Traditional Chinese medicine and species endangerment: an economic research agenda

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Abstract

The debate about Traditional Chinese Medicine (TCM) and species endangerment has generally focused on the species themselves and their role in the TCM pharmacopeia. There has been little research on the economics of TCM and its implications for species endangerment. Yet in China, the rapid transformation of the economy and the associated increase in the purchasing power of Chinese consumers mean that, left to its own dynamics, the market pressure on medicinal species for TCM will grow over the coming years. While the pressures themselves may be unavoidable, further research may contribute to mitigating the impacts. Based on discussions held at a workshop in China in 1997, this paper identifies some key issues regarding the relationship between the demand for TCM and the endangerment of medicinal species. It also proposes a research agenda in the economics of TCM which may go some way towards identifying options for alleviating the economic pressure on endangered species.

Abrégé

Jusqu'à présent, le débat sur la médecine traditionnelle chinoise (MTC) et la mise en danger des espèces est resté généralement centré sur celles-ci et sur leur place dans la pharmacopée de la MTC. On ne s'est guère penché sur les aspects économiques de la MTC et sur ce qu'elle implique quant à la mise en danger de la faune et de la flore. En Chine, pourtant, la transformation rapide de l'économie et l'augmentation concomitante du pouvoir d'achat des consommateurs chinois sont telles que, livrées à leur propre dynamique, les pressions du marché s'exerçant sur les espèces à usage médicinal utilisées en MTC ne feront que s'intensifier dans les années à venir. Si ces pressions sont sans doute inévitables, un surcroît de recherche pourrait contribuer à en mitiger les impacts. Basé sur les discussions qui se sont déroulées lors d'un atelier organisé en Chine en 1997, ce document identifie certaines questions-clés concernant les rapports entre la demande de MTC et la mise en danger des espèces à usage médicinal. Il définit aussi un programme de recherche en économie de la MTC pouvant contribuer à l'identification d'options proposées pour soulager la pression économique subie par les espèces en voie de disparition.

Resumen

El debate acerca de la medicina tradicional china (MTC) y las especies en peligro se ha ubicado generalmente alrededor de las especies mismas y de su papel en la farmacopea de la MCT. Ha habido muy poca investigación sobre el aspecto económico de la MTC y sus implicaciones para las especies en peligro. La rápida transformación de la economía china y el creciente poder adquisitivo de los consumidores apuntan, sin embargo, a que si se permite que este proceso siga su propio curso, la presión del mercado sobre las especies medicinales de la MTC aumentará en un futuro cercano. A pesar de que sea imposible evitar dichas presiones, un mayor esfuerzo investigativo puede ayudar a mitigar sus impactos. Esta monografía se basa en las discusiones que tuvieron lugar en un taller en 1997 en China, y señala los aspectos claves de la relación entre la demanda por MTC y las especies medicinales en peligro. También se propone aquí el establecimiento de una agenda de investigación relativa a los aspectos económicos de la MTC, que pueda ayudar a identificar opciones que alivien la presión económica sobre las especies en peligro.

Contents

Introduction

It is well established that traditional Chinese medicine (TCM) draws on a significant number of species of plants and animals that are rare or endangered[1]. Yet, TCM plays an integral role in Chinese culture. These two factors point to two equally problematic outcomes. The pressure of demand for certain species will push them towards extinction. On the other hand, attempts to protect species may conflict with essential Chinese values regarding the provision of health care. Clearly it is in the interests of both conservation and TCM to develop approaches to this problem that are effective and which respect the needs of each. To this end, a better understanding is required of the economic forces which are driving the demand for materials from rare or endangered species.

Until recently, several factors have tended to limit the impact of TCM on rare and endangered species. Many species were found in China or neighbouring countries, and for several years China had a limited exchange with more distant countries. But more recently this has changed as has the ability to harvest desired species at a global level. Some indigenous social constraints which may have helped conserve certain species will not necessarily apply outside of China. Hence, the pressure of demand will be influenced by other factors, such as the technical ability to harvest the resource, and economic factors that render the resource valuable.

The technical issues of accessibility and transportation have been addressed on a global scale: it is possible to seek valued materials wherever they may occur and to make them available to consumers of TCM services. In the absence of social safeguards based on culture or property rights, it is hard to conceive of a living resource that would not be pushed to extinction, given the appropriate economic incentives.

Some species that are otherwise endangered in their natural habitat, in particular rhinos and tigers, have experienced significant additional pressures from TCM. Addressing these pressures has become an integral part of the complex puzzles of endangerment and the measures to counteract it.

With rapidly growing wealth in China itself, the dynamics of the market for TCM are now rapidly changing. A market of more than 1.2 billion people with increasing disposable incomes, has the ability to sweep up the remaining individuals of key species, no matter what the market price. The traditional instruments for addressing endangerment, such as a hierarchy of domestic measures supported by major international conventions, on biodiversity (CBD) and on international trade in endangered species (CITES), risk being overwhelmed by this new factor. Efforts to uphold conservation measures that have so far barely managed to protect some of these species, also need to be more aware of the economic dynamics of demand for TCM preparations.

[1] A workshop was organised in May 1997 in Beijing to develop an economic research agenda on TCM and endangerment. This paper incorporatesm without individual attribution, information that was provided at that seminar, which was attended by representatives of the Chinese Academy of Sciences, the Chinese Academy of Social Sciences and the Chinese Academy of Traditional Chinese Medicine.

Growing income inevitably leads to increased demand for medical services, and in the case of China in some part for TCM services[2.] Nevertheless the situation in China is far more complex and merits much closer attention and analysis:

- The existence of alternative systems of medicine in the country represents a unique analytical challenge. Nowhere else has an 'alternative' form of medicine managed to survive as an effective competitor to the growth of 'western' medicine..

- The relationship between the demand for TCM in general and the demand for TCM pharmacological products is presumably different to the comparable relationship in 'western' medicine. In particular, the growth in demand for western medicine is driven, at least in part, by a conventional process of 'innovation' focused largely on instrumentation and pharmacology based on economic incentives derived from intellectual property rights. No such dynamic exists within the TCM system.

- The existence of a substantial informal market for TCM alongside the officially organised and recognised structures. This market serves both an informal but professionalised medical sector and uses that are privately determined, such as tonics and cosmetics.

This paper is the result of discussions held at a workshop in China in 1997. The primary objective of the workshop was to identify the salient issues regarding the relationship between the demand for TCM and endangerment that require further economics research and to outline some research hypotheses.

2 See below

Traditional Chinese Medicine

Traditional Chinese medicine[3] draws on a broad knowledge base acquired over centuries about the medicinal properties of materials derived from a large number of plants and animal parts. Systematic lists of these materials exist; and currently number over 7,000 plants and numerous animals. However, these figures are constantly changing as continued and large scale research in China produces a constant stream of data on species and their medicinal properties. These materials are combined into preparations for certain ailments, frequently reflecting the insights and experience of individual practitioners of TCM. The lack of a standardised system of application of TCM preparations gives even the relatively well-organised official system an informal character in the sense that variations can and do occur between individual practitioners.

