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ADB Institute Discussion Paper No.1

**Explaining Trends in Regional Poverty
in People's Republic of China.**

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Asian Development Bank Institute

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Introduction

How poverty is measured in the People's Republic of China (henceforth PRC) has considerable implications for analysis of the global trends in poverty. For some experience over the last 20 years in reducing poverty in PRC can be seen as the greatest success in meeting development goals of the twentieth century. Superficially at least the country appears a clear case study of the success of growth-oriented policies that have succeeded in pulling millions above the poverty line. However, it is also widely recognized that in some parts of the vast country the impact of growth on poverty has been less strong than in others. Also there is considerable dispute concerning the accuracy of the official poverty figures. This paper examines the question of poverty reduction in PRC by examining poverty trends across time and provinces in a simple panel data model. There is a lengthy literature on PRC that applies cross sectional regression models to provincial data however this is almost exclusively concerned with various tests for 'convergence' rather than examining trends in poverty. Examples of such convergence studies are Jian et al (1996), Raiser (1998), Fujita and Hu (2001), Aziz and Duenwald (2001) and Demurger et al (2001). The only cross-province study on poverty that we are aware of is in World Bank (2001) and we have tried to extend its analysis by applying a more detailed regression model over a longer time period.

The paper begins with an overview of the picture on poverty in PRC, pointing to the alternative estimates of the numbers of the poor that are available and the data on the regional dimension of poverty. The second section presents the methodology employed in our analysis to explain trends in poverty. The third section discusses our results and the fourth and final section considers some brief policy conclusions.

1. Poverty in PRC: the National Picture

In PRC there is a tradition of measuring income-poverty and in the post economic reform era since the late 1970's measures of national poverty have fallen dramatically. In turn, given the large population of the country this has had major implications for global poverty estimates with the estimated global fall in the numbers in poverty 1987-98 due entirely to performance in PRC (Stern 2001). For example, official government figures indicate a fall in numbers of the rural poor from about 260 million in 1978 to only 42 million in 1998 and further to about 30 million in 2000 (World Bank 2001, State Council 2001). Poverty amongst the registered urban population has always been treated as low with a figure of 14 million being a current official estimate, although this is based on a higher real poverty line than the rural data.¹ These figures translate into a very low headcount index for the country as a whole of below 4% and suggest that growth and economic reform have removed poverty as a major policy issue. This is an oversimplification for a number of reasons.

¹ This is based on an unpublished estimate.

1.1 What is the poverty line?

First, there is considerable debate about the poverty line to use in establishing a headcount index. The official line for rural poverty is based on the cost of a minimum calorie intake (2100 calories) plus an allowance for non-food items. However the official rural line is very austere -it is equivalent to US\$0.66 per day in purchasing power parity terms- and is designed to provide no more than the very minimum subsistence level for food and clothing. Further it is treated as inaccurate by some observers for a number of technical reasons. For example, for the official line it appears that for the benchmark year of 1988 the own consumption part of the food bundle was valued at controlled prices, rather than at the market prices the poor would have to pay; also nominal incomes were deflated by the national consumer price index rather than by regional price deflators (Chen and Ravallion 1996). The latter adjustment is significant since prices rose more rapidly in poorer provinces. There is also a dispute about how to treat the imputed rental income of own housing (Riskin and Li 2001). Different estimates of the poverty line naturally will give a different picture of the headcount index and may imply differences in its rate of change. For example, using a poverty line 25% above the official figure Riskin and Li (2001) suggest that between 1988 and 1995 there was no fall in the headcount index and with a growing rural population there was an absolute rise in the numbers of the rural poor.

However, the picture of a falling headcount from the late 1980's is still supported by other estimates that use a higher poverty line than the official figure. World Bank (2001) shows that using the international standard of US\$1 per day in constant purchasing power parity dollars the headcount for the rural population fell from 31% to 12% from 1990-98, although by this higher poverty line the numbers of rural poor were 106 million in 1998 compared with the official estimate of 42 million. Hence any inaccuracy associated with the official poverty line may be more with the absolute number of the poor than with the overall trend. None the less despite the uncertainty concerning the precise point at which to place the income poverty line there can be no dispute that large numbers of people in rural areas – and there were approximately 100 million below the constant price dollar a day line in the late 1990's – must be seen as still living with only a very minimum subsistence income and as being highly vulnerable to unfavorable shocks, whether personal, climatic or economic.²

Table 1 summarizes alternative national estimates of the numbers in poverty depending on the choice of poverty line.

