The effects of external openness on infant mortality rates in Chinese provinces : an empirical investigation

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Abstract

During the last decades, China has achieved some remarkable results in improving the health status of its population. Since the end of the seventies, it has engaged in a process of large reforms in integrating with the global economy. This openness in policy has already paid important dividends in growth. The purpose of this study is to investigate if external openness had any influence on the evolution of infant mortality rates (IMR) in Chinese provinces since the beginning of the eighteen's. The first section is devoted to a brief comment on the evolution of the IMR. In section 2 and 3 we present the theoretical framework and the methodology adopted. Our hypothesis are tested with a panel data model. The results are discussed in section 4. They show that external openness had indirect effects on IMR in a way which confirms the necessity to rebuild and expand medical insurance schemes. They also suggest it might be advisable to adopt measures in order to correct the health effects of the widening income disparities among provinces.

Key words : infant mortality rates - external openness - panel data - China

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Introduction

Since 1949, China has achieved some remarkable results in improving the health status of its population. Taken as a whole, the situation is better than might be expected when looking at per capita income. This can be illustrated by the fact that in 1995, the life expectancy at birth in developing countries which had a standard of living comparable to that of China was 63 years, whilst in China itself, it was 69 years (World Bank, 1997a). Over a period of 30 years there was a spectacular decline in the mortality rate for children under five, which fell from 173 per 1000 live births in 1960 to 45 in 1990.

In 1978, China undertook an ambitious programme of economic reforms aimed at what has been called *"market socialism"*. One of the elements of these reforms was the gradual opening up of the economy. Amongst other things, this entailed from the very beginning giving a certain amount of freedom to enterprises to engage in international trade. The openness of China has subsequently expanded and accelerated, particularly since the second half of the 1980s, both in the fields of international trade and of foreign investment, both having contributed to its impressive growth (Jian, Sachs and Warner, 1996; Démurger, 1997; Sachs and Woo, 1997; Jammes, 1998).

It is proposed here to analyse the effects of external openness on infant mortality rates (*IMR*) in Chinese provinces between 1983 and 1994. The first part of this study contains a brief look at the main features of the evolution of *IMR*. There follows the theoretical framework for analysis and the modelling of the relationship between external openness and the other determinants of *IMR*.The results of the econometric analysis are discussed in the final section.

1. The evolution of infant mortality rates

There exists a vast amount of literature given over to the measurement of health. We limit the present analysis to infant mortality rates[2]. The decline in infant mortality is appreciable in China, with the median falling from 33 deaths per 1000 live births in the 1980s to 29 in the 1990s, accompanied by a lowering of the maximum (Table 1). It can be seen that the situation in coastal provinces is better than that in the country as a whole. Moreover, there appears to be a reduction in overall disparity levels between provinces, as measured by standard deviation from the mean. However, since the beginning of the decade a period of stagnation which could be called a "plateauing out" phase can be observed. This phenomenon has also been recorded since the middle of the 1980s for child mortality rates (under five; World Bank, 1997a).

Table 1: Changes in infant mortality rates in Chinese provinces

(for 1000 live births)

	Period 1	1990	Period 2	Coast prov. P.2
Minimum	14	10	10	10
Maximum	100	74	71	46
Median	33	28	29	18
Coef. variation	0,63	0,56	0,55	0,50

Period 1 = 1978-81; Period 2 = 1992-94; Coast. prov. = Coastal provinces
Data sources: see appendix

2. Theoretical framework of the determinants of infant mortality rates in Chinese provinces

[2] *For statistical reasons*

Endogenous and exogenous risk factors of IMR

Infant mortality rate is determined by two types of causes or risk factors; those that are endogenous and those that are exogenous. The first type, linked to bio-genetic factors (malformation, incidence of twin births etc..), depend largely on the degree of development of medical science (Stoddart, 1997; Kodio and Etard, 1997) and are difficult to measure. Those of the second type are made up of factors which fall into four major categories : the socio-health environment, supply of care characteristics (quality, accessibility...), family behaviour and characteristics (household income, parental education, migrant or non-migrant status….) and the characteristics of the child (position in family hierarchy, amount of time between births, breast-feeding…); Murray and Chen, 1993; Schultz, 1993; World Bank, 1993; Kodio and Etard, 1997; Baya, 1998; Akin et alii., 1998; Guilkey and Riphan, 1998). The *IMR* may thus be expressed as:

$$IMR = s\,(HE, HCS, X, Z) + \mu \qquad [1]$$

where HE, HCS, X and Z are the vectors of the determinants of *IMR* and represent respectively the health environment, health care supply, family characteristics and the characteristics specific to the individual (child, mother); μ incorporates the non-measurable endogenous risk factors, as well as exogenous risk factors for which no data is available. These different elements have both a direct and an indirect influence on infant mortality rates and may also affect each other.

The effect of the level of external openness on IMR

External openness may have an effect on *IMR* by directly or indirectly influencing the main types of factors mentioned above and which have been demonstrated to differing degrees by both theoretical analysis and empirical studies to be important determinants in the incidence of infant mortality.