TCM is characterised by a strong tradition of preventive medicine. This makes it difficult to draw sharp distinctions between medical interventions which treat specific ailments with a clearly defined etiology, and measures for health maintenance and general well-being. Both strict medicinal applications and a broad range of preventive practice, including those designed to promote general well-being, draw on the same body of knowledge and on the same set of materials.

Over the past few decades, TCM has experienced several traumatic shocks. Medicine in general is intricately dependent on the society which supports it (Unschuld, 1985: 249), and this is particularly true of TCM. The transformation of Chinese society during the 20th century has been paralleled in the traditional system of medicine. The collapse of imperial China forced traditional Chinese medicine to establish a new ideological legitimacy.

> "*Despite the clear preference of Marxist thinkers for natural science and scientific therapy during the 1920s, 1930s, and 1940s, the fate of traditional medicine had by no means been determined when the Communists assumed power in China in 1949. Only seventeen years after the Marxist T'an Chuang had termed Chinese medicine the 'collected garbage of several thousand years' in 1941, Mao Tsetung formulated his famous dictum of 1958: 'Chinese medicine is a great treasure-house! We must make all efforts to uncover it and raise its standards!' Western secondary literature generally suspects the reasons for this rehabilitation of those elements of medical tradition that—unlike demonic medicine and Buddhist temple medicine—were not disqualified from the very beginning as 'superstition' and thus remained outside the bounds of discussion, to lie in quantitative considerations by the Chinese leadership. Indeed, until recently, modern medicine—in part because of the still relatively small number of its practitioners-was unable to offer the entire Chinese population one or another form of health care*" (Unschuld, 1985: 251-252).

[3] TCM is one of many systems of traditional medicine found worldwide. It is rooted in Chinese history and culture and should distinguished from other systems of traditional medicine, such as Tibetan. Other systems of traditional medicine also draw on plants and animals that are rare or endangered but TCM is by far the most widespread and is distinguished by its level of organisational detail (see below).

Over the first 35 years of Communist Party rule, the number of doctors of western medicine expanded each year while the numbers for TCM rose slowly until 1961, then declined by more than a third to 1972. By 1982 they had recovered to 1952 levels (World Bank, 1985: Table C-10). The market reforms of the past decade have put traditional and 'modern' medicine on a more directly competitive footing within China.

There are many ways to assess the effectiveness of a system of medicine, none of which is conclusive. Using average life expectancy as a criterion, the current Chinese mixed system is essentially as successful as western technology-based medicine alone. However, using the incidence of particular diseases that are typical indicators of health problems within a population as a criterion, the picture is much less clear. There are some indications, however, that the incidence of these diseases is related more directly to nutritional status and conditions of hygiene, that is to preventive measures, than to the level or type of medical services provided. Yet, in the case of TCM, other criteria, such as simple popularity are also valid. The point is that it is used, popular and gaining in subscribers, regardless of its 'efficacy' as deemed by western medicine. This is illustrated by the fact that about one third of the world population - more than 2 billion people - relies on the knowledge of traditional Chinese medicine for its health services.

The Organisation of TCM in China

In China alone there are an estimated 2,200 traditional medicine factories, employing 460,000 people (Mainka and Mills, 1995: 194). TCM is well organised and tightly supervised by the state through the State Administration of TCM (SATCM) and the State Pharmaceutical Administration (SPAC), both of which are part of the Ministry of Public Health. The SATCM oversees the TCM enterprises, production equipment, research institutes and hospitals. SPAC oversees pharmaceutical production (including registration of materials and preparations), medical instruments and pharmaceutical production equipment. This structure represents the formal market for TCM.

There is a sharp distinction between urban and rural health care in China, particularly regarding the balance between TCM and western medicine provision. In urban areas, medical services are mainly hospital based and western medicine predominates; average health care expenditures are approximately Rmb 90 ($11 at 1996 exchange rates) per person per annum. In rural areas, primary medical care is provided by more than 1.3 million village doctors (previously known as 'barefoot doctors') who draw largely on TCM. In addition, hospitals are less accessible and average health care expenditures are much lower at Rmb 10 ($1.20) per person per annum (Natural Medicine Marketing, 1996: 31). Given the differences between urban and rural incomes, the divergence is less pronounced but still significant with respect to expenditures as a proportion of income. Overall, about 40 percent of all health care expenditures in China flows to TCM but, because of the rural/urban difference, this amount represents a much larger share of the client base, and may be in excess of 50 percent.

Alongside the formal, state controlled market for TCM there is a large informal market for related products derived from the same materials. This market is determined by the existence of health practitioners outside the formal health care system and by the blurred distinction between TCM products for medicinal uses to treat specific ailments, preventive medical practice, health maintenance and general well-being. Much the same materials are used in all of these areas, albeit in varying forms, mixtures and concentrations. The formal, state-controlled product chain for the provision of TCM materials also supplies this informal market; in addition, however, there exist product chains outside these formal markets, which are capable of providing even banned materials.

It is possible that certain TCM materials - tiger bone for example - have been banned from the formal structure of TCM and still continue to play a significant role in other sectors of the market for TCM materials. Similarly in the case of materials that are supplied to the formal market from cultivation, farming, ranching or even from synthetic sources, the informal market may continue to generate significant demand for products taken directly from the wild. Finally, the informal market may generate demand for materials not prescribed in TCM but which have cultural significance.

Very little is known about the dimensions and dynamics of the informal TCM market, not least because much international interest in TCM is directed at its medicinal and therapeutic value and the prospects for learning from it, rather than at the sources of supply for materials. Research on the size and dynamic of the informal market is clearly a high priority for understanding the threats posed by the demand for TCM on medicinal species.

In general not enough is known about the composition, volume, value and trends in the demand for medicinal plants and animal parts in Asia. Approximately 1,000 medicinal plants are in common use, and of these 30 account for about half of total demand (Natural Medicine Marketing, 1996: 51). There are eight major markets where TCM materials are traded in China**.** No reliable information is currently available on price trends although this is a vital indicator of changing supply and demand, and of the existence of efficient markets for TCM materials.

Total demand for materials from medicinal plants is estimated at 1.6 million tonnes per annum. Without information on specific materials, this aggregate figure, while impressive, does not provide much insight on the impact on species and particularly species loss. Of this only approximately 0.3 million tonnes are cultivated. Information in this area is similarly not very reliable:

"*The private traders at the medicinal materials market in Chengdu advised that the majority of the material was wild harvested although their supervisors advised that most was cultivated. We surmise that the official line is that 'most is cultivated,' but in reality this is probably not the case. The issues of endangered species and overharvesting make this a delicate area and it is difficult to give an accurate assessment*." (Natural Medicine Marketing, 1996: 50-51).

The price of wild harvested materials is higher than that of cultivated materials yet the market for the former is larger. This suggests that, at present, cultivated materials are viewed by many market participants as a supplement to the wild species rather than supplying basic demand. The ability to distinguish reliably between like products from different cultivation is vital to any regime to adequately manage the risks of endangerment associated with TCM. This need creates the potential for major conflicts with the current interpretation of international rules governing trade within the World Trade Organization.

