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CHILD MORTALITY UNDER CHINESE REFORMS

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Abstract

This paper looks for the impact of the Chinese economic reforms on its health performance. From an appropriate health outcomes indicator, it appears that while still being one of the most performing countries, China's relative advance decreased during the reforms. Consistent with the fact that the health system had to rely more and more on private expenditures, we find an increasing impact of income on infant survival. We also show that relative prices matter for infant survival: for a given increase of income per capita, a currency real depreciation lowers survival. Focusing on poverty reduction still seems to be in China the main way to significantly improve infant survival.

Résumé

Cet article étudie l'impact des réformes économiques de la Chine sur ses performances de santé. A partir d'un indicateur approprié de mesure de santé, il apparaît que si la Chine est toujours l'un des pays les plus performants en la matière, son avance relative a diminué au fil des réformes. L'impact du revenu sur la survie infantile a considérablement augmenté avec les réformes, ce qui est cohérent avec un système de santé reposant de façon croissante sur des dépenses privées. Un rôle important des prix relatifs sur la survie infantile est également mis en évidence : pour un niveau donné de revenu par tête, une dépréciation réelle de la monnaie réduit la survie. Se concentrer sur la réduction de la pauvreté semble toujours être en Chine la meilleure façon d'améliorer la survie infantile.

Introduction

For the last twenty years, China experienced an exceptional economic growth period, while proceeding to dramatic structural changes in national economic management and health sector as well. At the very beginning of that period, China's level of health was quite high with regard to its level of income. It can be wondered whether over the two past decades of growth and reform China has still maintained such a relatively high "health performance" defined by the deviation of health indicator from the level which could be expected from the level of income. The answer depends on the way reforms have impacted this status. Actually the reforms may have improved or damaged a previously highly performing system. Since the depth of the reforms and of the growth rate and pattern have not been identical in the various provinces, and as far as data covering the different provinces and different years before, during and after the reforms are available, the impact of the growth and reforms in China can be investigated by a panel analysis of the health –growth- reform macroeconomic relationships between health and income at the provincial level and over time. Whereas many studies consider the determinants of health at the macroeconomic level to assess the impact of policy (Filmer, Hammer and Pritchett 2000, Anand and Ravallion 1993, etc.) , the literature offers very few quantitative analyses dealing with the impact of the reforms on health in the Chinese context.

To highlight the impact of market-oriented Chinese reforms on health status, we process as follows. Firstly, after designing the way we characterise health status in China, namely child and infant survival, supposed to be the best convenient synthetic indicators of health, given data constraints, we transform the

mortality indicator in order to take into account the non-linearity in its natural evolution. From an overview of the evolution of infant mortality/ survival in China, it is emphasized that the relative health level was initially significantly high in China compared to the rest of the world, and it remains so but to a decreasing extent (still higher than the expected level from the income per capita, but closer to it than twenty years before). It also appears that there is a strong heterogeneity of survival within China, at the provincial level and over time, with an increasingly closer relationship between income per capita and survival levels.

Secondly, we describe the main channels through which reforms may have influenced infant mortality/survival: those which are related to health policy and public expenditures can be seen as resulting directly in a change in health status, whereas the macroeconomic factors have only an indirect impact, mainly through income per capita and relative prices. It is argued that beyond a major positive effect through income per capita, some reforms may hinder health improvement, mainly when they increase inequality and lead to a depreciation of the provincial real exchange rate.

Thirdly, a model relying on the previous assumptions, , is tested with econometric panel data, to assess the respective impact of factors influencing mortality/survival. An appropriate non linear specification of the survival function is used, taking into account the existence of an upper limit of survival: macroeconomic indirect factors are becoming more and more important compared to factors linked to health sector reform and other organizational change. Finally present some perspectives for further work are proposed.

1. Assessing Health Performance in China

1.1 Choice of a Relevant Indicator

There is an increasing debate in the literature about the appropriate health indicator to be used in comparative analysis. It first concerns the choice of the gross indicators.

Amongst the usual proxies of health level used in the literature, such as life expectancy, child mortality/survival or infant mortality/survival, we would have preferred child mortality because it is recognized as the most sensitive and reliable indicator. However it is available at the provincial level only for 2000. Thus we will use child mortality in cross country comparison, but have to use infant mortality in cross province analysis.

First, this indicator has to be transformed into an appropriate index. We do not retain the index of the gross survival variable, nor its logarithm, since they impose respectively a constant marginal impact and (with a log-log specification) a constant elasticity of their determinants, whatever their initial level is. Indeed, depending on the initial level of survival, the same change in its determinants cannot be expected to have the same impact on the health status. This is all the more true as survival indicators are bounded. The closer to the bound, the harder it is to get closer. Following the logit transformation emphasized by Bhalla and Glewwe (1986), an achievement function is used, as previously estimated by Grigoriou and Guillaumont (2003) at an international level: we divide the actual level of survival by the distance to its upper level, expressed in logarithms. If m designs the infant mortality, s the infant survival with s=1000 – m, then $\log(\frac{s}{1-s})$ is used, as the indicator to be explained, and the survival achievement function is

given by the expression (4) in table 1. Note that the main explanatory variable (X) considered is generally the level of income per capita.

Insert Table 1 here

" Impact of a Variable X on Survival (s) according to the Specification"

The choice of the specification (4) is not only logically grounded, (cf. Grigoriou and Guillaumont 2003), it also appears relevant with regard to empirical tests: for instance the coefficient of determination (R-squared) is higher with the logit specification than with any of the three other ones: from cross-country regressions with a sample of 104 countries (developing and industrialized) conducted for four 5-years period over 1980-1999, it appears that the R-squared is systematically above 80% with the logit specification while hardly above 60% with the logarithmic one (2).

We thus can consider that among the above specifications, the coefficients of health determinants are better estimated using a logit transformation.

1.2. China Compared to Other Countries and over Time

At the aggregate level, data for 5-years periods on child mortality under five are available for approximately 100 countries (including China), covering the reforms period. Using 5-year periods to measure the GDP per capita as well, one can compare the actual level of health, assessed by child survival, to the predicted one according to the income level of the country. While quite simple, this analysis provides an overview on the relative performance of the Chinese health system.