Direct effects

These derive largely from certain characteristic traits in the development of the Chinese economy. It is hypothesised that a comparatively high level of openness in the provinces gives rise to more dynamic progress, particularly industrial progress (World Bank, 1997b), which is then reflected in more prosperous firms. As a result, and different from the situation which has been observed in the case of other firms, these prosperous enterprises are less likely to be obliged to reduce the medical cover they offer to their employees. In addition, the larger presence of foreign businesses in the comparatively more open provinces, particularly those on the coast, together with the previous point, suggest that the population in these areas is generally better covered by health care mechanisms. However, the decline in the population covered by the different health insurance schemes (state, "public" sector industries[3], and rural health co-operatives) is one of the key problems facing China in the health field today.

Indirect effects

Different hypotheses suggest that the external openness of China has had an indirect

[3] *Whatever their status.*

positive effect on the determinants of the *IMR* through three principal channels: 1) on the demand for health care, 2) on the education and behaviour of the individual, and 3) on the characteristics of the health care supply.

1. The per capita GDP is on average higher in those provinces which are comparatively open which, as well as encouraging better nutrition, promotes the use of health care services, as those are in the main not free even (and more and more), for preventive care such as vaccinations;

2. External openness has helped in the development of the education and training of men and women in those provinces which are relatively more open, because of a comparatively greater need for qualified labour in these areas (as has been suggested for a number of developing countries in analyses by Coé, Helpman and Hoffmaister, 1994), and this also with spillover effects (Chen,1983; Jammes, 1998);

3. Since income is generally higher in the more open provinces, private health expenditures per capita are normally also higher, which encourages the existence and maintenance of a more "functional" and effective[4] health care supply. In addition, the higher per capita GDP leads to the raising of more public resources,[5] not only because the average fiscal basis per capita is greater, but also because it is easier to tax it. The so-called "extra-budgetary" funds, based upon production taxes and which are not subject to the system of resources sharing between central government and decentralised units are therefore all the greater (Wong,1996; Raiser, 1889). It can therefore be assumed, all other things being equal, that public health spending in comparatively open provinces is greater than in those that are less open, and that this applies

[4] *Nevertheless it is clear that the inefficiency of health care establishments is one of the main challenges that China needs to address in the area of health care. However this question raises issues that are outside the scope of this article.*

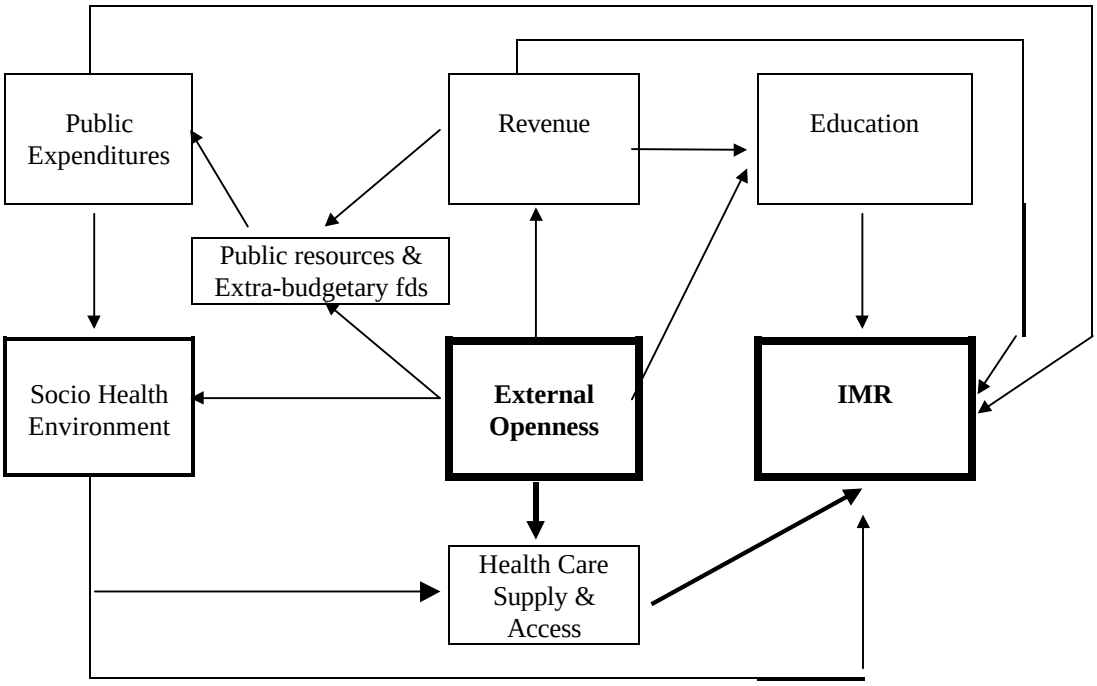
[5] *The transfers from central government to decentralised units does not compensate for the inequalities in fiscal potential between provinces.*

not only to the curative care but also to preventive one, the financing of which rests largely with local administrative levels and structures. In the poor provinces of China, the financing of vertical health programmes[6] is an acute problem. This lack of resources is puzzling as it has been observed in many countries that preventive care (most notably vaccinations) and basic health care activities play an important role in bringing down the infant mortality rate (Beenstock and Sturdy, 1990; Hojman, 1996; Filmer and Pritchett, 1997). Moreover, it is reasonable to assume that households in more open provinces live in a better health environment mainly through having more developed sanitation services and wider access to safe water, although it must be noted that the relationship between access to safe water and infant mortality is somewhat controversial (Galavardin, 1998).