Some commonly used plants are already listed as threatened. Less obviously, TCM materials are to a very large extent of plant origin, with only a limited number of materials derived from animals playing a significant role in TCM. In the area of plant materials, the principal concern focuses on interference with propagation, either because roots or rhizomes are the desired part of the plant or because harvesting occurs before flowering. However, endangerment to animals has probably been a greater concern for TCM since more media and campaigning attention has been paid to animal species. A variety of strategies exists to protect plant species, provided they are adopted.

The Supply of TCM Materials

Collection

Initially most medicinal materials were gathered from the natural environment, except where plants or animals were cultivated for other reasons, eg for nutrition or building materials. Medicinal use, particularly in preparations often involving small or diluted amounts, may not generate high volumes so that gathering materials seems a reasonable strategy. Medicinal uses will, however, generate relatively high value, which creates incentives to expand supply. Given the wide range of materials involved in TCM, collection from the natural environment remains the dominant strategy for supply. Many materials are used in limited amounts, making controlled production uneconomic.

Cultivation

Cultivation is one way to reduce overexploitation of naturally occurring resources and the risk to the supply of materials. Approximately 200 plants are currently cultivated for TCM materials. The figures on this sector of the economy are contradictory. In 1995, total planted area was estimated at almost 1 million acres, an increase of nearly 25 percent over the 1990 figures. At the same time, the number of farmers engaged in this sector is estimated at 13,000, for an average of 79 acres per farmer. Assuming the SATCM figures for total planted area are roughly correct, the number of farms involved is presumably higher than 13,000 and the number of farmers employed higher by at least one order of magnitude (Natural Medicine Marketing 1996: 50). The fact that figures for the most formalised market segment leave room for doubt suggests that all figures concerning volume and price need to be treated with some degree of caution.

Cultivation is attractive for economic reasons, provided that the volumes are sufficient to warrant the infrastructure necessary for distribution. In most instances, cultivation of plants for medicinal uses will deliver one of the highest levels of added value per unit of production inputs, whether land, water or labor. On the other hand, the cultivation of medicinal plants requires both technical skill to meet quality standards imposed by the SATCM and generally involves significant marketing effort. There are only a limited number of official markets for TCM materials, so supplying these requires access to the necessary information concerning demand and to infrastructure to ensure that products reach the market in acceptable condition and in a timely fashion.

Captive breeding

For breeding purposes, animals are kept in an artificial and managed environment, sometimes fenced or caged, but also open spaces akin to the natural habitat. Taking the desired species generally involves slaughter or a continuous extraction process, as for musk oil or bear bile. Captive breeding provides the greatest control and potentially reduces the risk to natural populations, although both may be sourced simultaneously. However, captive breeding can be demanding in terms of maintenance requirements. It also poses a number of issues that exist in all captive breeding situations, including the size of the containment, access to air and sunlight, the size of populations, the feeding regimes and the methods of slaughter or extraction. Moreover, unless rigorous controls are in place, the existence of a product stream

from captive populations creates opportunities to launder materials from wild populations, so that the pressure on wild populations continues.

Ranching

Ranching involves the management of populations in the wild to achieve certain goals, such as to increase populations or to permit culling. While ranching typically involves the least interference with naturally occurring populations it also provides the least control. It also exposes valuable species to poaching.

Each of these methods for supplying TCM materials poses particular issues of policy. In addition, the management regimes for animal species are almost always more complex than for plants since they involve containment, feeding, propagation and extraction of the TCM materials. In principle, however, there are few TCM materials that cannot be obtained under controlled conditions, provided the economic incentives are right. As these product chains develop, however, the risk of laundering wild harvested materials increases as well.

The prospect for increased international trade in TCM materials raises a significant issue since the WTO regime is currently entrenched in an interpretation of the underlying agreements that excludes distinctions between otherwise 'like' products by their process and production methods. It is difficult to conceive of an international trade regime for TCM that does not include a reliable, internationally recognised system for ensuring that distinctions between harvests from the wild, ranching, farming, captive breeding and synthetic alternatives can be maintained even when materials are chemically and physically indistinguishable, that is 'like'. At present China and Taiwan are not members of the WTO, but South Korea is. Significant markets for TCM materials exist in other countries that are members, notably Indonesia, Malaysia, Thailand, Canada and the Us. It is important that the issue of process and production methods for TCM materials be addressed in relation to the WTO regime in a timely fashion.

Income and Demand for Medical Services

Increases in income generally lead to increased demand for formal health services. This relationship has been well established in OECD countries. While the same may be assumed for non-OECD countries, transferring data from developed to developing countries, particular for demand elasticity, is extremely problematic. There are several factors that compound the complexity of this issue and which require a more contextualised analysis[4.]

The demand for health care: the theory

The most influential model of the demand for health care is the health capital model developed by Grossman (1972). This model is based on the theory of the household production function. The starting point of Grossman's model is that health care is not a direct argument of the utility function. Instead, the individual's utility is assumed to be a function of goods and services consumed and 'good health'. Thus, the individual does not demand health care as such, but rather demands 'good health'. Health is demanded for two reasons. First, as a consumption commodity, it is a source of direct utility. This is the opposite of saying that sickness is a source of disutility. This is known as the pure consumption model. Second, an individual's health state determines the time available for earning income. This is known as the pure investment model.

An individual's health, or health capital as Grossman calls it, is assumed to be a function of a number of 'health inputs' one of which is health care. Other health inputs include eg diet, eating, smoking habits, environmental variables (air quality), and exercise. The relationship between the individual's health capital and the health inputs is the so-called health production function. The demand for health care is a derived demand. The individual does not demand health care for the sake of health care, but rather the demand for health care follows indirectly from the fundamental demand for good health.

One of the assumptions of the model is that an individual's health capital 'depreciates' with age. However, by investing in health, for example through health care or any of the other health inputs an individual can, up to a certain point, compensate for this depreciation. When the individual's health capital falls below a certain critical level, he or she dies. Thus, age is endogenous in the model; up to a certain point, individuals can determine their own age. A second assumption of the model is that more highly educated people are more efficient producers of health. That is, with the same amount of health inputs they are able to produce more health.

For the rest, the model is fairly standard. The individual is assumed to maximise utility, which is a function of consumption and health (capital), under the restrictions imposed by the budget constraint and the health production function. A neat graphical analysis of (a static version of) the model is given by Wagstaff (1986) and is reproduced in Figure 1. The first quadrant shows the individual's indifference curves. The shape of the indifference curves illustrates that the model assumes that the individual can and does make a trade-off between

4 The country distribution of studies in this area appears almost random, reflecting the presence of an analyst interested in these issues, the availability of resources to support the work and the ability to generate meaningful data.

health and consumption. Health, in other words, is not sacrosanct. Some might object to this and reply that to most people, health is the most important thing in their lives. Undoubtedly, to most people health is indeed a very important matter. However, one only needs to look at peoples' everyday behaviour, for example, eating, drinking and smoking habits, to observe that many people knowingly put their health at risk every day. The assumption of some kind of trade-off, however small, between health and consumption thus seems reasonable. The second quadrant shows the health production function. As can be seen, an individual's health is an increasing function of health inputs, and the health production function is assumed to exhibit diminishing marginal returns to health inputs. The third quadrant shows the familiar budget constraint.