These differences between the predicted and the actual level have been graphed in Figures 1-4.

Insert Figures 1 to 4 here

Figures 1 to 4 represent ordinary least squares (OLS) estimates of child survival (once taken into account it is bounded, that is with the logit transformation) on GDP per capita (in logarithms). If a country is exactly on the regression line, it means that according to the average relationship between health and income, its health outcome is as expected from its level of GDP per capita. A country above (under) the regression line is considered as getting a better (poorer) actual survival outcome than expected with regard to its level of income, which reveals a relatively good(bad) health performance.

It is well known that China has been for a long time a good performer in health. On the whole period, China is systematically above the regression line, which highlights this relatively good performance of the Chinese health system. However, over time, China gets closer to the regression line, which exhibits a performance still relatively high, but to a decreasing extent. This is illustrated by the comparison between the actual level of child survival rate to its predicted level according to the level of GDP per capita.

Insert Table 2 here

“ Actual vs Predicted Chinese Child Survival According to the Specification”

As it appears in Table 2 Column (5), the difference between actual and (logit) predicted levels is positive (good performance) but decreases over time. The same decrease appears with the logarithm specification (column (3)). However comparing column (3) and (5) of Table 2 evidences a smaller (larger) difference at the lower and more recent (higher and former) levels between actual and predicted when using a logarithmic transformation, instead of the logit one we retain here: this result is consistent with the assumption of a decreasing rather than constant income elasticity of survival when the initial level of survival increases. Whereas in 1980-84, China was the main positive outlier, with a gap of 181 per thousand between the actual and the predicted rate of child survival, followed by Sri Lanka, it is in 1985-89 slightly behind Sri Lanka (respectively with a positive gap of 117 and 84 per thousand) and still well above other countries, and in 1995-99, it appears well behind Sri Lanka (respectively with a positive gap of 48 for China and 84 per thousand for Sri Lanka), at a level close to other good performers such as Hungary, Honduras, Nicaragua, etc.). We can conclude that the relatively high health performance of China, still effective, has been decreasing, the reasons of which are investigated below.

1.3. Infant Survival Disparity within Chinese Provinces

The factors underlying the changes in Chinese child mortality during the reforms may be investigated by comparing its evolution in the different provinces. However, for the Chinese provinces, data on child survival are only available for the year 2000. That is why we use data on infant survival, for which data are available for the years 1981, 1989, 1992, 1993 and 2000.

Figures 5 to 7 represent the scatter plot and the regression line linking the logistic transformation of infant survival and the GDP per capita (in logarithms) for three different years (1981, 1989, 2000). A striking change is that the impact of the GDP per capita has very significantly increased between 1981 and 2000 (the regression coefficient rose from 0.5 in 1981 to 1.14 in 2000), with about 77% of the infant survival variance predicted in 2000 by the GDP per capita level, while only 25% in 1981. We assume this change may be partly due to the reform process, which has progressively involved a more significant part of health outcomes depending on private expenditures (food as well as health expenditures) rather than on health planning or even on public expenditures. As a result, the impact of income per capita on health level has been increasing. This assumption needs to be more elaborated considering different channels through which reforms may have influenced health.

Insert Figures 5 to 7 here

2. Transmission Channels from Chinese Reforms to Health Outcomes

Two sorts of transmission mechanisms from reform to health can be distinguished. Some are direct effects of structural reforms both on health system and on other sectors. Others and probably more important effects are the indirect effects of reform running through macroeconomic variables, namely changes in income and relative prices. Macroeconomic factors highlight poverty reduction as a crucial intermediate variable of survival, in China as elsewhere.

2.1. Direct Effects of Structural Reforms

The first channel linking the reforms to health status deals with reforms both in the health sector and in a more general manner in the national economic management.

China's health system and reforms of the health sector

A health system that ensured very broad access to affordable health care services in both rural and urban areas was behind the outstanding health status of China, compared to other developing countries. By World Bank estimates, close to 90 percent of China's citizens was covered either by government and state enterprise health insurance or by the rural cooperative health system in 1975. However, this system of almost universal access to publicly-funded or subsidized basic health services had its problems that manifested primarily as inefficiency, a common problem under central planning. As a result, China's economic reform program also included measures to introduce market mechanisms to the health care sector.

During this reform and transition period, access to health services by rural residents and urban poor has become more problematic. This resulted from the collapse of the rural collective health system and from the fiscal decentralization and health sector reforms, all of which were combined to increasing costs to users while also adversely affecting the number and the quality of institutions delivering services to the masses.

Firstly, the rural cooperative medical system collapsed as the rural economy was de-collectivized during the late 1970 -mid 1980s period. This means

the majority of rural population was left without any forms of health insurance and started to pay for health services out-of-pocket.

Second, in urban areas, reform measures were introduced to contain costs. In 1985, the Chinese State Council approved health reform proposed by the Ministry of Health for national implementation. One of the measures was to limit public funds allocated to the health sector to cover only basic personnel wages and new capital investments, accounting for about 25-30 per cent of hospital expenditures. The funding gap was to be filled by "alternative" sources, which would include user fees. At the same time, co-payment was instituted for insured patients in most cities in order to make users more cost-conscious.

Since 1992, the focus of health reforms has shifted to increasing "socialization" or risk pooling by moving away from employment-based insurance schemes. However, the reform is far from being complete, resulting in an increase in the number of uninsured, especially in urban areas where the unemployed and rural-to-urban migrants remain outside the insurance system.

In terms of financing, the overall impact of economic and health sector reforms in China has been a shift towards greater reliance on private payments for health services. There are indications that this has been the case particularly since the 1990s. For example, the percentage of population not insured for medical care was 29 in 1981, and increased to 79 by 1993. Out-of-pocket expenses as a share of total national health expenditures rose steadily from 20 per cent in 1978, to 26 per cent in 1986, and to 42 per cent by 1993. This natural trend implies that income is becoming more and more crucial to access to health services, consequently to determine health outcomes.

Unfortunately, the corresponding data are not available both at the provincial level and on different time periods, so that they could be used in our econometric estimates. However, we can try to capture some effects of the change in China's health system through indirect indicators of structural reform.