Figure 1 below shows the theoretical relationship between openness and level of *IMR*.

[6] *Especially in the case of the Epidemics Prevention Service, the Extended Vaccination Programme and the Mother and Infant Health Programme.*

Figure 1: Effects of external openness on the *IMR*



The direct and indirect effects of openness on the *IMR* can therefore be expressed as:

$$IMR = s\,(EO, HE, HCS(EO), X(EO), Z) + \mu \qquad [2]$$

EO being external openness, the other vectors as previously mentioned in [1].

3. Determinants specification and data

Unobserved heterogeneity, correlation between independent variables and the estimation process

The estimation process of the relationship between the infant mortality rate and its determinants may be subject to heterogeneity bias. Levels of mortality may also depend, for

example, on the differences already existing between individuals or families and which result from the fact that they live in different regions. The use of panel data with fixed or random effects and the introduction of a variable indicating whether or not the province is coastal[7] (dummy variable, *Coast*) enables unobserved heterogeneity to be controlled for.

There are two stages to the estimation process. In the first stage, the *IMR* is estimated using the rate of external openness (EO). In the second stage, the *IMR* is estimated using EO and simultaneously introducing the other determinants of infant mortality. If the coefficient of EO is significant for the first stage, it covers *both* the direct and indirect effects by which the external openness acts upon the infant mortality rate. If it remains significant for the second stage, this means that external openness has had a definite direct impact on the *IMR*. On the other hand, if the EO coefficient changes to be no longer significant, then the hypothesis of a direct effect is not verified: external openness will therefore have had only an indirect effect on the *IMR* via the influence it has on the other variables which determine *IMR*.

The independent variables

- *External openness (EO)*

A number of different ways of measuring external openness have been proposed depending on whether one is looking at the policy of external openness or the level of

[7] *Regions along the coast benefited earlier than others from external openness measures and their coastal characteristics significantly contribute to the "explanation" as to why they had more rapid growth between 1978 and 1993 (Jian, Sachs and Warner, 1996). These regions are: Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shangdong, Guangdong and Guangxi. Heilongjang, situated in the North West on the border with Russia, with whom it has strong trade links, has also been included here as "coastal", as it enjoys a comparable status to coastal provinces since much of its agricultural production is exported (Guillaumont-Jeanneney and Hua, 1998).*

openness itself (Guillaumont, 1994; Guillaumont and Boyreau-Debray, 1996). This analysis is concerned by the second approach. External openness may be measured by looking at the level of exports and imports as a percentage of GDP (*XY*; *XMY*) or per capita (*Xhab*; *XMhab*). There is no particular reason in theory why one of these measures should be preferred over the other; therefore all will be tested here.

- *The socio-health environment and initial situation in the province (HE)*

The environmental situation is traditionally measured by looking at the percentage of the population having access to safe water (*Water*). The initial situation in each province at the beginning of the period of research may be assessed using life expectancy (*Life*), which we know depends largely on the behaviour of the mother, illiteracy, access to potable water and income (Barlow and Vissandjée, 1998). The relationship between initial life expectancy and mortality rate is a priori difficult to determine: i) the better the environment and personal circumstances at the start, the harder it is comparatively to improve level of health; inversely, ii) a healthy environment to start with promotes the dissemination of skills and knowledge which help to reduce mortality rates.

- *Health care supply (HCS)*

It is generally accepted that basic health care and preventive health care, particularly the vaccination programmes against target diseases (tetanus, rubella, diphtheria, tuberculosis, whooping cough and polio) are most effective in bringing down the mortality rate. In Chinese provinces for the period 1982-1992, Hammer (1996a) found a negative correlation between vaccinations and *IMR*.

In the absence of data on the number and type of health establishments per province and on the main vertical health programmes, it has been necessary to fall back on somewhat approximate indicators, specifically, the number of doctors (*Docth*) and the number of beds (*Bedh*) per thousand inhabitants. The traditional limitations of these indicators are all the more acute given that in general China does not suffer problems of geographical accessibility to health care and that excess staffing levels and excess structural capacity can frequently be found across all levels of the health pyramid above that of the village (Wilkes et alii, 1997). Nevertheless, it is reasonable to assume that a relatively substantial pool of doctors indicates that there is less of a shortage of operational resources per inhabitant, which translates, all other things being equal, into more efficient health care being on offer. Hammer (1996a) has shown for 1992 a positive correlation between per capita GDP in the provinces and vaccination levels. If this relationship remains stable over time, it may be supposed that the variable income, when introduced into the model (see below) also reflects this aspect of health care supply which cannot be measured in any other way because of a lack of data.