Figure 1 The demand for health and health care

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One can now trace out all the combinations of health and consumption that are available to the individual given budget constraints and the health production function as follows. Suppose the individual buys three units of health inputs. Using the health production function in the second quadrant, this gives 3.5 units of health, which is transferred to the health axis in the first quadrant. Using the budget constraint in the third quadrant it can be seen that consuming 3 units of health inputs leaves the individual with enough income to buy 1.6 units of consumption. Using the 45 degree line in the fourth quadrant, this is transferred to the consumption axis in the first quadrant. This way one gets one possible combination of health and consumption that the individual can choose from given the health production function and budget constraint. By repeating this procedure for all levels of health inputs, one can trace out all combinations of health and consumption the individual can choose from. This gives the curve joining points a, b and c in the first quadrant. Under the assumption of utility

maximisation, the individual will choose that combination that puts him on the highest indifference curve attainable. The individual will thus choose point a.

The prediction of this model for the effects of a rise in income are not very surprising. An income rise will result in an increased demand for health and for health care. Higher education, which is assumed to increase the efficiency with which the individual transforms health inputs into health, will result in a higher demand for health, but at the same time is likely to result in a lower demand for health care. This is because of the increased efficiency in health production. Note, however, that higher education is usually associated with higher income and that the end result of higher education may well be an increased demand for health care.

While this is a fairly straight-forward model for a developed market economy, its application to other societies raises numerous issues, particularly the functioning of economic institutions, the ability of individuals to exercise choice and the social and cultural context within which health care is delivered and utilised.

Income and the demand for health care: empirical results

The strength of the association between income and demand for health care is measured by the income elasticity of demand, which is defined as:

$$\text{income elasticity} = \frac{\text{percentage change in quantity of health care demanded}}{\text{percentage change in income}}$$

If the income elasticity is larger than 1, this indicates that an increase in income results in a more than proportionate change in the quantity of health care demanded. For example, if the income elasticity of the demand for tiger bone would be 2, then a 1 percent increase in income would lead to a 2 percent increase in the quantity demanded. In terms of endangerment, the pressures on the remaining populations would more than proportionately increase with rising income. For products, which are currently available - whether legally or illegally - and risk endangerment, the challenge of conservation is to achieve an income elasticity that is negative, at least as far as wild harvested materials are concerned.

A good with an income elasticity greater than 1 is called a luxury good, a good with an income elasticity smaller than 1 a necessity. Luxury goods are termed as such because a value of the income elasticity greater than 1 implies that the share of income spent on this good will increase with an income rise. However, this definition of a luxury good is purely a technical definition, and does not necessarily correspond with everyday use of the words. So while many studies find an income elasticity for health care greater than 1 – ie, a luxury good - most people would not regard it as such.

Studies that have attempted to measure the income elasticity for health care can roughly be divided between macro-economic and micro-economic studies. The former usually make use of data from a cross-section of countries. They relate national (or per capita) expenditures on health care to national (or per capita) income and thus derive an income elasticity. The latter employ data on health care expenditures and income at the level of an individual or household.

There is a striking difference in the results of these two types of studies. While the macro studies consistently find a very high income elasticity (usually well above 1), the micro studies usually find very small or no income effects on health care demand. The most obvious explanation lies in the effect of insurance. On the level of the individual, insurance means that the individual's demand for health care is not restricted by his income. He or she only has to pay the insurance premiums, and from then on all costs for health care are covered; his or her income does not represent a real constraint on consumption of health care. On the national level, however, this shifting of costs is not possible. The nation as a whole has to face the full costs of medical care.

Below we will briefly discuss the results of the macro studies and the micro studies. The next section will then discuss in more detail the results of a study of the demand for health care that was carried out in China.

Results for developed countries

Macro studies.
Most of the macro type studies of the income elasticity of demand for health care have made use of cross-sectional data from (a sample of) OECD countries. Using cross-sectional data from 13 countries, Newhouse (1977) found that 90% percent of the variation in per capita medical expenditures could be explained by variation in per capita Gross Domestic Product (GDP). Income elasticities are in the range of about 1.15 to 1.3, depending on per capita GDP[5.]

Parkin *et al* (1987), criticise Newhouse (1977) and similar studies on a number of grounds and provide some new evidence. Instead of using conventional exchange rates to make expenditures comparable across countries, they make use of Purchasing Power Parities (PPPs). They show that, for their data set, this results in a drop of the income elasticity from 1.12 to 0.90. They further criticise the use of what is essentially a micro-economic theory on macro data, making it hard to interpret the results correctly. They show that the choice of functional form can have a dramatic impact on the results, and point out that certain functional forms will always result in an income elasticity greater than 1 no matter what the value of the real income elasticity.

Milne and Molana (1991), like Parkin *et al* (1987) use PPPs and also include a relative price variable in their analysis. Although they find an income elasticity well above one, their results for the coefficients for the income and the relative price variable imply that the income effect is largely compensated by the price effect. That is, the more than proportionate income effect is compensated by a rise in the relative price of health care. In real terms, then, the income elasticity may well be close to 1.

Saez and Murillo (1994) show that PPPs might not be an appropriate deflator for medical expenditures either, and derive their own price index. Using panel data from a number of EU countries they estimate a long run income elasticity at or around unity. Like Milne and Molana (1991), their results show the importance of relative price effects. Interestingly, they also indicate that the income elasticity is higher for lower income than for higher income countries. If this can be generalised, it implies that for developing economies such as China,

5 Income elasticities are in general not constant over the whole range of income

the income elasticity should be over 1. However, this finding might well be a result of the functional form they have chosen for their regressions. As Parkin *et al* (1987) point out, a linear functional form will always result in lower income elasticities for higher income levels. On the other hand, the fact that Saez and Murillo used panel instead of cross-section data might have counteracted this effect.

Micro studies

Studies based on micro level data typically find much lower income elasticities than the macro level studies, and some even find that income has no effect at all. The RAND Health Insurance Study (HIS) is usually regarded as one of the best studies of the demand for health care in developed countries. It found an income elasticity of around 0.2-0.3. However, it should be noted that income effects can vary considerably with coinsurance rate, with lower coinsurance rates resulting in lower income elasticities.

Evidence for developing countries

There is much less empirical evidence regarding income elasticities in developing countries. There are some micro based studies, but often these do not report separate income elasticities. Firstly, income is hard to measure in low income countries. To overcome this, income is often approximated by total consumption (total monetary expenditures plus the value of home production). Secondly, income is often interacted with price or other variables measuring the costs of obtaining health care and no separate coefficient for income is estimated. This is because in many cases the objective of these studies is to estimate the price elasticity of demand in order to estimate the effects of user fees or time costs on utilisation.