Table 1 Alternative National Poverty Estimates

Official Poverty line ^a yuan/year	Numbers of rural poor in millions (% of rural population)	World Bank Poverty line ^b US\$/day	Numbers of rural poor in millions (% of rural population)	Riskin Poverty line ^c yuan/year	Numbers of rural poor in millions (% of rural population)
1990 Y300	85 (9.5%)	US\$1	280 (31.3%)	Na	Na
1995 Y530	65 (7.1%)	US\$1	200 (21.8%)	Y662	113 (12.4%)
1998 Y635	42 (4.6%)	US\$1	106 (11.5%)	Na	Na

² All figure cited above are based on an income poverty line. If an expenditure-based line is used the numbers of the poor are much higher, since around the poverty line in PRC incomes exceed expenditure. World Bank estimates suggest that in 1999, 240 million people lived in families with expenditure per person below the US\$1 per day expenditure poverty line (Stern 2001).

Notes a) Current prices
 b) In constant 1985 purchasing power parity dollars
 c) Based on a poverty line of yuan 301 in 1988 inflated using provincial price indices.
 Na is not available.

Source: World Bank (2001) table 1 and Riskin and Li (2001) table 14.4.

Our analysis below looks at the rate of change of poverty utilizing estimates by province based on the official poverty line data. This is required because detailed provincial estimates were not available utilizing the alternative poverty lines. Hence we are assuming implicitly that the rate of change is broadly similar whatever absolute level is set for the poverty line.

1.2 Growing Inequality

In addition there is strong evidence that since the late 1980's the growth effect on poverty reduction has been weakened by rising inequality between social strata, between rural and urban dwellers and between provinces. Table 2 summarizes data on Gini coefficients and ratios of urban and rural per capita incomes from the sample household surveys Analyzed in great detail by Riskin et al (2001). A ratio of average urban to rural incomes of above 2.0 is relatively rare internationally and suggests a particularly acute disparity in PRC.

Table 2 Inequality indicators

Year	Rural Gini	Urban Gini	National Gini	Urban/rural ratio (income per capita)
1988	0.338	0.233	0.382	2.41
1995	0.416	0.332	0.452	2.79

Source: Zhao (2001)

Also a rise by seven percentage points in a Gini coefficient over such a brief period is, if accurate, a very rapid increase in inequality. Growing inequality in PRC is certainly the result of forces unleashed by market liberalization, both in relation to agricultural markets in the 1980's and to foreign trade and investment in the 1990's. Although these reforms contributed to the high rates of growth over the same period rising inequality must have had a significant effect in weakening the relation between a given rate of growth and poverty reduction. (Chen and Wang, 2001).

1.3 Regional Disparities

Regional inequality, both between urban and rural areas and between rich and poor provinces also increased over the same period. Table 3 summarizes the regional picture by using the conventional official distinction between three groups of provinces –Eastern, Western and Central. Growth rates have been high by international standards in each of the three regions and also in each of the provinces within each region. However growth has also been fastest in the higher income Eastern region, so that direct convergence in income between provinces has not taken place. However simple comparisons of average incomes between regions do not reveal dramatic disparities, with the poorer Western region having an average income per capita of roughly 60% of the national average. Disparities within regions, between urban and rural areas and between social strata are considerably greater than between regions themselves.

Table 3 Regional trends

	Eastern region	Central region	Western region
Per capita GDP growth 1981-1999 ^a	10.9%	8.4%	8.1%
Regional GDP per capita ^b 1999 national average = 100	157%	75%	56%

Source: Calculated from China Statistical Yearbook

Note a) GDP per capita is at 1980 prices using provincial GDP deflators and growth rates are calculated as time trends.

b) As above GDP per capita is at constant 1980 prices.

In terms of the trend in regional disparities formal analyses of conditional income convergence, in the sense of a negative coefficient on the term for initial income in a cross provincial growth equation controlling for various provincial characteristics, present a mixed story. Early results suggested that history post-1949 could be divided into distinct time periods. In the first of these up to the mid 1960's no clear trend is discernible. From the mid-1960's to late-1970's biases in the resource allocation mechanism of the central planning system widened provincial income disparities. In the liberalization period from the late 1970's to 1990 conditional convergence is found. However this trend weakens in the 1990's with the accelerated expansion in the Eastern-coastal region (Jian et al 1996, Raiser 1998). More recent work finds some, albeit statistically weak, evidence of conditional convergence over the whole period, but a clear tendency for direct divergence in the 1990's with the poorer provinces growing more slowly than the richer areas (Demurger et al 2001, Fujita and Hu 2001).