A number of studies across several different sample countries have posed questions about the role that public health expenditure plays in influencing level of health, including *IMR* (Anand and Ravaillon, 1993; Calipel and Guillaumont, 1994; Hammer, 1996b; Jamison *et alii*, 1996; Bidani and Ravaillon, 1997; Brun and Mathonnat, 1997; Filmer and Pritchett, 1997; Hojman, 1996). The results are contrasting. All but three[8] conclude that there are no discernible effects. It is still necessary however to look at their impact on *IMR* in the provinces of China. Here too, though, statistical limitations prevent us from directly analysing their effects. But Hammer (1996b) has shown that in Chinese provinces, public health care expenditure is a function of the level of per capita GDP per province. These observations tend to agree with those of Luo (1995) for a sample of twenty counties. It may therefore be

assumed that per capita GDP is an indicator that also partly reflects public expenditure on health care.

- *Family and province characteristics (X)*

- Income

Per capita GDP has been retained as an income measure (*Yhab*). However, in any given province, the effects of an average level of per capita income on *IMR* will vary from the point of view of nutrition and access to health care, according to whether the income is more or less equally distributed. Within a household, the income effects on *IMR* will be influenced by the constraints arising from the composition of that household.

- Income and its distribution

Previous studies clearly show that, all other things being equal, a greater concentration of income is associated with a higher *IMR* (Bidani and Ravaillon, 1997; Filmer and Pritchett, 1997). The indicators used for hypothesis testing purposes are the *Gini* coefficient[9], the incidence of poverty (*Pover*)[10] and the percentage of the population employed in agriculture (*Agr*). The introduction of the incidence of poverty is theoretically justified for two reasons: on the one hand, because the poor are more likely than others to be faced with the risk of illness; and on the other hand because the way in which they go about seeking health care is different from non poor. These issues have been empirically confirmed by studies, which looked simultaneously at the effects of income and the incidence of poverty (Behrman, 1990; Carrin and Politi, 1996). In China, Wilkes et *alii* (1997) have shown that the poor spend less than

[8] *Jamisson et alii, Anand and Ravaillon, Bidani and Ravaillon.*
[9] *For 1992, in the absence of other available years.*

others in total on health care, but proportionately more as a percentage of their income (Carrin *et alii*, 1996). Hao, Sua and Lucas (1997) found that within a sample of counties more than half those individuals with "low" incomes and claiming to be ill had not sought health care for financial reasons, compared with less than a quarter of those who enjoyed a relatively "high" income.

Various systems of health insurance help to reduce the effect of income on health care demand. In China, the percentage of the total population which is not insured has gone from 30% in 1981 to 80% in 1993 (Wei, 1996). In rural areas, the percentage of the population covered by the system of rural medical co-operatives has fallen from 48% to 7% (Carrin *et alii*, 1996; World Bank, 1997b). The share of the population opting for the system of agricultural family responsibility (*Respon*) and the percentage of the population living in rural areas (*Poprur*) are variables which help to account for the breakdown of the system of health insurance in rural areas where it is of most importance. Since the vast majority of health care is monetary cost, this change strengthens still further the potential impact of income on health care demand, and no doubt most especially on the demand for preventive, compared with curative care.

- *Income and openness*

Numerous studies of China have shown that the increase in per capita income in the more open provinces, particularly those on the coast, has been more rapid than in other provinces, and that it has been more pronounced in rural areas than in urban ones. This means, all other things being equal, and particularly if these differences in revenue growth are not counteracted in those provinces experiencing more "rapid" growth than others by higher

[10] *The incidence of poverty relates to the years 1992-93 (using a threshold of 500 yuan per month), which is clearly a statistical constraint.*

increased costs in access to health care, that the growth dynamic linked to external openness leads to provincial divergence on two counts: first, to a widening of the differences in *IMR* between open/coastal provinces and others, and second, to greater *IMR* disparities between urban and rural areas in provinces which are less open than others. The interactive variable *Cotinc* (*Yhab* x *Coast*) enables this hypothesis to be tested partly. It is also advisable to retain a multiplicative variable in order to identify any possible additional effect, which may result from the combination of income and degree of openness (*Multi*).

- *Income and family composition*

The composition of the family changes the impact of income on *IMR* for two reasons: i) demand for health care increases with level of dependence; ii) in a situation of equal income, the likelihood of not being able financially to deal with illness is less in the case of a household made up of relatively young adults than it is in one of the same size, but which contains old people and children. This effect is tested by introducing the dependence rate resulting from the presence of old people (over 65, *Aged*), children under 15 (*Child*) and a combination of the two (*Depen*). It is worth explaining why the level of dependence of children has been taken into account. In the first place, it is justified by the great differences in child dependency, which exist between provinces. In effect, each province issued its own rules concerning the number of births allowed, and as Attané (1998) has shown, the degree of adherence to these directives varies in rural areas according to province.[11] For example, in provinces with a high proportion of ethnic minorities, 70% of women have the right to bear two children; in Xianjing, 40% are allowed to have three (Attané, 1998). However, these provinces are comparatively poor, which further accentuates the income constraints resulting from child dependency. In addition,

[11] *The one-child rule is enforced in urban areas.*

it is possible that the children of individuals insured through the three main insurance schemes[12] are not covered or covered only to a limited degree.