Musgrove (1983) uses standard household income and expenditure surveys to derive income elasticities for private health care spending in Latin America. Elasticities for total health care spending (except private health insurance) in five countries ranged from 0.81 to 1.34, indicating that health care spending is fairly elastic with respect to income. Using data on mean spending per income quartile for 10 cities, he obtains an income elasticity of 1.5. More detailed data from a Brazilian household survey gives an income elasticity of 1.17. A problem with all these elasticities is that the data do not correct for any public reimbursement and thus overestimate true expenditures by households. Another finding of the study is that not all components of health expenditure show the same pattern. Drugs and medicines tend to saturation with rising incomes. That is, the income elasticity is not constant but declines for higher incomes. However, as Musgrove points, out this might be due more to differences in availability of drugs in high and low income regions than to true differences in income elasticities.

Ellis *et al* (1994) use household survey data to analyse the demand for in-patient and out-patient medical care in Cairo, Egypt. From the survey results they estimate a simple income (or rather expenditure, because income was approximated by total expenditure) elasticity of demand for health care of 0.55, that is, substantially less than 1. Note, however, that this income elasticity does not correct for insurance or any other effects from other variables influencing demand for health care.

Most studies of the demand for health care in developing countries use so-called discrete choice models of choice of provider. Such models analyse the choice of provider given that an individual has decided to look for medical care for his/her illness. For example, the individual might have a choice between going to a government clinic, a district hospital, a

mission clinic or a traditional healer. The estimated models give the probabilities of an individual going to a certain provider as a function of the characteristics of the provider and the characteristics of the individual. Although such models give income effects, these cannot (straightforwardly) be interpreted as income elasticities in that they give the relationship between the quantity of health care demanded and income. Rather, they give marginal changes in the probabilities of a certain provider being chosen as a function of changes in income.

Examples of such studies are Akin *et al* (1985), Mwabu (1989), Gertler and van der Gaag (1990) and Ellis *et al* (1994). Often these studies do not find any statistically significant effects of income or price on choice of provider. Gertler and van der Gaag (1990) do however find significant price and income effects and conjecture that the failure of other studies to find significant effects might be due to the use of low quality data and/or the misspecification of the models.

The China Rural Health Insurance Experiment

The only study on the demand for health care in China seems to be the China Rural Health Insurance Experiment (CRHIE), carried out by RAND for the Chinese Ministry of Public Health (Cretin *et al*, 1995; Sine, 1994). In the study, individuals in 26 villages in Sichuan province were offered a health insurance programme. The main objective was to determine the effect of different levels of co-insurance on demand, but the study also assessed the effects of other factors such as income. Co-insurance effects were investigated by assigning different levels of co-insurance to the different experimental groups. An experimental group consisted of a number of villages. The experiment ran for two years and after one year the co-insurance rates were changed. This allowed the estimation of a fixed effects (first difference) model in addition to a fully specified model. It was thought that the fixed effects model would give a more accurate estimate of the co-insurance effects than the full model. This is because fixed effects model controls for any unobserved differences between the experimental groups which may cause differences in observed utilisation rates.

In Cretin *et al* (1995) the models that were estimated analysed annual expenditures on health care. A two part model was estimated. First, a logit model was estimated that gave the probability of any use and second, for those individuals who had used medical care, a regression analysis of the log of annual expenditures. These models were estimated separately for both outpatient and inpatient expenditures. In the outpatient models, income was a statistically significant (p#0.01) predictor of both the probability of any use and of the log of annual expenditures if any use was recorded. However, the coefficient on income was very small compared to those for other factors. It thus seems that, although income significantly influences use and expenditures, other factors are much more important. These other factors are, amongst others, the presence of a functioning health station in the village and whether or not the individual reported having a chronic disease, which influenced the likelihood of any use positively. Variables influencing demand negatively were, amongst others, living farther away from the closest lower level outpatient facility and having a higher rate of coinsurance. Also age and gender were significant predictors, with some age-gender combinations having higher and others lower than average expenditures.

These findings stress the importance of including variables such as access to health care, health status, insurance coverage and socio-demographic characteristics in studies of the

income elasticity of demand for health care. For inpatient care, the coefficient on income was negative. However, this coefficient was not significantly different from zero. It is not possible to straightforwardly calculate income elasticities from the models reported.

Sine (1994) analyses the same data but the dependent variable in his models was the number of episodes of care demanded. His findings were, not surprisingly, very similar to those reported above, but the interesting feature of his analysis is that it is somewhat easier to get an idea of the quantitative strength of the relationship between income and demand for health care. Individuals were classified into one of three income groups: low (less than 550 yuan), middle (550 to 650 yuan), or high (greater than 650 yuan). Individuals in low income households had 15 percent less episodes than individuals in middle income households. However, since the precise income levels are not available, an income elasticity cannot be calculated.

Summary

The evidence from the macro studies from developed countries suggest that the income elasticity of the demand for health care is well above one and might be declining to one for higher income countries. It is, however, not clear whether the results of these studies are anything more than an illustration of the empirical observation that the share of health care expenditures in national income increases with increasing national income and that this effect is more pronounced for lower income countries. Whether they are representative of the true income elasticity at the individual level or even on a macro level, or reflect a real increase in health care consumed, is unclear. Micro-level studies generally find a much lower income elasticities.

For developing countries, the evidence is mixed. The results from Musgrove (1983) seem to suggest that the income elasticity is well above one, while Ellis *et al* (1984) find an income elasticity of only 0.55. Straightforward income elasticities are not widely available because most studies estimate discrete choice models of choice of provider, rather than models that analyse expenditures or number of visits. The China Rural Health Insurance Experiment (CHRIE) did find significant income effects, although not in all cases.

None of these studies captures the influence of factors other than normal health care on the underlying demand for health, which is assumed to drive consumption decisions. Such an approach may be acceptable in societies where health care, preventive activities and expenditures for wellbeing are fairly well distinguished, either because they involve different products or because the relevant demand is met through different market structures. In the case of the materials for TCM, however, these distinctions are inappropriate since the materials are frequently the same and the markets must be presumed to overlap even though so little is known about certain parts of the informal market that it is almost impossible to draw any conclusions. From the perspective of endangerment, however, the significant variable is demand for materials for TCM, and in particular for certain materials known to be derived from rare or endangered species of plant or animal. These figures can only be derived from information that encompasses formal and informal markets alike. Such information can only be generated by research based on household surveys.

The Relationship between Demand for Materials and Endangerment

The relationship between demand for materials for TCM and medicinal species is complex because it involves the interaction of economic, social and cultural factors on the one hand and ecological issues on the other. Economic relationships that are relevant here are the availability of different sources of given materials, the degree to which substitution between these different sources is possible, their quality, relative prices and consumer acceptance.