Reforms in national economic management

The main component of the reform in national economic management of China is probably the opening of the economy. The trade (exports + imports) ratio to GDP increased from 13% in 1970 to 45% in 2000. This increased openness is often considered as a major factor behind the Chinese growth of income (see for instance Demurger, 2002, Shan and Sun, 1998, Chen, 2003). It is also alleged to have had significant effects on the distribution of income (Demurger and Guillaumont, 1999). But besides these effects, controlled as suggested above, the direct effects of openness on health in China are rather uncertain[1].

The reforms also implied an increasing privatisation leading to a decrease in the share of workers employed in the State Owned Enterprises (SOE), here called "soel" (76% in 1980, 35% in 2000). A negative effect of privatisation (a positive effect of "soel") on survival, due to the decline of the "iron rice bowl" system could be expected. However, the effect of wage differential between SOEs and the rest of the economy is ambiguous: hourly wages in SOEs seem to be higher than in collective enterprises, but not that in foreign ones (and even lower if annual wage is considered) (Chen Yi, Demurger, Fournier, 2004). Moreover the

[1] Since we include the GDP per capita and a fixed effect in the regression, we can consider openness as a policy variable, the actual measure being purged from its main structural variables, namely the GDP per capita, the area of the country and whether it is landlocked or not.

final impact on health and mortality is likely to depend on the net increase of the total number of people employed.

Another aspect of reform relevant for the health status is the decentralization (autonomy of Provinces), noted above and associated to a delegation of insurance schemes to provinces (GIS: Government Insurance System) and enterprises (LIS: Labor Insurance System). Even if it may lead to more heterogeneity and then to a more uneven coverage in health care, its effect is still ambiguous as far as greater efficiency can also be explained by decentralization. Without appropriate data on decentralization in social services, a proxy indicator of centralization for each Province available over time is the share of central government in total capital investment.

Thus, the direct impact on health of the above three structural reform variables, openness, privatisation and decentralization, beyond their clearly positive indirect effect through a higher level of the average income is *a priori* unclear. On one hand, there may also be a negative impact due to a greater vulnerability, to a decrease in health coverage, to the end of the "iron rice bowl system" and to the loss of public jobs. On the other hand, the positive impact due to an increase in productivity and growth and to a better allocation of the resources caused by an increase in openness, privatisation and decentralization, which is a source of income growth, may also influence the efficiency in the delivery of social services and then may not be fully controlled for by the income per capita variable in the regression.

2.2. Indirect Effects through Macroeconomic Variables: the Growth and the Distribution of Income per Capita

We naturally expect an indirect effect of the reforms on survival through income growth. But as the increase in income is associated with an increase in inequality, this positive effect is likely to be attenuated. In the literature on the macroeconomic factors of infant or child mortality, many studies have emphasized the impact of income (see for instance, Anand and Ravallion (1993), Kakwani(1993), Filmer and Pritchett (1997)). The impact of income growth on survival will be controlled for by the log of GDP per capita.

The dramatic increase in Chinese GDP per capita has been associated with increasing inequalities, whose impact on health is expected to be negative for a given level of income per head (see for instance Waldmann (1992), Hobijn and Franses (1993), Filmer and Pritchett (1997)). Without any indicator of inequalities at the Province levelavailable over time, inequalities are in this paper proxied by the ratio of urban to rural areas income.

Relative prices and inflation

Macroeconomics matter for health not only with regard to the level of income per capita. As elsewhere, the reforms in China have impacted the structure of the relative prices, in particular between tradable and non tradable goods, i.e. the real exchange rate. The real exchange rate is here proxied by the provincial real effective exchange rate (REER). In a previous study relying on an international panel estimate (Grigoriou and Guillaumont (2003)), we found, controlling for the level of income per capita, a negative (positive) effect of a real

depreciation (appreciation) on survival. This effect has been explained by the impact of the real exchange rate on the price of food and medicines, two tradable goods important for health. For instance, Diakosavvas, Horton and Kerr (1988) had evidenced a negative impact of cereal prices on infant mortality (an increase in the cereal price implying an increase in infant mortality). Such effects can also be relevant for China, with some specificities as considered below. Furthermore, real depreciation has also been shown to increase inequality within Chinese provinces (Guillaumont-Jeanneney and Hua 2001). Using a real exchange rate indicator is convenient for our purpose, not only due to its link with exchange rate policy, but also because specific food or medicines prices are not yet available at the province level and over time. Regarding China, the role of food prices at the Provincial level would need to be considered. However, the lack of available data on food price at the provincial level over the whole period does not allow us to test this possible channel of transmission.

Let us note that if relative prices are likely to have an impact on infant survival, it can be expected to be the stronger the lower the level of income per capita. Considering the evolution of China during two decades of reform, where both the level of income per capita and the discrepancies among provinces have significantly changed, it is relevant to examine an interactive effect, through a variable corresponding to the real effective exchange rate multiplied by the income per capita.

Not only relative prices which affect the relative real incomes, but also the rate of inflation may matter, due to the lower capacity of the poor to protect their assets against inflation, which may involve to include a price level variable,

beside the relative price variable. However, the empirical evidence of the impact of inflation on health (outside China) is mixed.[2]

3. Econometric Estimation

3.1 Two Models

Following the previous analysis of the factors likely to explain child/infant mortality in China and the constraints resulting from data availability, we successively design two models.

Traditional structural factors: two regimes assumed

Firstly, in a "basic model", we only consider the traditional/structural factors of infant survival (see appendix 1 for the definition and for the sources of the variables), and how their global impact may have been modified between the beginning and the achievement of the reforms. Let us call (all variables being expressed in logarithms);

- income per capita (y_{it}) expressed in constant yuans of 1978,
- average income disparity between urban and rural areas (ur_{it}), as a proxy for inequality
- social expenditures ($soce_{it}$), namely health and education expenditures expressed in percentage of GDP
- a proxy for urbanisation ($popagr_{it}$)
- and an infrastructure index ($infr_{it}$)

[2] In cross-country analyses, while Hojman (1996) and Botero, Onyeiwu and Shrestha (1997) found no evidence of an impact of inflation on health, some studies such as Romer and Romer (1998) emphasized a negative impact of inflation on the well-being of the poor.