- *Education*

The role of education in the reduction of infant mortality has been greatly dealt with in previous studies (Schultz, 1993; Murray and Chen, 1993; Filmer and Pritchett, 1997). Whilst older empirical studies showed that the mother's education had a greater influence on *IMR* than that of the father (Barrera, 1991),[13] more recent studies have tended to demonstrate that the influence of the father is by no means negligible (Baya, 1998). We have retained a variable of "stock" of knowledge, the adult illiteracy rate (*Illite*), in order to avoid the difficulties posed by the issue of time-lag when "flow" variables such as the number of years of schooling are introduced in a model.

The other characteristics of both individuals and families (Z), such as position of the child within the family hierarchy and time between births are difficult to monitor and consolidate at province level. They are covered by μ. On the whole, the analysis of the effects of these factors on *IMR* has led to some very controversial results (Guilkey and Riphan, 1998).

4. The determinants of the infant mortality rate in Chinese provinces

The relationship between the infant mortality rate and the degree of openness at the *first stage* is expressed by:

[12] *Public employee's health scheme, workplace health insurance, rural medical cooperative system.*
[13] *Good education enables mothers to take better care of their offspring and encourages a lower birth rate.*

$$\log(IMR_{it}) = a + b_1 \log(XY_{it}) + u_{it} \qquad [3]$$

The relationship between the infant mortality rate and its determinants at the *second stage* is expressed by equation [4] as follows:

$$\log(IMR_{it}) = a + b_1 Coast_{it} + b_2 \log(XY_{it}) + b_3 \log(Water_{it}) + b_4 \log(Life_{it}) + b_5 \log(Docth_{it}) + b_6 \log(Bedh_{it}) + b_7 \log(Yhab_{it}) + b_8 Gini_{it} + b_9 \log(Pover_{it}) + b_{10} \log(Poprur_{it}) + b_{11} \log(\mathrm{Re}\, spon_{it}) + b_{12} \log(Agr_{it}) + b_{13} \log(Cotinc) + b_{14} \log(Multi_{it}) + b_{15} \log(Depen_{it}) + b_{16} \log(Illite_{it}) + m_{it} \qquad [4]$$

where i = 1,n provinces; t = 1 to T years, the other variables having been defined above. We used the software Limdep.

Direct and indirect effects of external openness on infant mortality

As hypothesised, (stage 1) *external openness*, as measured by the level of exports (*XY*, exports as a percentage of GDP),[14] positively influences the reduction of the *IMR* (Table 2, equation 1). However, as we have seen, this effect may be direct or may work indirectly if the degree of openness also affects the other determinants of *IMR*. Either way, its impact is confirmed (Table in appendix 1) since relationships which are both significant and with the sign anticipated, have been observed between the level of exports and the per capita GDP (positive relationship), the illiteracy level (negative relationship) and the density of medical practitioners (positive relationship).

[14] *This indicator appears to be more significant than the alternative measures of openness (higher t-ratio).*

It is then appropriate to introduce into the second stage the whole of the potential determinants of *IMR* alongside that of degree of openness. The final results can be seen in Table 2 (equation 2). It should be noted that the presence of random effects attests to an unobserved heterogeneity between provinces.

The export ratio coefficient is no longer significant. That means that the effect of external openness on *IMR* is only indirect: its influence is felt through the other variables, principally that of income, as medical coverage (*Docth* and *Bedh*) and education (*Illite*), variables with which the degree of openness was correlated, are not significant. Knight and Song had already highlighted in the 1970s that level of literacy had no effect on the *IMR*. It may be assumed that since overall literacy rates are quiet fair[15], the differences between provinces are too small for this factor to stand out as a determinant of infant mortality. A certain number of other variables have no effect on *IMR*. These are the interactive variables level of export with income (*Multi*) and coastal province with income (*Cotinc*) as well as the variables access to safe water (*Water*), two indicators of income distribution (*Gini* and *Pover*)[16] and the dummy variable, coastal province (*Coast*).

As the per capita GDP was correlated with the level of exports, a regression analysis was carried out on it against export level[17], and the residual (*ResYhab* in table 2*)* was introduced into the model in place of the observed values. The coefficient is both significant and negative as per the proposed hypothesis and thus confirms in the case of Chinese provinces one of the conclusions most clearly seen in the existing literature as to the determinants of infant mortality. This first value of elasticity - an other is obtained from equation 3 (see comments below) - is equal to 0.38, which is around the lower end of the bracket generally found in studies for developing countries.

[15] *Around an average of 16 %, with 14% for eastern and 22% for western provinces.*
[16] *The fact that the variables Gini and Pover are not significant might be due to the way in which they were measured (one year available).*

Table 2: Estimate of the parameters of infant mortality

Variables	Model 1 coefficient	t	Model 2 coefficient	t	Model 3 coefficient	t
XY	- 0,276	- 3,475**	0,181	1,011ns	0,201	0,821ns
Life			-7,479	-6,177*		
ResYhab			-0,380	- 1,879**	-0,687	-2,232*
Poprur			0,104	- 1,825**	0,202	2, 222*
Depen			0,545	2,539*	0,922	4,149*
Constant	2,714	12,847*	36,084	6,806*	5,527	1,746***
R^2 ddl	0,748		0,783		0,882	
F	15,31		17,29		18,37	
N	73		73		73	
Effects[μ]	A		A		A	

*Significant at 1%; **significant at 5%; **significant at 10%
μ The value of the LM test leads to the rejection of the OLS, and the Hausman test (null hypothesis - fixed effects, versus alternative hypothesis - random effects) leads to the rejection of the fixed effect model in favour of the random effect model at normal confidence levels.