Property rights to wild populations will also affect the extent to which increased demand may lead to extinction. From the economic theory of the management of renewable natural resources it is known that, for a profit maximising producer, in most cases overexploitation leading to extinction of the resource, is not the optimal strategy. However, this assumes well-defined property rights to the resource. For wild populations property rights may be difficult to establish and are often hard to enforce, leading to, for example, poaching. The result is an open access resource with all the resulting dangers of over-exploitation. Note that the scarcer, ie the closer to extinction, the species, the greater the incentives for poaching; the high prices will make otherwise unacceptable costs - even death - seem acceptable. From an economic perspective, illegal activities such as poaching or the existence of a black market, are simply expressions of underlying market dynamics and the relevant economic incentives. The risk of being caught and punished can be converted into an element of price and thereby factored into the cost/benefit calculation underlying any market transaction.

Whether an increase in pressure on wild populations will result in extinction depends on a range of factors, such as habitat, human/animal conflict, the overall situation of the species in its environment, and its natural regeneration rates. This is a particular problem for materials harvested from wild populations. For cultivated or ranched species growth rates and the carrying capacity of the environment may pose serious constraints on the maximum yields that can be realised, which ultimately may lead to poaching the wild populations.

In the absence of any natural or synthetic substitutes, an increase in the demand for wild harvested material should lead both to an increase in prices and in the number of individuals harvested, resulting in a new balance between supply and demand, expressed through price. However, increased efficiency of obtaining the material from the species or in the use of the material means that this relationship between demand, price and individuals harvested does not necessarily hold. Increased scarcity, leading to higher prices could provide economic incentives for more efficient use of the material. To what extent such efficiency gains are possible depends on the extent to which more of the raw material from one plant or animal may be obtained. Improved methods of extraction of the raw material could be one possibility. Where complete parts of plants are harvested as the raw material, eg, the rhizomes, efficiency gains in the sense of obtaining more raw material from the same plant seem unlikely. However, efficiency gains are still possible in the preparation of the pharmaceutical from these plant parts. For example, the use of more efficient methods of extraction in the preparation of tonics can reduce pressure on the remaining populations. Issues surrounding the complex relationship linking demand to endangerment require further elucidation.

Development of substitute materials

Two options for developing substitutes are possible: a) using (parts of) more abundant or easy to rear plants and animals, eg, dog bone instead of tiger bone, or b) developing synthetic substitutes, through isolating and synthesising the effective substance in the plant or animal. The extent to which either of these strategies may help alleviate pressure on wild populations depends on numerous factors, including the cost of supply and the perceived efficacy of these substitutes compared to the materials from wild populations. The introduction of substitutes may also remove the economic incentives for local communities to protect wild growing species and thereby reduce the cost of poaching. Therefore, these options must be used in conjunction with other conservation strategies. With increased scarcity of wild individuals, price should go up, increasing the scope for developing markets for substitutes or synthetics.

However, even if ranched or synthetic substitutes could be supplied at a lower cost, perverse price signals could still induce consumers to buy the materials from wild sources. In the market for TCM, many consumers treat price as a quality signal, ie, higher priced materials are assumed to be more effective and better quality. Such effects are most likely to occur in the informal market for TCM. In the official, regulated TCM market, doctors will normally base prescriptions on objective rather than on perceived efficacy. Objection to the use of synthetic substitutes is often based on the belief that, because of its natural basis, TCM results in less undesirable side effects, although this is not necessarily warranted (Skolnick, 1996).

Another question is whether sufficient alternative materials can be produced to satisfy the market. The idea that supply will not be able to match demand does not make much sense from an economic point of view. It presumes that demand is a fixed parameter. Demand for a material, however, is price dependent and price is determined jointly by demand and supply. If supply is less than the quantity demanded at current prices, price will go up, resulting in reduced demand until the quantity supplied and demanded will again be in balance. If the remaining wild populations cannot be protected from illegal harvesting this process might result in the extinction of the wild populations as harvesting efforts increases in response to price signals, leading ultimately to population collapse.

The relationship between demand and supply for medical services is unusual because in this market, suppliers - medical professionals - in large measure control the demand on account of the unique relationship between doctor and patient. Evidence from OECD countries shows that the incidence of certain basic procedures correlates well with the proximity of a teaching hospital and shows only a poor correlation with the health status of the affected population. This relationship is unlikely to be replicated in countries such as China where health care services are not in ample supply even though the underlying market relationships between patients and health care providers is fundamentally comparable.

The combination of a much expanded client base (due to population growth) and their increasing per capita incomes has led to a dramatic increase in demand for medical services in China, involving among other things, an increased demand for the fauna and flora from which TCM derives its pharmacopoeia.

An exploration of the economic issues linking rapid change in the Chinese economy and demand for traditional medicine is urgently needed. While it is assumed that increased incomes will lead to increased demand for formal medical services, no formal analysis of this

linkage exists. Indeed, it remains unclear how to construct a model that could adequately link economic growth and demand for medicine on the one hand and the distribution of this demand between the two available medical traditions on the other. Among the questions that need to be resolved is the distribution of income within Chinese society and the possible relationships to demand for particular styles of medical delivery. Income growth is greatest in urban areas but this is not where demand for traditional medicine is highest.

Some of the plants and animals involved in supplying the pharmacopoeia of Chinese medicine are now being cultivated to augment or replace wild strains, although the effectiveness of cultivated forms can differ from the wild ones in a variety of ways. Many of the plants and animals continue to be harvested for medicinal purposes in the wild. Presumably significant volumes of such harvested medicinals move in international trade. This trade is concentrated on Chinese and other Asian communities in a large number of countries. Some of the medicinals are endangered (Mainka and Mills, 1995: 194-198); they may be listed under CITES or should be.

Many of the species important to TCM are significant for the Biodiversity Convention. The knowledge associated with the use of these products represents an important factor in current knowledge world-wide about medicinal uses of fauna and flora. It is certainly conceivable that this knowledge will give rise to products that can be protected under current intellectual property regimes. Issues of equity and distribution of available rents represents an important set of issues under the current international regime for the protection of intellectual property rights.

An alternative approach for realising the full market potential of traditional medical knowledge is the development of a strategy of certification and brand names, similarly designed to segment markets and provide producers with greater security of tenure. These issues can only be explored on the basis of an adequate understanding of the current structure of demand and the extent of existing market-based responses.

Few systematic studies have been undertaken of the economics of Chinese medicine and its impact on endangered species, its contribution to endangerment or its relationship to biodiversity. Attention has thus far concentrated on a limited number of species of fauna, tigers and rhino in particular. This approach that may underestimate the impact of Chinese medicine on biodiversity and endangerment even as it does injustice to that form of medicine itself by focusing on a minuscule part of the pharmacopoeia.

The contribution of a study of the economics of Chinese medicine will potentially be significant, both to this branch of medicine and to the functioning of the Convention on International Trade in Endangered Species (CITES) and the Biodiversity Convention. It should include:

- an assessment of the value of medical services in the Chinese economy, the structure of provision and the likely impact of growing wealth on demand;
- an assessment of the market for medicinal plants in Chinese medicine and the likely direction of further development in demand and supply;
- an assessment of the economic factors impacting on Chinese demand for medicinal species worldwide and worldwide demand for medicinal species in China and the likely effect of changes in demand on the status of such plants;

- identification of TCM species where significant risks of endangerment exist;
- consideration of the possibilities for the creation of reliable market segments for TCM materials that are taken from the wild, produced in controlled circumstances or involve the use of synthetic materials;
- the potential for the further use of knowledge associated with traditional medicine in China, particularly as it relates to intellectual property rights;
- the significance of medicinal species, harvested from the wild or cultivated, for sustainable development in China, in particular of rural areas.

