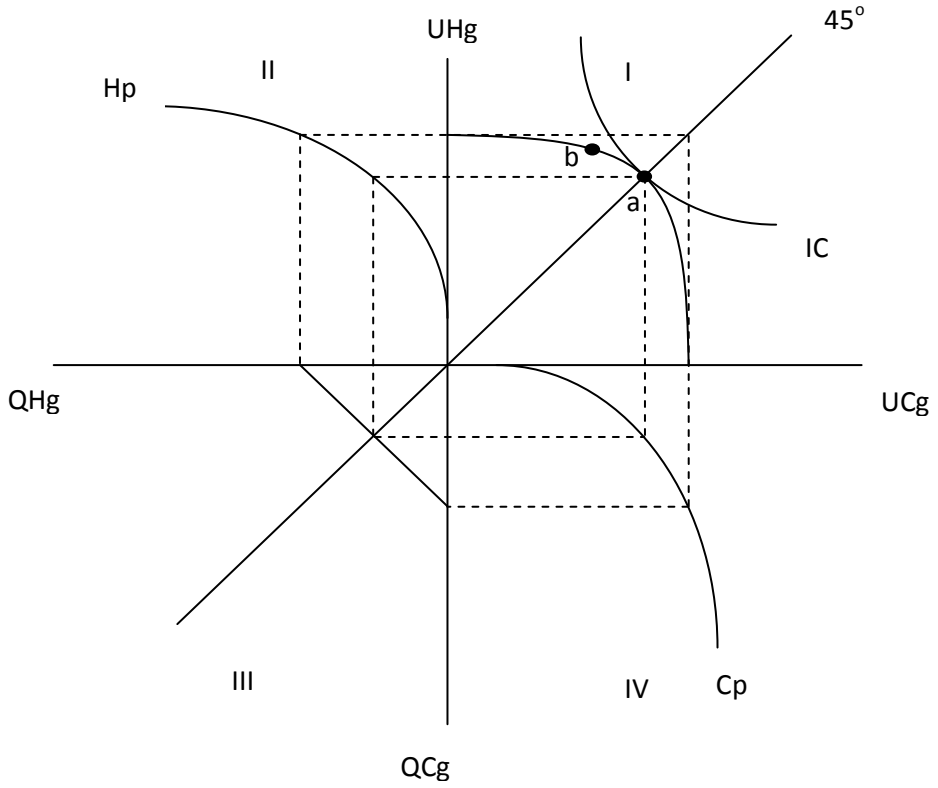
[3] In this case we have shown the private market providing more opportunities for individuals than those provided by a public sector provider. It is possible that the market provision would be below that of the public sector - or prices such that the individual's budget constraint is closer to the origin and the individual is on an indifference curve below *IC1*.

where 0 < α, β < 1. The individual faces the usual budget constraint, with an income, *M*, and prices *ph* and *pc* for the health and care good respectively. Solving the model yields the following solution:

$$\frac{H\prime}{C\prime} = \frac{ph}{pc} \qquad (2)$$

This result can be demonstrated in Figure 4 below. The south-western quadrant of the figure (quadrant *III*) describes all the alternative combinations of health (*Hg*) and care (*Cg*) that could be purchased for a given budget (*M*). The north-western (*II*) and south-eastern (*IV*) quadrants contain the health production and care production functions and they both exhibit diminishing marginal returns, as suggested by equation *(1)*. The north-eastern quadrant (*I*) shows the all possible combinations of utility that a consumer could obtain from the possible combinations of health and care (*Ush*). The consumer's indifference curve (*IC*) describes the combinations of utility from health care and social care that the consumers is indifferent between. The indifference curve is convex, demonstrating a diminishing marginal rate of substitution between the health good and the care good - increasing amounts of one good are required to compensate for decreases in the other good. If goods were perfect substitutes the indifference curve would be a straight line. If the goods were perfect complements the indifference curves would be L shaped. For a given amount of the health (care) good utility would not increase as the quantity of the care (health) good was increased. The optimal combination is where the indifference curve is tangential to the utility frontier. In this case this is when the consumer splits their expenditure equally between the health and the care good.