Defining a dummy variable, D90, for the years "after" the reforms (1992, 1993, 2000), the assumption of an higher impact of income on survival after the reforms than before is tested by including this dummy both additively and interacted with the GDP per capita.

H_{it} being the health status measured as the logistic transformation of infant mortality, the "basic model" to be tested can be expressed as;

(1) H_{it} = f (y_{it}, ur_{it}, $soce_{it}$, $popagr_{it}$, $infr_{it}$, D90, yit.D90)
+ - + ? + ? +

Reform and policy factor included

Secondly, in a "reform and policy model", two kinds of new policy variables are introduced, instead of the nineties dummy (added additively and interacted with the GDP per capita):

- macropolicy variables: the real effective exchange rate ($reer_{it}$), as a proxy for relative prices, and the consumption price index (cpi_{it}), as a proxy for the overall level of prices (or inflation);

- structural reform variables: openness (measured by the trade to GDP ratio: ouv_{it}), a proxy for the extent of public sector, which is the share of the labour force employed in State owned enterprises ($soel_{it}$) and a proxy for centralization, which is the share of public investment ($cgks_{it}$).

We then obtain the "reform and policy model":

(2) H_{it} = f (basic model variables, $reer_{it}$, ipc_{it}, ouv_{it}, $soel_{it}$, $cgks_{it}$)
+ - ? ? ?

The dummy for nineties is dropped in (2) since specific variables are expected to capture the reforms process over the nineties.

3.2 Panel Data

Our estimates rely on panel data. Due to data constraints we use data of infant mortality for 1981, 1989, 1992, 1993, 2000. The data are extracted from the *China Population Yearbook* (various issues), the *China Statistical Yearbook* (various issues over the eighties and nineties) and *the Comprehensive Statistical Data and Materials on 50 Years in New China* (1999). The use of panel data econometric and of a fixed effects model allows us to control for unobservable constant heterogeneity between provinces. Thus, the two following models are to be estimated.

(1') $H_{it} = a_0 + a_1.y_{it} + a_2.ur_{it} + a_3.soce_{it} + a_4.popagr_{it} + a_5.infra_{it} + a_6.D90 + a_7.y_{it}.D90 + ?_i + e_{it}$

with the following expected signs:

$a_1>0$, $a_2<0$, $a_3>0$, $a_4<0$, $a_5>0$, $a_6<0$, $a_7 > 0$, a_8 ?, a_9 ?

$?_i$ being the fixed effect, e_{it} the error term;

(2') $H_{it} = a_0 + a_1.y_{it} + a_2.ur_{it} + a_3.soce_{it} + a_4.popagr_{it} + a_5.infra_{it} + a_6.reer_{it} + a_7.ipc_{it} + a_8.ouv_{it} + a_9.soel_{it} + a_{10}.cgks_{ij} + ?_i + e_{it}$

with the following expected signs:

$a_1>0$, $a_2<0$, $a_3>0$, $a_4<0$, $a_5>0$, $a_6>0$, $a_7<0$, a_8 ?, a_9 ?, a_{10} ?,

$?_i$ being the fixed effect, e_{it} the error term;

3.3.Results and Interpretation

The basic model: the increased impact of income

The results of the basic model relying on traditional structural factors of mortality in a two periods (pre-reform and post-reform) framework are given in Table 3.

Insert Table 3 here

Structural Factors Explaining Infant Survival in China:

the Increased Impact of Income, a Panel Estimate (Within Estimator)

The estimated coefficients have the expected signs and are statistically significant (with urban-rural inequalities only significant at 13% in column (2). The positive (negative) impact of an increase (decrease) in income per capita, in the rate of social expenditures, or in the density of infrastructure beside the negative impact of inequality explains about 38% of the variation of infant survival. Including the share of agricultural population (in logarithms) leads to a lower impact of income on survival (divided by two), which can be explained by the strong correlation between the two variables, around 85%) and by a positive specific impact of urbanisation on health. To avoid a downward bias in the estimation of the coefficient of the income per capita and to separate the effect of income and of urbanisation, in column (1) and (2), we have purged the share of agricultural population from the impact of income.

In column (2) we include a dummy set to 1 for the years after 1990 (0 otherwise), both additively and interacted with income per capita. The additive

variable (D90) appears to have a significant negative coefficient, while the multiplicative one (y_{it}.D90) has a significant positive coefficient, supporting the assumption of a stronger importance of income during the nineties. The coefficients associated to the other variables remain roughly unchanged. The impact of income per capita appears to be significantly more important during the nineties than before (coefficient of 1.36 = 0.72 + 0.64, instead of 0.97).

The coexistence of a positive coefficient for the multiplicative dummy (stronger slope) and of a negative coefficient for the additive one evidences two patterns of the relationship between income and survival, once controlled for other factors, as represented on Figure 8:

- the pre-reform pattern (1), related to the years 1981 and 1989.
- the post-reform pattern (2), related the years 1992, 1993, 2000, where a stronger slope reveals a greater impact of income due to the reform.

An increase in income per capita has, *ceteris paribus*, a stronger marginal impact on infant survival in the pattern 2 than in the pattern 1. However, for lowest level of income (typically (A<D), a lower infant survival is expected with the post-reform pattern than with the pre-reform one (A1-A2), whereas for a high level of income (B), infant survival is expected higher in the post-reform pattern (B2-B1). This does not necessarily mean that the reforms worsened the health status of the poorest areas while it improved that of the wealthiest, since the comparison has been made for a constant GDP per capita: even for the poorest provinces (located below (O), supposed “to lose”, the impact is ambiguous, since the GDP per capita may have strongly increased from 1981 to 2000, what is likely to compensate the

initial loss. Let us illustrate this point, calling s_j the infant survival logit of the pattern j, (j = 1, 2) and y_j the GDP per capita of the pattern j;

- the pre-reform pattern (1): $s_1 = \beta_1 + \alpha_1.y_1$
- the post-reform pattern (2): $s_2 = \beta_2 + \alpha_2.y_2$;

  with $a_1 < a_2$ and $ß_1 > ß_2$

It follows that there is a minimum increase in GDP per capita, Δy, needed to compensate the loss, Δs, due to the lowering of the curve for low levels of income per capita:

$\Delta s = s_2 - s_1 = \alpha_2.y_2 - \alpha_1.y_1 + \beta_2 - \beta_1$

$\Delta s = \alpha_2.\Delta y + \Delta\alpha.y_1 + \Delta\beta$

hence, $\Delta s = 0$ if $\Delta y = k - z.y_1$, with $k = \frac{-\Delta b}{a_2}$ and $z = \frac{-\Delta a.y_1}{a_2}$

We note that the increase of income which makes the change of pattern neutral not only depends on the changes in the coefficient of income ($\Delta\beta$) and of the constant ($\Delta\alpha$) but also of the initial level of income y_1 (the lower this level, the higher its increase is needed). On the Figure 8 the increase in GDP per capita that compensates the loss (A_1-A_2) due to the change of pattern is represented by the distance AC: if after the reform the initially low level of income (A) has been increased enough (beyond C), the global effect of reforms on survival is considered as positive.

Insert Figure 8 here

Reforms process and impact of income per capita on health outcomes

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From regression (2), related to the panel of 31 Chinese provinces, we can compute the level of income that corresponds to (O) in Figure 9: it is 1096 yuans of 1978, which roughly represents 500 dollars of 1995. The 19 provinces[3] with an average GDP per capita (constant dollars 1995) in the nineties above 500 dollars (of 1995) may be unambiguously considered as "winners" with regard to health outcome, while the 12 others cannot be considered as "losers"[4]: computing for each country the minimum increase in GDP per capita, Δy, needed to compensate the lowering of the curve for the lowest level of income per capita, it appears that Guizhou is the only province where the increase in GDP per capita between the pre-reform and the post-reform period did not compensate the loss in health status due to other factors than income.

[3] Beijing, Tianjin, Hebei, Shanxi, Neimenggu, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Shandong, Hubei, Guangdong, Chongqing, Xizang, Gansu, Qinghai, Ningxia.
[4] Anhui, Fujian, Jiangxi, Henan, Hunan, Guangxi, Hainan, Sichuan and Chongqing, Guizhou, Yunnan, Shaanxi Xinjiang.

The reform and policy model

Insert Table 4 here

Policy Reform Explaining Infant Survival in China:

Panel Estimates (Within Estimator)

The results obtained with the reform and policy model are presented in table 4[5]. This model predicts nearly 50% (48% in column 4) of infant survival variations (which presents a significant improvement, compared to the results of the "basic model" without the 1990 dummy variables, and still to a minor extent, when these variables are included).

Let us first consider the results of column (3), still controlling for the traditional factors of the basic model, in particular the income per capita. The provincial real effective exchange rate has a significant coefficient with the expected sign: real depreciation has negatively impacted infant survival, a result similar to what we obtained from an international panel data regression of the child mortality (Grigoriou and Guillaumont, 2003). We simultaneously note that the coefficient associated to the inequality is no longer statistically significant, which is consistent with the thesis that the real depreciation in China has increased inequality (Guillaumont-Jeanneney and Hua, 2001). According to the present results, the effect of urban/rural inequality on infant survival found in Table 3 seems to mainly be the consequence of a relative price change. We also observe that, while it has the expected sign, the coefficient of the price index is not statistically significant: it probably means that the impact of inflation on infant

survival runs through poverty, and is already captured by the income per capita. Therefore, the inflation variable has been dropped in the estimates of column (4), (5) and (6).

Once the three other reform variables introduced (column (4), the signs and magnitude of the coefficients remain unchanged. The impact of openness on survival does not appear statistically significant, due to the fact that the REER captures a part of the impact of openness, since a real depreciation implies an increase in openness: when dropping the REER, in column (5), the coefficient of the openness variable becomes significant and negative. To be underlined, the negative effect of real depreciation on infant survival appears because the effect of income per capita, itself strongly and positively influenced by openness, is controlled for.

Let us now consider the coefficients of the proxies for centralization (cgks) and of the extent of public sector (soel). Both are negative and statistically significant, reflecting besides a likely effect through income per capita, a positive impact of these reforms on infant survival (an increase in cgks means an increase in the share of centralism, an increase in soel means an increase in the share of the labor in SOEs). However, both may have a negative part of their impact captured by another variable included in the regression, namely the relative share of agricultural population, since we know that around 90% of rural population have now to self-finance their health expenditures. Actually, the (negative) coefficient of the share of agricultural population is dampened when the structural reform

[5] The same equations have been estimated with the dummy D90 added: the coefficient associated

variables are included (cf. column (4) compared to column (1). On the other hand, our results evidence a strong positive impact of income per capita, the level of which is likely to have been positively influenced by the reforms.

It remains that beyond this indirect impact through income structural reforms have a significant positive impact on infant survival. It can be interpreted as the impact on health performance of a better resource allocation due to the reforms (privatisation and decentralization). However, we do not forget that the only proxies available at the provincial level may not be the most appropriate.

Policy reform and the increasing impact of income per capita

The results of the "basic model" given in Table 3 have evidenced an increasing impact of income on infant survival, while the results of the "reform and policy model" support the assumption of an impact on survival of economic policy (in particular of the real exchange rate) beside that which goes through the level of income. It then appears relevant to examine whether the impact of policy reform variables itself depends on the level of income and contribute to explain the increasing impact of income.

Regarding the impact of the relative prices (real exchange rate) this assumption is consistent with our analysis of the channels of transmission: if an increase in relative prices of tradable (food, medicines, etc.) is likely to increase mortality, these effects can be expected all the more important as the income per capita is lower. A simple test of this assumption has been to introduce in the policy reform model the real effective exchange rate multiplied by the income per

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was never significant and did not alter significantly the other coefficients.

capita (both variables are in log). Since the effect of urban-rural inequality and that of openness have appeared to be linked to relative prices effect, these two variables have been simultaneously deleted in this regression. The results are given in column (6). The hypothesis of a lower effect of real depreciation when the income is higher (i.e. of a higher impact of income when the real exchange rate is lower) is not rejected.