Income and infant mortality

The indirect impact of the degree of openness on the *IMR* raises the question of the impact of export levels on the differences in mortality rates between provinces because external openness widen the income gap between more open provinces and the others[18]. As we have seen, the variables *Cotinc* and *Multi* used to try to capture these effects are not significant.

In addition, the question was also posed as to whether the effect of income on the *IMR* might not increase over time, for three reasons: i) the proportion of the population benefiting from social insurance has declined strongly, and a number of studies have shown that income

[17] *The same approach has also been used for Docth and Bedh, but these variables remain unsignificant.*
[18] *Cf above § "Income and openness".*

and the price paid (out-of-the-pocket) by those seeking treatment has an effect on access to care[19]; ii) the increase in the cost of access to care has in general been more rapid than the increase in income (World Bank, 1997a), which means that a higher income level is necessary in order to be able to purchase the same amount of health care; iii) finally, and this reinforces the point above, the mother and children health centres at county level have, for several years, had to raise the majority of their revenue from user fees. This has encouraged them to give priority to treatment rather than to preventive activities (such as vaccinations) which are in themselves less financially rewarding, but more efficient in fighting infant mortality. Treatment practices are also often modified in a more costly and less efficient way. One example of this is the treatment of diarrhoea, an important contributor to infant mortality. For some years it has been quite frequently treated at hospital level, which is expensive, but more financially rewarding for the health care provider. It may even involve hospitalisation of the infant, instead of the use of traditional treatments such as dehydration salts and intestinal antiseptics administered at out-patient level (World Bank, 1997b).

The hypothesis that the influence of income on *IMR* increased with time was tested in two ways. The first involved dividing the sample into two periods (1978-89 and 1990-94), and comparing the elasticities of each of them. No significant differences were found between the coefficients of the two periods. The second test consisted of introducing as follows the multiplicative variables which had been set up: a dummy variable was created which successively took the value 1 for the years 1994-89,1994-90, 1994-91 and zero for the other years. Each variable was then multiplied by the per capita GDP and introduced one by one into the models. The coefficients were not significant. Thus there is no evidence from the results obtained here that the *IMR* becomes increasingly sensitive to income. Leaving aside

[19] *Bloom and Wilkes (1997) in rural areas; additionally, Lu* (1997) *found that external health care demand amongst those who were insured in the town of Hang Zhou was more price sensitive (in terms of elasticity) where the poor were involved, serving to underline the importance of income.*

issues of methodology, one of the reasons for this may be that the decline in medical coverage is uneven between provinces and counties, inducing an increasing effect of income very difficult to capture. For example, a study[20] in the relatively poor province of Shanxi, has shown that around one third of the villages had continued to maintain some form of community financing of health care, whilst in the much poorer province of Guizhou any such form of financing had practically disappeared.

Initial situation, family characteristics and infant mortality

Three other variables offer a significant explanation for the differences in the IMR between provinces: life expectancy at the beginning of the period, the degree of dependence and the percentage of the population living in rural areas. Life expectancy at the start of the period (*Life*) comes up with a negative value, which is a reflection of the length of time the effects of acquired learning, including individual behaviour, which has a positive effect on the *IMR*, last for. The global level of dependence (*Depen*) appears to be of more significance than the level of dependence of children and old people, which is not really surprising. The coefficient has the expected positive value which suggests, as hypothesised, that a comparatively high level of dependence slows down the reduction of the *IMR*: on the one hand, it imposes more constraints on income, and on the other it may be translated into the mother having less time to devote to younger children. Finally, the results show that the greater the proportion of the population in rural areas (*Poprur)*, the higher the *IMR*, which confirms the initial hypothesis[21].

[20] *"The Five Provinces Survey", cited in the World Bank Report, 1997b.*
[21] *The share of the population opting for the system of agricultural family responsibility (Respon) is not significant.*

A study of the correlation matrix shows that life expectancy at the start of the period (*Life*, equation 2), is correlated with the other independent variables. The model was therefore recalculated leaving out this variable (equation 3), which resulted in higher coefficients and higher significance levels for the other variables. Thus, for example, income elasticity increases from 0,38 (equation 2) to 0.68, which corresponds approximately with the upper bracket of estimates found in existing literature concerning the effect of income on infant mortality in developing countries.

Conclusion

External openness does not appear to have a direct effect on the infant mortality rate in Chinese provinces after controlling for other factors. The results of this study show that its influence is indirect, mainly through the positive effects of openness on per capita income. This relationship between external openness, income and infant mortality rate suggests, bearing in mind the conclusions concerning external openness and the growth of Chinese provinces in existing literature, that external openness will spur on the differences in the rates of infant mortality between the open provinces, particularly those on the coast, and the others. Consequently it suggests it might be advisable to adopt measures in order to correct the health effects of the widening of income disparities among provinces[22]. Conversely, in the relatively open provinces, external openness will tend to narrow the *IMR* gap between rural and urban area.