Figure 4: Health production model



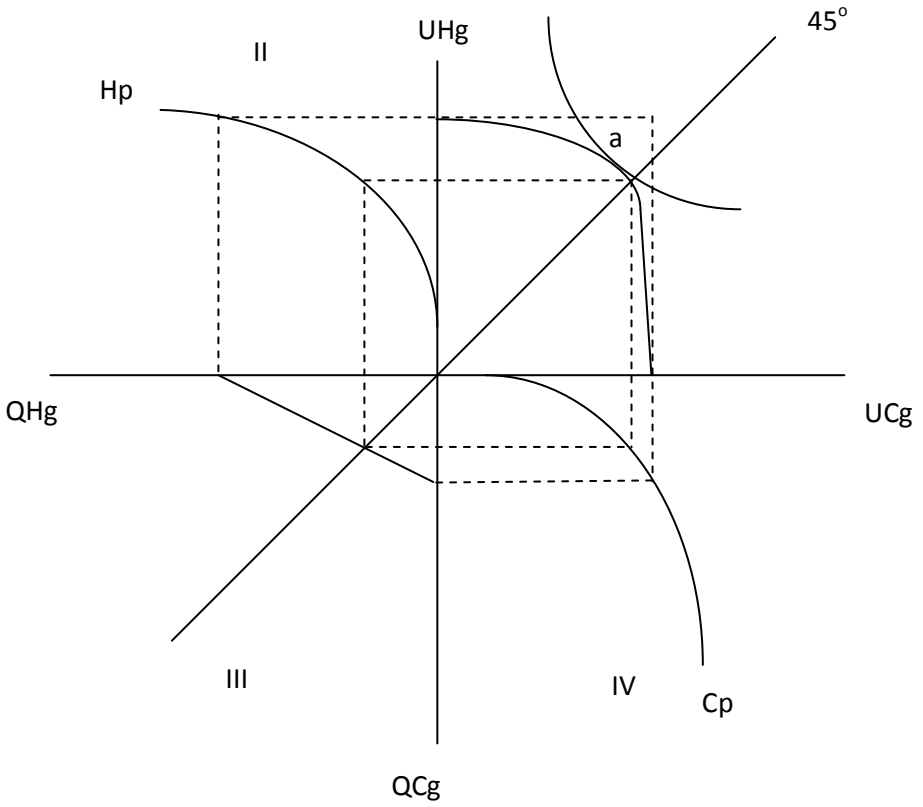
This approach highlights some of the issues surrounding health care and social care and their role as substitutes and complements. If health care is used as a substitute for social care, even with

technical efficiency, i.e. the consumer chooses a combination that means that they are on their utility frontier in quadrant *I*, say at point *b*, then the individual is worse-off than at point *a*. The individual would be better off reducing the amount of the health good consumed and increasing the amount of the care good and moving to point *a*, at this point there is allocative and technical efficiency.

We can extend this analysis to consider a number of scenarios. From our optimisation the impact of reducing the price of the health good (*ph*) is $\lambda^{*}Hg^{*}$, where λ^{*} is the optimal value of the Lagrange multiplier and Hg^{*} is the optimal level of the health good purchased. This is positive and indicates that a reduction in the price of the health good increases the amount of the health good purchased, although there will be a substitution and an income effect that may lead to changes in the consumption of the care good as well.

Firstly, we consider the scenario where the health good is less expensive than the care good (Figure 5). This is an important scenario because for many individuals health care is less expensive than social care. In many countries there is more intervention in the health care market than in the social care market, meaning that the payments that individuals incur for health care, at the point of delivery, are generally lower. This may be due to the government provision of health care, or it may come from individuals having insurance.