This effect may contribute to explain the increasing impact of income evidenced by our "basic model". Now combining the basic model and the policy reform model, we introduce in the last regression the dummy variable for the nineties D90, not only additively but also multiplied by the income per capita (y_{it}.D90, Table 4, column 7): the coefficient of the two real exchange rate variables (not only the additive, but also the multiplicative one) are still significant, whereas the two nineties dummy variables are no longer significant. The increasing impact of income over time (in the nineties) is captured by its increasing (decreasing) impact with real currency depreciation (appreciation)[6]. This result supports the view that the increased impact of income on survival in the nineties is linked both to the real currency depreciation and to an impact of the latter conditional on the level of income, which has been increasingly different among the provinces.

[6] We have checked (table 4, column (8) that if we drop the two real exchange rate variables in the regression, the two structural reform variables (soel, cgks) still included in the basic model, are not significant, whereas the two nineties dummy variables remain significant: the impact of income is still significantly increased in the nineties without depending on the impact of the structural reforms.

Conclusion

For the last twenty years, China implemented an historical economic reform process, from a planned economy to a market-oriented one. During this period, the China's relative advance compared to the rest of the world with regard to health performance, still significant, has decreased. This paper aims at assessing the impact on Chinese infant survival both of the growth of income and of the main associated reforms, using a panel data analysis and an appropriate indicator of infant survival.

We have highlighted the increasing impact of income per capita on infant survival along with the reforms and tried to explain it by the main aspects of the reforms which have occurred: real depreciation, openness, decentralization and privatisation. The results are consistent with the well known fact that the new China health system relies more and more on private expenditures. Among the proxies used to capture the main aspects of the reform, the change in the real exchange rate has enhanced the stronger impact. Infant survival primarily depends in China on the poverty reduction, which itself depends on the change in income and relative prices.

The impact of the structural reforms variables (privatisation and decentralization), beyond their impact through income per capita or social expenditures, appear to have had a positive impact on infant survival, notably due to a better resource allocation in the health system.

Appendix 1- Definition and Sources of the Variables

s_{it}	Logistic transformation of infant survival	China Population Yearbook (various issues)
y_{it}	Real GDP per capita (yuans 1978)	Comprehensive Statistical Data and Materials on 50 Years in New China, China Statistical Yearbook (various issues over the eighties and nineties)
$soce_{it}$	Social expenditures purged from the GDP per capita	Comprehensive Statistical Data and Materials on 50 Years in New China, China Statistical Yearbook (various issues over the eighties and nineties)
$infr_{it}$	Length of Roads, Railway and Navigable Inland Waterways on the total area	Comprehensive Statistical Data and Materials on 50 Years in New China, China Statistical Yearbook (various issues over the eighties and nineties)
ur_{it}	Ratio urban vs rural income	Comprehensive Statistical Data and Materials on 50 Years in New China, China Statistical Yearbook (various issues over the eighties and nineties)
$popagr_{it}$	Share of agricultural population purged from the GDP per capita	Comprehensive Statistical Data and Materials on 50 Years in New China China Statistical Yearbook (various issues over the eighties and nineties)
ouv_{it}	Openess (ratio of the sum of exports and imports on GDP)	Comprehensive Statistical Data and Materials on 50 Years in New China China Statistical Yearbook (various issues over the eighties and nineties)
$cgks_{it}$	Share of central investment in capital on total capital investment	Comprehensive Statistical Data and Materials on 50 Years in New China China Statistical Yearbook (various issues over the eighties and nineties)
$soel_{it}$	Share of the staff in State Own Enterprises in total staff	Comprehensive Statistical Data and Materials on 50 Years in New China China Statistical Yearbook (various issues over the eighties and nineties)
ipc_{it}	Consumption Price Index	Comprehensive Statistical Data and Materials on 50 Years in New China China Statistical Yearbook (various issues over the eighties and nineties)
$reer_{it}$	Real Effective Exchange Rate	Comprehensive Statistical Data and Materials on 50 Years in New China China Statistical Yearbook (various issues over the eighties and nineties) Calculations of the CERDI

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Table 1- Impact of a Variable X on Survival (s) according to the Specification			
Specification	Derivative	ds/dX = ß	Interpretation
(1) $s = a + ß_0.X$	$ds = ß_0.dX$	$\frac{ds}{dX} = ß_0$	Constant marginal impact
(2) $\ln s = a + ß_1.\ln X$	$\frac{1}{s}.ds = ß_1.\frac{1}{X}.dX$	$\frac{ds/s}{dX/X} = ß_1$	Constant elasticity
(3) $\ln \frac{s}{1-s} = a + ß_2.X$	$\frac{1}{s.(1-s)}.ds = ß_2.dX$	$\frac{ds}{dX} = ß_2.s.(1-s)$	marginal impact depending on $ß_2$, and on s.(1-s)
(4) $\ln \frac{s}{1-s} = a + ß_3.\ln X$	$\frac{1}{s.(1-s)}.ds = ß_3.\frac{1}{X}dX$	$\frac{ds/s}{dX/X} = ß_3.(1-s)$	elasticity depending on $ß_3$, and on (1-s)

Table 2- Actual vs Predicted Chinese Child Survival, According to the Specification					
		Logarithm Specification		Logit Specification	
year	Actual (1)	Predicted (2)	(3) = (1)-(2)	Predicted (4)	(5) = (1)-(4)
1980-85	950	812	138	769	181
1985-90	954	844	110	837	117
1990-95	958	865	93	877	81
1995-00	962	887	75	914	48

Table 3- Structural Factors Explaining Infant Survival in China: The Increased Impact of Income , a Panel Estimate (Within Estimator)		
	(1)	(2)
y_{it}	0.97 (0.00)***	0.72 (0.00)***
y_{it}.d90		0.64 (0.00)***
D90		-4.48 (0.00)***
ur_{it}	-0.81 (0.00)***	-0.52 (0.13)
$popagr_{it}$	-8.26 (0.02)**	-9.60 (0.02)**
$soce_{it}$	2.11 (0.00)***	2.20 (0.00)***
$infr_{it}$	0.41 (0.00)***	0.26 (0.00)***
Constant	-2.69 (0.05)**	-1.57 (0.18)
R^2	0.40	0.46
Number of Observations	142	142

*, ** and ***: respectively significant at the 10%, 5% and 1% level. p-value associated with the t-student in parenthesis (from robust standard errors).