Amongst the variables which have emerged as being significant determinants of the infant mortality rate, three - per capita income, level of dependence and percentage of the

[22] *Generally speaking, the central Government intends to put a break on the growing disparities among regions (Fifth Plenary Meeting of the Fourteenth Central Committee, 1995).*

population living in rural areas - underline the need to rebuild medical insurance schemes in China, which is one of the main objectives of the government.

Finally, the presence of random effects in the econometric results demonstrates the (expected) existence of non-observed heterogeneity. Outside of a lack of homogeneity in the data, which cannot be ruled out, these random effects confirm how great are the disparities existing between provinces and within these, between counties, the subject of which invites further investigation. Several case studies have already revealed that the reality of the health situation in Chinese provinces is extremely complex. These calls for further micro-economic analyses to be undertaken to complement the more global approaches, such as the study carried out here.

Appendix 1 : Relations between external openness and other determinants of IMR

Variables	Yhab coefficient	t	Illite coefficient	t	Docth coefficient	t
XY	0,708	9,411*	- 0,345	-8,938*	0,060	9,41*
R^2ddl	0,461		0,851		0,702	
F	62,3		51,03		18,4	
N	73		73		73	
Effects α	A		F		A	

α Fixed effects (F), random effects (A)
*Significant at 1%

Data sources used:

Health indicators: National Health Economic Institute and data from the Chinese government; Incidence of poverty and Gini coefficient, World Bank, 1997b; All other data has been taken or calculated from the China Statistical Yearbook for different years. Where possible, missing data for certain years were estimated using growth rates.

References

- Akin J., Guilkey D., Hutchinson P. and McIntosh M., (1998), Price elesticities of demand for curative health care with control for sample selectivity on endogenous illness : an analysis for Sri-Lanka, *Health Economics* 7, 509-531.

- Anand S. and Ravaillon M., (1993), Human Development in Poor Countries : on the Role of Private Incomes and Public Services, *Journal of Economic Perspectives*, vol. 7, n°1.

- Attané I., (1998), *La politique de contrôle des naissances en Chine*, INED, Paris. 28 p.

- Barlow R., and Vissandjée B., (1998), *Determinants of National Life Expectancy*, mimeo, 22p.

- Barrera, A. (1991), The Interactive Effects of Mother's Schooling and Unsupplemented Breastfeeding on Child Health, *Journal of Development Economics, 34*, 81-98.

- Baya, A. (1998), Instruction des parents et survie de l'enfant au Burkina-Faso, cas de Bobo-Dioulasso, *Dossiers du CEPED*, 48,6-27.

- Beenstock M. and Sturdy P. (1990), The Determinants of Infant Mortality in Regional India, *World Development*, vol. 18, n° 3, 443-453.

- Behrman J., (1990), The Action of Human Resources and Poverty on One Another, *LSMS Working* Paper n° 74, World Bank.

- Bidani B. and Ravaillon M. (1997), Decomposing social indicators using distributional data, *Journal of Econometrics*, 77, 125-139.

- Bloom G, Gu X., and alii, (1995), Health Expenditures and Finance in Three Poor Counties of China, *IDS Working Paper n°21,* University of Sussex, England.

- Bloom G, and Wilkes A., ed, (1997), Health in transition : Reforming China's Rural Health Services, *IDS Bulletin*, vol. 28, University of Sussex, England.

- Brun J.F., and Mathonnat J. (1997), Les effets du financement extérieur sur le niveau des dépenses publiques d'éducation et de santé dans les pays en développement - Une analyse économétrique sur données de panel, *Etudes et Documents,* 35 p., CERDI.

- Calipel S., and Guillaumont P., L'évolution des dépenses publiques d'éducation et de santé : déterminants et conséquences, in Guillaumont P. et S. (éd), *Ajustement et Développement - L'expérience des pays ACP*, Economica, 1994.

- Carrin G., and Politi C., (1996), *Exploring the Health Impact of Economic Growth, Poverty Reduction and Public Health Expenditure*, DICC, OMS, Genève.

- Carrin G. *and alii*, (1996), *The Reform of the Rural Cooperative Medical System in the People's Republic of China*, DICC-OMS, Genève.

- Coe D., Helpman E., and Hoffmaister A., (1994), "North South R&D Spillovers, *IMF Working Paper* WP/94/144.

- Chen J. (1983), *Multinational Corporations, Technology and Employment*, Macmillan.

- Gu X. and Shenglan T. (1995), Reform of the chinese health care financing, *Health Policy*,32: 181-191.

- Démurger, S. (1997), *Ouverture et croissance : le cas de la République Populaire en Chine*, Thèse de Doctorat, Université de Panthéon-Sorbonne, Paris, 248 p.

- Filmer D. and Pritchett L. (1997), Child Mortality and Public Spending on Health, *Policy Research Working Paper n° 1864*, World Bank, 41 p.