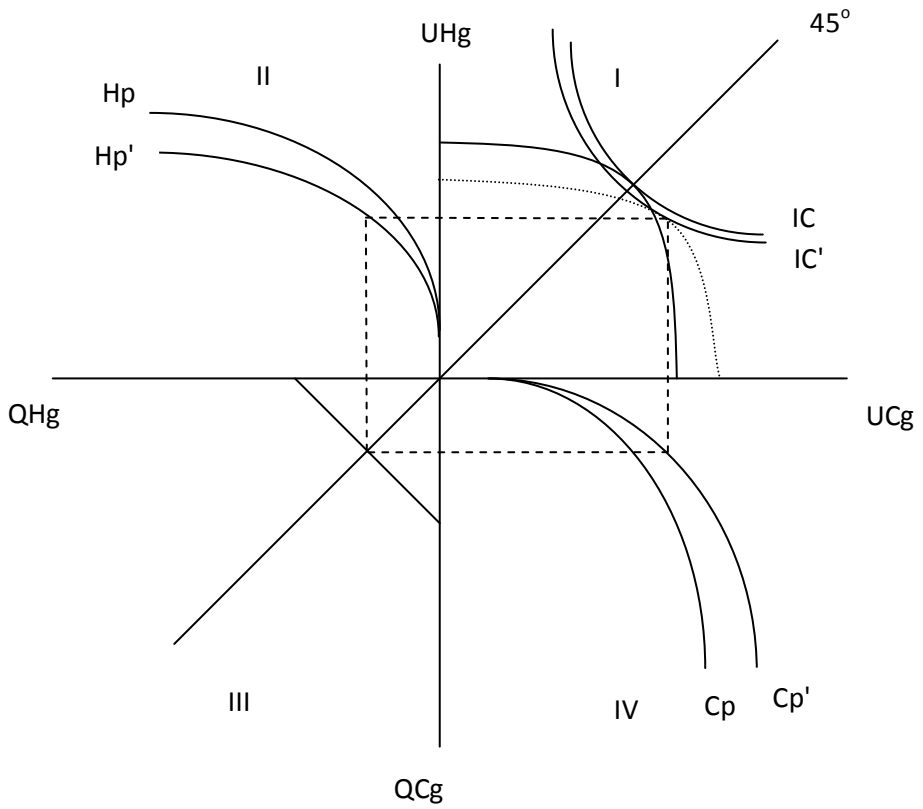
Figure 5: Less expensive health goods



In Figure 5, a new budget line in quadrant *III* means that a new set of consumption opportunities are available. These are represented by the new utility frontier in quadrant *I*. From the figure it can be seen that the optimal point (*a*) involves the consumption of more of the health good and less of the care good.

In this framework, the parameters α and β describe the way that the health good and the care good are transformed into utility. Changes in these parameters affect the utility and the optimal choices of the individual, with an increase in one of these parameters increasing the amount of utility the individual can obtain for a given input. Further, an increase in the parameter α (β) will increase the amount of the health (care) good consumed.

Figure 6: Ageing individuals and changes in the production functions



One possible way that ageing may affect individuals is that they gain less from a given amount of health care, i.e. their health production function falls, in this case moves down in quadrant II towards the *Qh* axis (*Hp* to *Hp'*). However, individuals may benefit more from a given amount of social care. Social care to an independent individual in their 40s is unlikely to provide much benefit, but would be beneficial to an older individual. If these changes are proportional we can re-write the utility function in the following form:

$$U = Hg^{1-\beta} + Cg^{\beta} \qquad (3)$$

In this scenario as the parameter β increases the ability to transform care goods to utility increases, but the ability to transform health goods decreases. This is a way to consider the ageing process. As individuals age, their ability to transform care goods to utility increases and their ability to transform health goods decreases. This is shown in Figure 6 which demonstrates how the utility frontier changes shape. The comparative statics for the model demonstrate that as β increases the production functions rotate in quadrant *II* (down) and quadrant *IV* (up). These movements result in a change in the utility frontier in quadrant *I*. In this example the individual moves to a lower indifference curve (*IC'*) and chooses a combination containing more of the care good and less of the health good.