Table 4- Policy Reform Explaining Survival in China Panel Estimates (Within Estimator)							
	(1)	(3)	(4)	(5)	(6)	(7)	(8)
y_{it}	0.97 (0.00)***	1.03 (0.00)***	0.92 (0.00)***	0.87 (0.00)***	3.08 (0.01)***	3.01 (0.02)**	0.63 (0.00)***
ur_{it}	-0.81 (0.00)***	-0.43 (0.23)	-0.47 (0.20)	-0.66 (0.03)**			
$popagr_{it}$	-8.26 (0.02)**	-8.73 (0.00)***	-7.06 (0.02)**	-6.48 (0.03)**	-6.50 (0.03)**	-6.72 (0.05)**	-8.85 (0.00)***
$soce_{it}$	2.11 (0.00)***	2.33 (0.00)***	2.50 (0.00)***	2.74 (0.00)***	1.89 (0.00)***	1.91 (0.00)***	2.05 (0.00)***
$infr_{it}$	0.41 (0.00)***	0.25 (0.00)***	0.22 (0.00)***	0.27 (0.00)***	0.17 (0.00)***	-0.17 (0.01)***	0.20 (0.00)***
$reer_{it}$		0.40 (0.04)**	0.32 (0.08)*		3.92 (0.02)**	3.78 (0.05)**	
$y_{it}.reer_{it}$					-0.50 (0.05)**	-0.49 (0.08)*	
ipc_{it}		-0.51 (0.27)					
ouv_{it}			-0.06 (0.30)	-0.11 (0.067)*			
$soel_{it}$			-2.66 (0.09)*	-3.88 (0.012)**	-2.27 (0.11)	-2.21 (0.11)	-1.85 (0.22)
$cgks_{it}$			-0.69 (0.08)*	-0.87 (0.02)**	-0.34 (0.32)	-0.30 (0.43)	-0.34 (0.41)
D90						-0.71 (0.77)	-4.07 (0.00)***
$y_{it}.d90$						0.10 (0.77)	0.57 (0.00)***
Constant	-2.69 (0.05)**	-3.17 (0.28)	-2.58 (0.23)	0.10 (0.95)	-18.91 (0.02)**	-18.15 (0.04)**	-0.23 (0.89)
R^2	0.40	0.46	0.48	0.46	0.48	0.48	0.46
Number of Obs.	142	142	142	142	142	142	142

*, ** and ***: respectively significant at the 10%, 5% and 1% level. P-value associated with the t-student in parenthesis (from robust standard errors)