The continuing regional disparities in income and level of development within the country have been the subject of considerable policy debate with the recognition that poverty levels are significantly higher in the Western and some Central provinces. This is illustrated in table 4 which summarizes the provincial growth rates and the official rural poverty estimates for the 12 provinces now classed as being part of the Western region (Guangxi and Inner Mongolia have recently been added, although geographically they are in the center of the country).

Table 4 Western Region: Rural Poverty and GDP growth by province

Province	GDP growth 1980-2000 (%)	Numbers of rural poor (mill) 1996	Poverty incidence Headcount (%) 1996
Southwest		20.7	10.5
Chongqing	9.3	1.6	6.6
Sichuan	9.0	4.9	7.0
Guizhou	9.1	3.8	12.8
Yunnan	9.9	7.7	22.9
Tibet	8.3	0.2	10.1
Guangxi	9.4	2.5	6.4
Northwest		14.3	18.6
Inner Mongolia	10.2	1.3	
Shaanxi	9.6	4.8	17.5
Gansu	9.1	4.5	22.7

Qinghai	7.6	0.6	17.7
Ningxai	9.5	0.7	18.5
Xinjiang	10.4	2.4	27.4
National rural		58	6.3

Source: World Bank (2001) table 1.2 and China Statistical Yearbook various issues.

It can be seen that despite having had relatively high past rates of economic growth, in 1996 the Western provinces had a significantly higher incidence of rural poverty, of 11% in the Southwest and 19% in the Northwest, compared with a national figure of only 6%. Roughly 60% of those in rural poverty by the official definition are in the Western region.³ More recent data taking the story up to 1999 are only published at the aggregate regional level. They show a continued decline in rural poverty both nationally and in the West and suggest an incidence of rural poverty in the West as a whole of only 7% (State Statistical Bureau 2000). Sceptics might suggest that this acceleration in the rate of decline of measured poverty is due in part to the need to achieve the overall national target of 30 million poor by the year 2000 set by the Seven-Year Priority Poverty Alleviation Program. However, as we discuss below, there are clear economic reasons that can be shown to explain the decline in official estimates of poverty in the West and elsewhere over the period 1988-96.

It is an oversimplification to explain all rural poverty in PRC in 'ecological terms', as related to mountainous and rainfed terrain of low agricultural productivity, since there seems little doubt that there is an element of rural poverty caused by the inability of some households to compete in the new market environment (Riskin 1994). However, as far as the Western region is concerned the ecological explanation is generally accepted to be largely convincing (Ravallion and Jalan 1999). The Western Region is widely recognized as having the bulk of the poorest and most remote agricultural land in PRC in the form of mountains, hills, plateaus and deserts. For example, roughly half the mountainous counties in the country are in the Western Region, whilst roughly 65% of the designated poor mountainous counties are in the West. Unlike many other countries the rural poor are generally not landless since they have land use rights. The problem in the West and in other mountainous areas is the low quality and hence low productivity of the land. Many of the rural poor rely on grain production for income or self-consumption and, as we explain below, there is evidence that higher grain yields have a strong effect on poverty reduction. Partly as a consequence of this geographical disadvantage the local farmers tend also to be disadvantaged in social terms. The rural poor in the Western Region tend to be worse educated than elsewhere. The rural illiteracy rate in the Western Region was around 15% in 1998 compared with 9% nationally and about 6% in the other regions.⁴ Further, health indicators show a strong correlation between low income and poor health status. Inaccessibility of village location in the Western Region, as measured for example by distance to either markets or the nearest town, also appears to be correlated with the risk of poverty (State Statistical Bureau 2001).

The situation is complicated by the presence of ethnic minorities, who are significantly over-represented in the rural poor in the Western Region relative to their share in total population. Nationally it is estimated that minorities are less than 9% of the total population, but they may be

³ However the severity of this poverty in terms of the distance of the poor from the poverty line is far from uniform within the region and the bulk of the most severe poverty is to be found in the Northwest and Yunnan in the Southwest. This is based on the 'squared poverty gap' estimates in World Bank (2001) table 12 annex 1. The squared poverty gap is the summation for all those in poverty of $((pl-y)/p)^2$ divided by the total population, where y is the income of a poor person and pl is the poverty line.