In this case we assume that the social care production function moves upwards - towards the *Uh* axis in quadrant *IV*. The impact of such an ageing process would suggest that individuals would substitute away from health care towards social care. This would move the individual's utility frontier in quadrant *I*, although whether overall utility would increase or decrease would depend on the magnitude of the changes to the health and social care production functions. However, if, as individuals age, there is an increase in the use of health care, rather than social care, then the individual will move onto a lower indifference curve (even if technical efficiency is maintained). The marginal rates of substitution are not equal and so the individual would be worse-off. This is potentially the scenario that is witnessed among older individuals.

Introduction of a new good: Assisted living technologies (ALTs)

The models considered thus far can be extended to consider the role of new technologies that are aimed at improving care. There is a considerable focus on the role of the private sector to provide ALTs that are beneficial for ageing individuals and that may also ease the cost burden on the public purse. There are potential externalities that may be derived from the introduction of ALTs, in which case we would expect the market to under provide them.

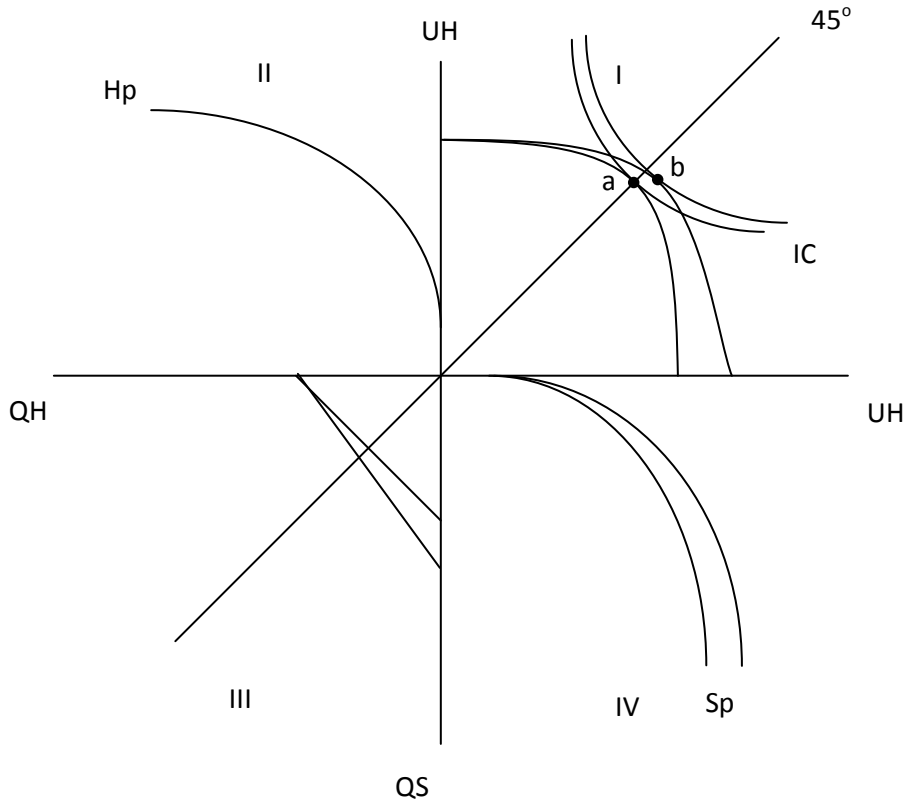
Firstly, we can consider how the ALTs may be beneficial to the ageing process. ALTs could be considered simply as another care good. Individuals purchase these goods, along with other care goods and the purchase of these goods increases utility at a decreasing rate. If the existence of ALTs reduces the cost of care goods then the budget line will pivot in quadrant *III* (Figure 7).

However, we suggest that the use of technology provides potential efficiency gains, meaning that for a given amount of the care good individuals gain greater utility. In our model this would mean an increase in the parameter β in equation (1), in the four quadrant diagram this means rotating the function in quadrant IV upwards, so that there is greater utility derived for a given amount of the care good, ie an increase in technology. [4]

The result (in Figure 7) would be that individuals would purchase more of the care good and less of the health good (although the exact nature of the change would depend on the income and substitution effects stemming from a price change).