Figure 1- 1980-1984

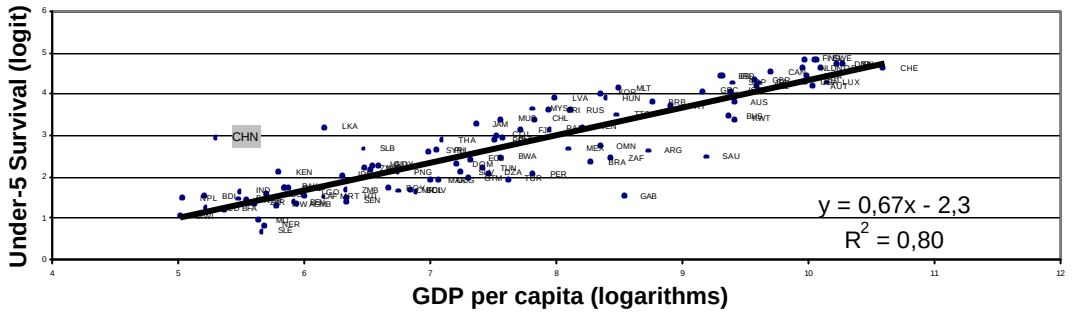

Figure 2- 1985-1989

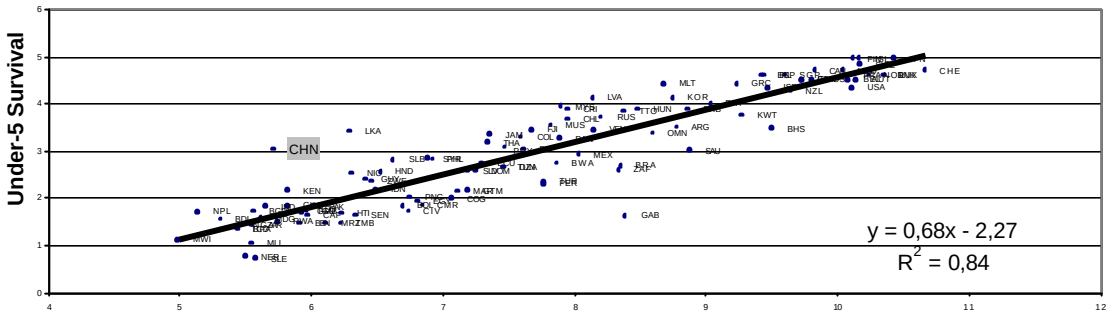

Figure 3- 1990-1994

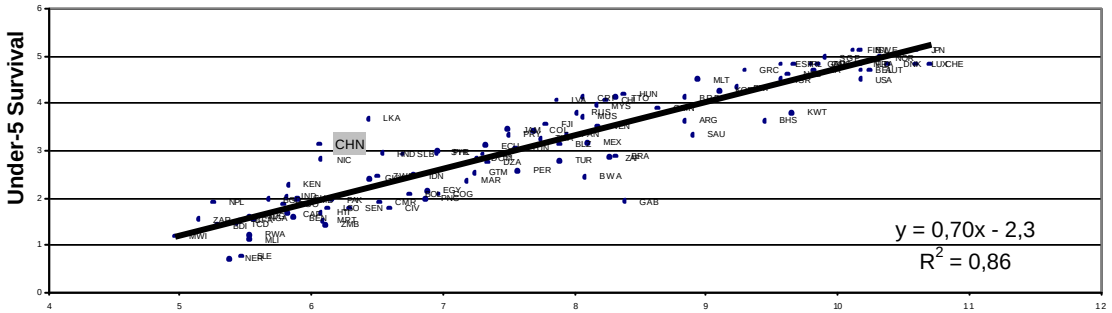

Figure 4- 1995-1999

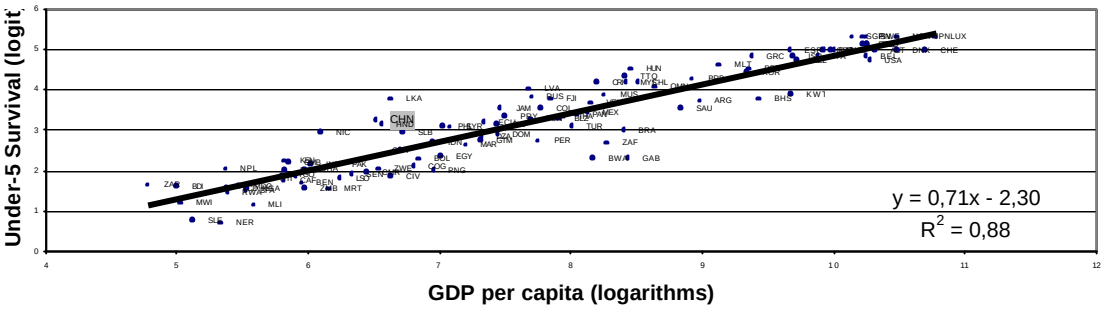

Figure 5- 1981

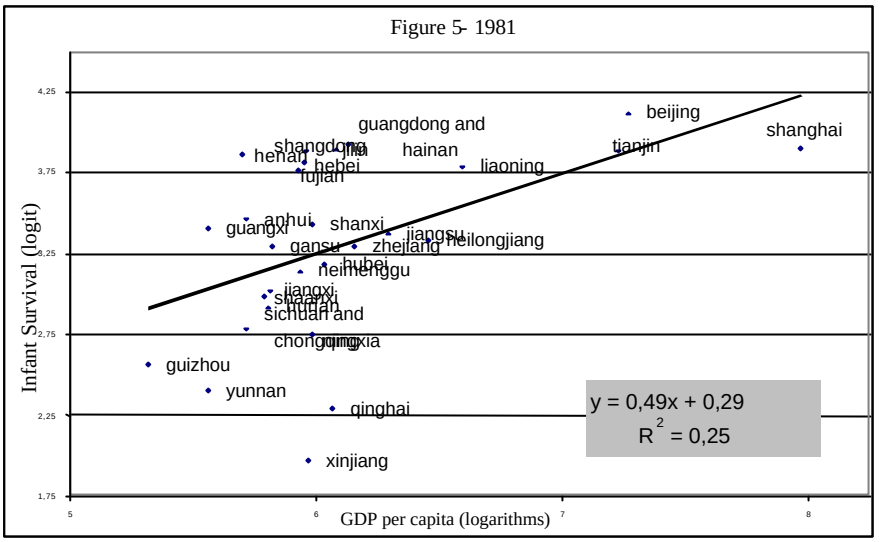

Figure 6- 1989

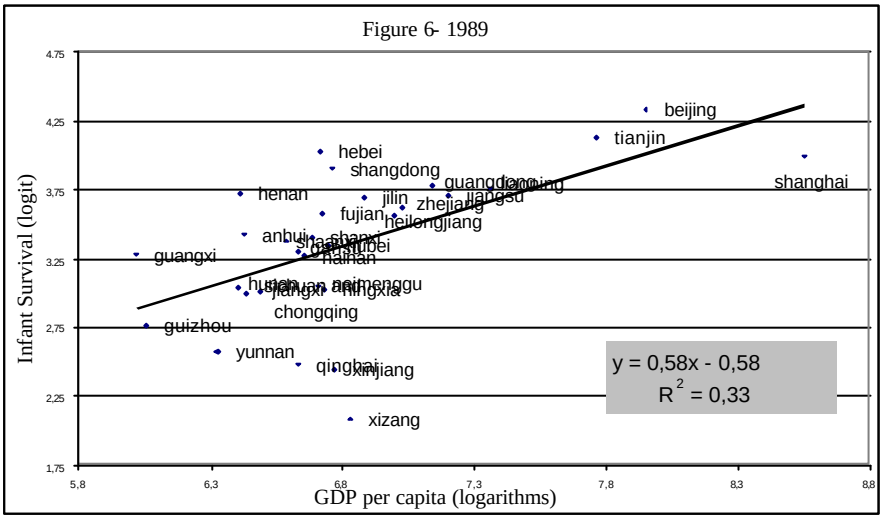

Figure 7- 2000

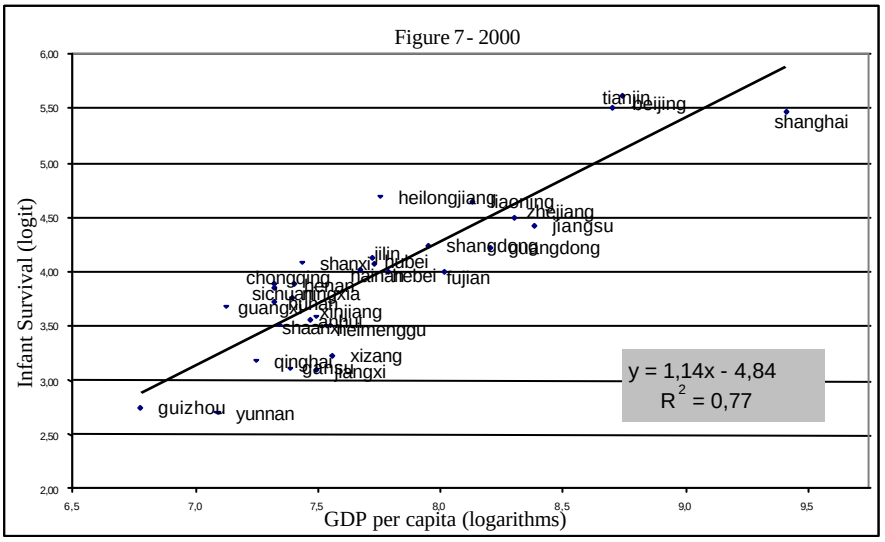

Figure 8 – Reforms process and impact of income per capita on health outcomes