Each of the issues outlined above represents a significant research task. The internationally available information base for this work is limited. The ultimate challenge is clearly to develop reliable data streams and analytic models that will permit close monitoring of the evolution of both the demand for traditional Chinese medicine and the supply of species and parts of species, relating these to general economic trends.

The importance of work in this area is almost self-evident. It represents a largely unexplored field of long term significance for both CITES and the Biodiversity Convention, for sustainable development in rural areas harboring desirable species, as well as for the well-being of a large proportion of the human population.

The availability of information for this kind of analysis is greater for western medicine in China than for traditional medicine. On the other hand, traditional medicine has firm roots in contemporary Chinese culture which in turn does not always produce quantifiable and analytically based assessments of the kind required in western doctrine. The editors of a recently published special issue of the journal Social Science and Medicine intimated as much in underlining the difficulty in obtaining articles which could meet the requirements of western peer review (McEwan, 1995).

Economic issues in TCM and endangerment

The debate about TCM and endangerment has generally been a debate about the species involved and their role in the TCM pharmacopoeia. There has been little research on the economics of TCM and its implications for endangerment. Yet the dominant social reality of China today is the extraordinarily rapid transformation of the economy and the associated increase in the purchasing power of many Chinese consumers. There can be little doubt that, left to its own dynamics, the market pressures on endangerment from TCM in China will grow over the coming years. The pressure itself may well be unavoidable but research can certainly help to predict the extent and direction of this pressure. Research may also help to identify steps to alleviate it, for example in the use of market-based incentives, more vigorous promotion of cultivated materials and synthetics, or measures to bring more accountability to the informal market.

The economic research agenda on TCM and endangerment is sizeable since the chain that links consumers of TCM to endangered species is quite long and inadequately researched.

Systematic identification of endangerment issues in TCM

While not strictly speaking an issue for economic research, it remains essential to monitor the understanding of the relationship between TCM and endangerment. The relationship is a dynamic one, insofar as patterns of demand for TCM materials are liable to change as will

insight into the issues of biodiversity and endangerment. The relationship is dynamic but must be monitored against actual developments in the natural environment on a continuing basis. This requires a continuous exchange of information, much of it based on economic analysis, between TCM experts and those concerned with biodiversity and endangerment in China.

The growth in demand for medical services in China

The extraordinarily rapid growth of the Chinese economy will trigger significant growth in demand for medical services. Nevertheless the precise dynamics of this process are unknown. Systematic studies linking income to growth in demand for medical services exist, but are primarily for OECD countries at a time when their economies had already matured and the market for medical services was reasonably well defined. Studies on the comparable dynamics in developing countries are relatively rare, and in many cases are linked to research undertaken by or for the World Bank. None have been undertaken with respect to the more comparable Asian economies of Japan, Taiwan or South Korea. Similarly, there is the issue of scale which makes any comparison of developments in China with any previous experience problematic.

The research response at this stage needs to focus on the development of a model that reflects the essential dynamics of the relationship between growth in income and growth in demand for medical services in China and to test this model against actual developments over a period of time.

The balance between TCM and western medicine

The availability of two separate systems of medical services, competing to some extent, but mainly complementary, means that China is a unique case No other country has maintained a comparable dual system of medicine before and analysing the relationship between the two systems is essential to an understanding of the development of each.

The regulated market for TCM

The regulated market for TCM represents the largest element of the overall market for TCM. Useable data can be available on key economic indicators in this market but little analysis has thus far been undertaken of these data. In particular price data for TCM materials along the production and transformation chain may be available but have not been analysed over time. Certainly a consideration of the relationship between TCM and endangerment must begin with the regulated market for TCM. Any hopes of successfully addressing the issues of endangerment rest with this market: this is where basic relationships between actors have been established, essential provisions for transparency exist or can be introduced, and the data streams can be generated that will be needed to ensure adequate accountability and control.

The informal market for TCM

"Within Chinese culture food and medicine are perceived as one and the same and tonics are a logical extension of this philosophy"(Natural Medicine Marketing, 1996: 193). Much more so than in Western societies, the lines are extremely fluid between formal medical practice and informal health maintenance and the use of preparations for general wellbeing. The result is the existence of a large informal market for TCM preparations. In many instances, the same materials are used for both the formal and the informal markets. In general, the TCM system is highly adaptable to application by lay persons or experienced individuals without formal training. This also favours the development of informal distribution channels. This is in fact

an informal market for TCM materials as distinguished from TCM as an integrated system of delivery of medical services centered on professional advice.

In principle, all materials for TCM should be marketed through official channels. In practice, a certain amount of material finds its way to market from informal sources through informal channels and into informal uses. Virtually every market in China offers certain herbs and live animals (snakes in particular) that are considered desirable for tonics; most also have a range of decoctions and preparations that are available independently of the advice of TCM practitioners.

By its very nature, this informal market is extremely difficult to influence or control. Popular perceptions of the efficacy of certain tonics and preparations - for example as aphrodisiacs or as general tonics - can be deeply ingrained. There is some evidence that certain animal materials that play a limited role in the formal TCM system which, because of their scarcity or doubts concerning their efficacy, continue to be attractive in the informal markets. Research is needed about the size, composition and structure of the informal market for TCM material as very little is known about these areas.

Consumer acceptance of cultivated products and synthetics

Cultivation is a simple solution to endangerment where plant materials are concerned. It has the dual attraction of solving the problem of supply and providing an attractive market opportunity for rural areas with the necessary natural endowment. As a general rule, the rents available from growing materials for TCM will be larger than those for most other crops. The development of synthetic formulations to replace natural materials or even preparations has advanced quite rapidly. As the active ingredients in TCM have been identified it has also become possible to develop synthetic versions. Research has shown that at least some of these synthetic products have good efficacy. Promising synthetics exist in two areas that are important to the TCM pharmacopoeia and are sensitive from the perspective of endangerment - bear bile and musk.

Synthetics generally have the attraction of lower prices and extreme economies of scale. Typically, they are urban based, in terms of both development and production, and consequently do not have the impact on the rural economy that cultivated products can have. However, consumer hesitancy to accept both cultivated and synthetic materials represents an additional and considerable obstacle to addressing the problems of endangerment.

TCM materials in international trade

The growing international trade in TCM materials poses a number of challenges from the perspective of current interpretations of the WTO and endangerment. This complex of issues requires careful analysis, based on a better understanding of the trade in TCM materials and a further analysis of the legal texts underlying the WTO. To achieve this ambitious goal, it will be necessary to undertake several interlinked research activities. The most important is a household survey to ascertain current levels of TCM use from both formal and informal markets. Such a survey needs to be conducted on a national basis in several provinces, and involving an urban and a rural sample in each instance.