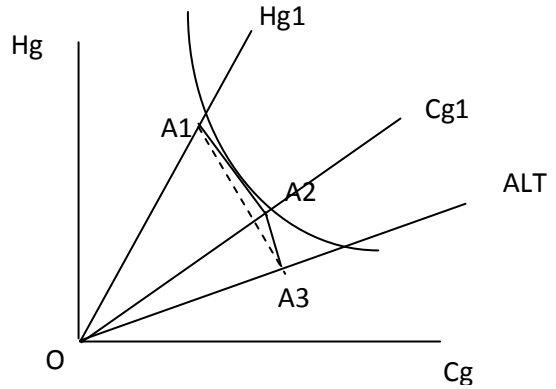
[4] In this case we assume that we are starting from equation *(1)* and there is no adverse impact on the health production function in quadrant *II*.

Figure 7: The effect of ALTs



However, the market for ALTs seems to be under-developed, why may this be the case? Returning to the Lancaster (1966) (Figure 8) framework it is possible to consider the introduction of a new good. In this case ALTs. In the model goods are bundles of attributes, in this case the attributes are health care and social care. Firstly, we assume that ALTs provide more of the social care attribute than either of the other goods. In this case we introduce a new ray on our figure (*OALT*).

Figure 8: Introduction of ALTs



If the individual purchases *Hg* and *Cg* the efficient frontier is *A1A2*, if they purchase *Cg* and ALT is it *A2A3*. If the consumer purchases *Hg* and *ALT* then it is *A1A3*. So at current prices, if the consumer spends all their income on ALTs they can purchase *A3*. We can also see that the individual will never purchase all three goods. Furthermore, the individual will not purchase combinations of *Hg* and ALT

because this frontier (*A1A3*) lies within the *A1A2A3* frontier. The consumer will purchase either *Hg* and *Cg*, or *Cg* and *ALT*.

At the current prices and the current preferences, as given by the indifference curve, the consumer will purchase combinations of *Hg* and *Cg* and none of the ALT good. In this case the price is too high. At lower prices *A3* would move out to the right and it may be possible to find multiple equilibria where there are feasible bundles of *Hg* and *Cg* and *Cg* and ALT between which the consumer is indifferent.

Alternatively one could recast the Lancaster formulation to consider the introduction of ALTs compared to other care goods. In this case the attributes would be the different social care attributes provided by care goods, such as independence, peace of mind, dignity, social interaction etc... Each of these attributes will have an implicit price πj. The key for firms is to find the value of the implicit prices for the attributes, perhaps from market data or from discrete choice experiments, which will provide the maximum price the ALTs could be sold at. The problem may be that the valuation of the attributes is weighted in favour of other social care goods. For example, one issue surrounding ALTs may be the fact that they reduce the need for social interaction by reducing visits to the doctor, or by reducing the need for home helpers. This may mean that consumers are always more willing to purchase goods providing the social interaction attribute, regardless of how low the price of the ALT.

Discussion

This paper has considered a framework where there are two goods, a health good and a care good. In order to understand the problems associated with ageing we have considered how individuals may combine these two goods in order maximise their benefit. We have shown how it is possible, even when faced with technical efficiency, to have a suboptimal combination of health and care. Combinations may be on the utility frontier but the marginal rates of substitution are not equal, so by reallocating their budget, so consuming less of one good and more of another, it is possible to achieve a better outcome, demonstrating the need to consider health and care as complements and not substitutes. However, it may be the case for social decision makers with fixed budgets, especially where the care budget is much less than the health budget, that they are treated as substitutes.

We have also demonstrated, using this framework, how the ageing process may impact on the way that health and care are viewed as substitutes or complements. Care is more important as individual's age. Health goods become less productive through ageing; individuals need more in order to maintain a given standard of health. This approach would be in line with health production models, such as those suggested by Grossman (1972) where individuals require an increasing investment in the health stock in order to maintain the level above the death stock. Such an approach highlights the increasing importance of care and how individuals would shift towards increased care, and less health, as they aged. Consumers are willing to give up health goods in order to obtain more care goods that have a higher marginal benefit.