- Galavardin S. (1998), *Les déterminants de la mortalité infantile et l'ajustement structurel - Une étude empirique sur le continent africain*, Mémoire DEA, Cerdi, Université d'Auvergne.

- Guilkey D. and Riphahn R. (1998), The determinants of child mortality in the Philippines : estimation of a structural model, *Journal of Development Economics*, 56, 281-305.

- Guillaumont, P. (1994), Politique d'ouverture et croissance économique : les effets de la croissance et de l'instabilité des recettes d'exportation, *Revue d'Economie du Développement*, vol.1, 92-114.

- Guillaumont, P. and Boyreau-Debray, G. (1996), La Chine et la convergence, *Revue d'Economie du Développement*, vol.1, 33-67.

- Guillaumont S. and Hua P. (1998), *Taux de change réel et inégalité entre les revenus ruraux et les revenus urbains en Chine*, Communication au Colloque International sur l'Economie Chinoise "Ouverture et disparités en Chine", Cerdi - Idrec, Université d'Auvergne, 22-23 Octobre, 23 p.

- Hammer J., (1996), *Health and Poverty in China*, The World Bank, Policy Research Department, miméo, 19 p.

- Hammer J., (1996), *Setting the Context of Health Care Finance in China*, The World Bank, Policy Research Department, miméo, 19 p.

- Hao Y., Suhua C., and Lucas, H. (1997), Equality in the Utilisation of Medical Services : A Survey in Poor Rural China, *IDS Bulletin* vol. 28, n°1.

- Heady C., Wong C. and Woo W. (1996), *Fiscal Management and Economic Reform in the PR of China*, Oxford University Press.

- Hojman D. (1996), Economic and other determinants of infant and child mortality in small developping countries : the case of Central America and the Caribbean, *Applied Economics*, 28, 281-290.

- Jamison D., Jia W., Hill K., and J-L. Londono (1996), *Income, Mortality and Fertility Control in Latin America : Country Level Performance 1960-90*, mimeo, LAC Technical Department, The World Bank, Washington.

- Jammes, O. (1998), *Investissements étrangers directs, capital humain et rattrapage en Chine*, Colloque International sur l'Economie Chinoise "Ouverture et disparités", CERDI, 23p.

- Jian T., Sachs J., and Warner A., (1996), Trends in Regional Inequality in China, *NBER Working Paper* 5412.

- Knight J, and Song L, (1993), The Length of Life and the Standard of Living : Economic Influence on Premature Death in China, *The Journal of Development Studies*, vol. 30, n° 1, 58-91.

- Kodio B., Etard J.F. (1997) Evolution récente de la mortalité infantile à Bamako, MALI? *Population*, 2,381-398.

- Lu Y. (1997), *An analysis of the demand for outpatients services in Hang Zhou City*, Department of Health Economics, Shangai Medical University, mimeo, 28 p.

- Luo W.J., (1995), *Study of health financing and and organisation in poor rural areas of China;* Paper presented at the IHPP Research Workshop, Washington, 1-9 March, mimeo.

- Ma, Y., (1994) Macro-economic Management and Intergovernmental Relations in China, *Policy Research Working Paper*, World Bank.

- Murray C. and Chen L. (1993), In search of contemporary theory for understanding mortality change, *Social Science and Medicine*, 36, 143-155.

- Raiser M., (1998) Subsidising Inequality : Economic Reforms, Fiscal Transfers and Convergence Across Chinese Provinces, *The Journal of Development Studies*, vol. 34 n°3.

- Sachs J., and Woo W., (1997), Understanding China's Economic Performance, *NBER Working Paper*, 5935, 54 p.

- Schultz T. (1993), Mortality Decline in the Low-income World : Causes and Conséquences, *American Economic Review Pepers and Proceedings*, vol 83, n°2, 337-341.

- Stoddart G. (1997), Les défis de la santé dans les économies modernes, in Jacobzone (éd), *Economie de la santé - Trajectoires du futur*, Insee Economica, 69 p.

- Wei, Y. (1996) *An Introduction to Health Financing Patterns in China*; Institut National d'Economie de la Santé, Pékin.

- Weigel, J.Y. (1997), The Quest for the "Socialist-Market Economy" in China and Vietnam, *Mondes en Développement*, n°99, 19-25.

- Wilkes, A. *et alii*, Coping with the Costs of Severe Illness in Rural China, *IDS Working Paper* n° 58, 1997

- Wong C., ed., *Financing Local Government in the People's Republic of China*, Hong-Kong, Oxford University Press.

- World Bank (1992), China, Long-term issues and options in the health transition, *A World Bank Country Study*, 133 p.

- World Bank (1995), China, Macroeconomic stability in a decentralized economy, *A World Bank Country Study*, 1995.

- World Bank (1997a), *World Development Report*, Washington.

- World Bank (1997b), *China 2020-Financing Health Care*, 83 p.

- World Bank (1997c), *China Engaged*, 40 p.

- World Bank (1997d), *Sharing Rising Incomes : Disparities in China*; 79 p.

- UNICEF (1995), *Mother and Children in China*, Pékin.

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