In addition, systematic research on TCM materials and endangerment as well as the collection of market information on TCM materials is necessary to identify species of concern and to

analyse market data in light of information gained from the household surveys. Finally an assessment must be undertaken of the international trade issues relating to TCM materials.

References

Bowers, John Z., et al. (eds) 1988. *Science and medicine in twentieth century China: research and education*. (Science, Medicine, and Technology in East Asia, vol. 3): Center for Chinese Studies, Ann Arbor, MI.

Chen, C.C. 1989. *Medicine in rural China. A personal account*. University of California Press, Berkeley, CA.

Cretin, S., Williams, A.P and Sine, J. 1995. *China rural health insurance experiment: final report*. Report prepared for the Ministry of Public Health, Peoples Republic of China. RAND Project Memorandum PM-335-MOPH. RAND, Santa Monica.

Feng Xueshan, et al. 1995. 'Cooperative medical schemes in contemporary rural China.' *Social Science and Medicine* 41(8): 1111-1118.

Fielding, R., et al. 1995. 'Health care utilization as a function of subjective health status, job satisfaction and gender among health care workers in Gunagzhou, southern China.' *Social Science and Medicine* 41(8): 1103-1110.

Grogan, Colleen M. 1995. 'Urban economic reform and access to health care coverage in the People's Republic of China.' *Social Science and Medicine* 41(8): 1073-1084.

Grossman, M. 1972. 'On the concept of health capital and the demand for health.' *Journal of Political Economy* 80: 223-255.

Henderson, G. et al. 1995. 'Distribution of medical insurance in China.' *Social Science and Medicine* 41(8): 1119-1130.

Hoizey, D. and M-J. 1993. *A history of Chinese medicine*. UBC Press, Vancouver.

Lok Sang Ho 1995. 'Market reforms and China's health care system.' *Social Science and Medicine* 41(8): 1065-1072.

Mainka, S.A. and Mills, J.A. 1995. 'Wildlife and traditional Chinese medicine - supply and demand for wildlife species.' *Journal of Zoo and Wildlife Medicine* 26(2)(June): 193-200.

McEwan, P.J.M. 1995. 'Editorial.' *Social Science and Medicine* 41(8): 1041.

Milne, R. and Molana, H. 1991. 'On the effect of income and relative price on demand for health care: EC evidence.' *Applied Economics* 23: 1221-1226.

Newhouse, J.P. 1977. 'Medical care expenditure: a cross national survey.' *Journal of Human Resources* 12: 115-125.

Parkin, D., McGuire, A. and Yule, B. 1987. 'Aggregate health care expenditures and national income: is health care a luxury good? *Journal of Health Economics* 6: 109-127.

Sine, J.J. 1994. *Demand for episodes of care in the China Rural Health Insurance Experiment*. Dissertation. RAND Graduate School. RAND, Santa Monica.

Skolnick, A.A. 1996. 'China is eager to export its traditional medicine, but some Chinese scientists urge more scepticism.' *JAMA* 276(21) December 4: 1707-9.

World Bank. 1984. *China: the health sector. A World Bank country study*. The World Bank, Washington, DC.

Unschuld, P.U. 1985. *Medicine in China: a history of ideas*. Univ. of California Press, Berkeley, CA.

Unschuld, P.U. 1986. *Medicine in China: a history of pharmaceutics*. Univ. of California Press, Berkeley, CA.

Xiang Zheng and Hillier, S. 1995. 'The reforms of the Chinese health care system: county level changes - the Jianxi study.' *Social Science and Medicine* 41(8): 1057-1064.

Xingzhu Liu and William, C.L. Hsiao. 1995. 'The cost escalation of social health insurance plans in China: its implication for public policy.' *Social Science and Medicine* 41(8): 1095-1102.

Yuanli Liu, et al. 1995. 'Transformation of China's rural health care financing.' *Social Science and Medicine* 41(8): 1085-1094.

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☐ **International Trade and Recycling in Developing Countries: The Case of Waste Paper Trade in India**. P. van Beukering and V. Sharma (eds). November 1996. 155 pages. £20

The importance of international trade in the global economy is expanding, not only for primary products but also for recyclable waste. The main objectives of this study were to determine the economic, social and environmental impacts of international trade of waste paper for recycling purposes in India. The report addresses three main sectors: (i) the world market for waste paper, (ii) the local waste paper market and (iii) the Indian paper industry. It also makes recommendations for policy makers at an international, national and local level: international agreements should distinguish between hazardous and non-hazardous waste; national trade barriers to waste imports should be eliminated; and existing local informal recovery sectors should be favoured over formal Western-style recycling systems.

☐ **Mangroves or Fishponds? Valuation and Evaluation of Alternative Uses of a Mangrove Forest in the Philippines.** Ron Janssen & Jose Padilla. September 1997. 258 pages. £25.

One of the major threats to mangroves in the Philippines is the rapidly increasing aquaculture industry. This study includes a review of valuation methodologies and their application to the case study area of the Pagbilao experimental mangrove forest in the Philippines. Valuations of goods and services and environmental functions of the forest are employed to assess alternative management regimes using both cost-benefit analysis as well as a multi-criteria approach. Much depends on the management objectives: conversion to aquaculture is the most economically efficient management option. However, if equity and sustainability objectives are included, commercial forestry is the preferred alternative.

☐ **Incentives for Eco-Efficiency. Market Based Instruments for Pollution Prevention: A Case Study of the Steel Sector**. Ritu Kumar, Nick Robins, A.K. Chaturvedi, R. Srinivasan and J. Gupta. December 1997. 96 pages. £20.

Mounting pressures on industry to reduce pollution, to remain globally competitive and to meet the requirements of international standards, require fundamental changes in government policy and corporate approaches to environmental management. This report presents the results of an international study assessing the potential for market-based instruments for pollution prevention in the steel sector in India. It recommends a set of policy measures to reduce discharge levels in the most cost effective manner, to induce firms to adopt cleaner technologies and to encourage firms to economise on energy and water resources. In this regard, the importance of achieving coherence with existing policies, building trust among key stakeholders and gradually phasing in market-based instruments is emphasised.

☐ **Economic Incentives for Watershed Protection: A Case Study of Lake Arenal, Costa Rica**. Bruce Aylward, Jaime Echeverria, Alvaro Fernandez Gonzalez, Ina Porras, Katherine Allen, Ronald Mejias. February 1998. 323 pages. £30.

Conventional wisdom holds that cutting down tropical forests for livestock production is not only bad business but bad for the environment. In particular, it is thought that conversion of natural forest to pasture leads to a rise in the sedimentation of waterways and resevoirs, increased risk of flooding and loss of dry season water supply. In the case of Lake Arenal, Costa Rica, this conventional view is stood on its head by research showing that ranching, dairy farming and associated downstream hydrological effects represent important positive values to the Costa Rican economy, values that significantly outweigh expected returns from reforestation

☐ **Plastics Recycling in China. An International Life Cycle Approach.** Edited by Pieter van Beukering. April 1999. 148 pages. £20.

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