The problem for consumers is that often, as they age, they are required, or the incentives are such, that they consume more health goods. In fact there may be an over consumption of health goods, especially if there are negative externalities that arise from the increased burden on the public purse. Again, health goods are acting as substitutes for care goods, rather than complements.

The use of a production framework also allows the consideration of the attributes of the health and care goods. In this paper this has been simplified to two attributes, health care and social care.

Approaching health and care in this manner allows the recognition that they are derived demands and that health and care both provide the attributes, just in different proportions. Substituting health for care is possible because health goods provide the attribute social care, although not to the same extent as care goods. Likewise, it would be possible to substitute care for health because care goods also provide the attribute health care but not to the same extent as health goods.

Using the attributes framework it is possible to demonstrate how corner solutions may occur, especially those where individuals only consume the health good. If the health good did not provide the social care attribute such corner solutions would not be possible. Pricing care goods is vital; if they are too expensive then consumers will purchase more health goods, perhaps to the complete exclusion of care goods.

The analysis has been developed further in order to consider the role of ALTs. These may be a method for relieving some of the burden of an ageing population. ALTs could be viewed as improving the technology and increasing the marginal benefit of care goods.

Market failures

One issue that has not been considered here, but has been widely discussed elsewhere is that of market failure (for an example for long-term care see Wittenberg et al (2002)). In a perfect market age provision would be tackled through insurance, for both health care and social care. An individual who is going to live longer would consume less now, save more and smooth consumption through time. This process occurs because individuals value consumption in the future more than they value consumption now. However, ageing is an uncertain process and in the presence of uncertainty risk-averse individuals will purchase insurance in order to maximise utility. Actuarially fair insurance will provide the risk-averse agent with security in the future and protect against adverse outcomes. Insurance may be bought for health care, for long-term care, and, in the case of pensions, by the purchasing of annuities. The difficulty is that, due to market failure, there are problems in all of these insurance approaches.

At the heart of the problem are information asymmetries. There is a potential problem of adverse selection where individuals may have knowledge about their potential need for long-term care which the insurer is not aware of. This creates a problem at the heart of pooling risks for insurers. If insurers set their premiums at a level for a fair premium based on the average risk of needing care, then individuals who have knowledge that they are above average risk will purchase the insurance, while individuals who are below average risk will not purchase insurance. This leads to the average risk of the insured increasing, pushing up premiums. This same process continues until only those at highest risk are insured, and the costs of meeting the needs of these individuals are too great for the insurance companies to cover. The problem of moral hazard is less likely to be an issue, although it depends on the structure of the insurance policy.

A further issue for adult social care is an inter-temporal issue where the events being insured against occur a considerable time after the insurance policy is taken out. Even if insurance is offered at the age of 65 it is possible that social care will not be needed for 15-20 years or more, this means that it is difficult for insurance companies to assess potential costs. In fact if life-expectancy is increasing as well over this time then the projections could be very wide of the mark. If insurance is offered at 40 then this time period could be 50 years hence, making it even more difficult.

A further problem with insurance is that it may not provide any encouragement for cost-containment. Having a third party payer means that there is no incentive to adopt efficient practices, it is possible to shift the cost to the private sector. Like health care there are considerable issues in information gaps. There is heterogeneity and market power among providers of social care making it difficult for individuals to make choices. It is difficult for individuals to ascertain and differentiate

between the benefits the services the various providers offer and large segments of the market are dominated by non-commercial organisations exerting near monopolistic powers in terms of price or quality of service provided. There are problems regarding information around the demand for unfamiliar goods. In classical economics it is considered that individuals are the best judge of their own welfare but in terms of social care it is often the decisions of others which matter. Informal carers are an important part of social care. It is often the availability of family and friends, and their willingness to contribute which affects the use of more expensive residential care. This creates problems for the incentives behind any funding system, especially where the person needing care has assets. The problems of overlapping generations, and the problem of increasing house prices has increased the importance of bequests. Furthermore, the classical model takes no account of cognitive decline in assuming that an individual is their own best judge.

Another issue that has not been raised is the problem of informal carers. It may be that care goods are largely consumed outside of the market with, in essence, charitable giving crowding out market goods. Care, and the attribute social care, can be provided by informal carers. So consumers may not substitute away from care to health goods but they may substitute care goods for informal care. Informal care provides the attribute social care, and it may do so at a lower cost than the market is able to provide this attribute. Further, informal care may provide positive externalities and reduce the cost of care for the ageing population. It has been estimated in evidence to the Dilnot commission, Casey (2011), using human capital valuation, that informal care is equivalent to 1.4% of annual GDP and that 0.8% of GDP is forgone by informal carers non participation in the labour market, based on estimates by Leontaridi and Bell (2001) and Henz (2004). In fact at the interaction between consumers and informal carers there may be opportunities for technologies such as ALTs. If ALTs can help informal carers they may be an important method of helping both the ageing individual and their informal carers.

A further level of complexity and market failure in this area is added by the possible presence of supplier induced demand. A key assumption of perfect markets is the independence of the utility functions of suppliers and demanders. However, in the area of health care it has always been suggested that supplier induced demand is a considerable problem (Labelle et al., 1994). The problem may be that the costs of the ageing population are confounded by the presence of supplier induced demand, and that the (potential) over consumption of health care by individuals is physician led and not patient driven. Birch et al. (2013) use data for England and suggest that the ageing population is not the driver behind increasing health care use, but supply. Any models of costs need to account for these potential confounders. Our framework has been and results have been developed assuming that supplier induced demand is not a problem.

Conclusion

This paper has provided a framework for considering health care and social care as complements and substitutes. We have approached this through two production mechanisms. The first approach follows the model of Lancaster and considers health care and social care as attributes provided by goods. This approach is insightful because it highlights why and how health and social care become substitutes, and further, demonstrates how individuals may end up consuming sub-optimal combinations of health and social care. In the presence of subsidised health care individuals will over-consume health care and under consume social care. This is partly made possible because health goods provide the attributes that care goods provide.

The second framework uses the individual health production model of Grossman. In the model health care and social care are considered only in the goods space (not attributes space). However, it

is possible to demonstrate how, even in the presence of technical efficiency, in the sense that the individual is on their highest utility frontier, it is possible to have inefficient allocations of health and social care. Further, within this framework it is possible to consider how the ageing process may impact on the individual's ability to transform health and social care goods into utility, and how the individual would increasingly prefer social care to health care.

Within this framework we also introduce technology in the form of assisted living technologies (ALTs). There has been an increasing focus on the use of these technologies to aid the ageing process. We demonstrate, using the Grossman approach, how these technologies may benefit the ageing process by increasing the marginal product of social care. We also demonstrate, using the Lancaster framework, why ALTs may not be able to obtain a presence in the market - they are crowded out by the presence of health care and social care which has a large state provision.

This analysis is conducted against the background of market failure in the health care and social care. Both areas face considerable problems because of the presence of asymmetric information. The key driver behind the cost of ageing is found in the interdependence between the utility functions of the supplier and demanders of care. We have highlighted the fact that evidence exists that suggests that the use of health care is increasing at a faster rate than need in the population (Birch et al, 2013). This factor is one of the major cost drivers for ageing care and is a further reason why health care is a substitute for health care. However, our contribution demonstrates how, even from the demand side, such problems may arise.

This analysis suggests that there are considerable efficiency gains to be made by allowing individuals to have greater autonomy over their choice of care. Hall and Jones (2007) suggest that as individuals become wealthier it is beneficial for individuals to purchase additional years of life, people become saturated in non-health consumption and the marginal utility from extra years of life is higher than for other consumption possibilities. If individuals are to purchase more years of life it is important to have well functioning markets and clear information that allow individuals to choose the optimal bundle.

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