⁴ These literacy figures are based on survey data from Ministry of Labor and Social Security.

as much as 40% of the poor by the official definition of poverty (World Bank 2001). Minorities are concentrated in the Western Region and tend to occupy the least fertile land there. In the past they have been at a particular disadvantage relative to other poor groups; official anti-poverty programs apparently until recently did not reach very successfully into minority areas (World Bank 2001). Also the lack of knowledge of Han Chinese has made it difficult for members of these minorities to migrate to seek work (World Bank 1997).

In the more prosperous rural areas of the country the rapid growth of Township and Village Enterprises (TVEs) in the 1980's offered non-agricultural rural jobs often at higher income levels than could be earned in agriculture. This outlet for the rural poor is available for some of the rural poor in the Western Region, but the scale of TVEs is generally much less than elsewhere. For example, in value terms in the early 1990's output of TVEs per capita was nearly six times as great in the richer Eastern region as compared with the West, although rate of output growth in TVE activity in the latter was still very high up to then (Sun and Dutta 1997 table 7). Further evidence on this relative lack of rural industrialization is provided by data on the proportion of rural workers engaged in industry. Table 5 gives data on rural industrial employment and wages by province. Employment rates in TVEs are uniformly low in the Western Region but average wage rates within the region differ markedly with the highest in Ningxia roughly three times that in the lowest in Guizhou. In general in the West they average half of those in the Eastern region, although they are similar to those elsewhere in the country. In terms of employment growth World Bank (2001: table 2.10) reports falling TVE employment in most of the Western Region during the 1990's, although employment in private enterprises generally grew rapidly in most provinces.

Table 5 Rural industrial employment by province

	Rural employment in industry to total rural employment (%) 1995	Average monthly wage of TVE workers (Yuan) 1995
Eastern region	17.0	208.2
Central region	6.6	100.0
Western region	3.5	97.4
Chongqing	NA	NA
Sichuan	4.7	90.6
Guizhou	3.0	54.5
Yunnan	2.6	84.7
Shaanxi	5.0	64.6
Tibet	NA	NA
Gansu	4.0	69.3
Qinghia	3.7	125.5
Ningxia	2.8	151.5
Xingjiang	2.5	138.3
Guangxi	3.1	153.2
Inner Mongolia	3.0	71.4

Source: State Statistical Bureau cited in Zhang (2001) table 9.7.

Note: Regional figures are simple averages of province data.

Urban poverty has only recently become a policy issue and estimates of urban poverty rates by province are uncertain, particularly because of the difficulty of covering migrants not registered in

their city of residence. Our analysis omits all reference to urban poverty, although there is no doubt that with the closure of loss-making state owned enterprises (SOEs) urban poverty is likely to become a very significant policy issue in the coming years.⁵

2 Cross Province Analysis of Poverty

There is a long tradition of regression analyses on PRC that apply cross-sectional techniques using provinces as the unit of analysis. This is in contrast with more conventional studies that examine trends across different countries. However, this PRC literature deals exclusively with disparities in average per capita incomes between provinces not with trends in poverty between provinces. We carry out a panel data cross-province analysis, covering both different time periods and provinces, to explain poverty reduction. Given the lack of time series estimates on urban poverty our focus is exclusively on the rural side. We use the provincial rural poverty estimates from the State Statistical Bureau covering a number of years within the period 1988-96.⁶ In a panel data model we pool data across both provinces and the periods 1988-89, 1989-91 and 1991-96. The variable we seek to explain is the average annual change in a measure of poverty across regions in each period. For the latter two periods annual changes are derived by taking a geometric average. For each region there are three observations corresponding to the three periods and with 30 regions, in most cases this gives 90 observations for the panel analysis. The appendix lists the main variables included and gives information on data sources.

2.1 Regression Model

To explain trends in poverty we use a simple model that makes changes in poverty across provinces a function of income growth and a number of control variables that reflect province characteristics and external shocks. This follows from the analysis of growth-poverty relationships across countries in the work of Dollar and Kraay (2000) and others. Insofar as we are dealing with observations within a single country some of the criticism of this approach, most particularly that it attempts to find an average relationship across a heterogeneous set of countries, will not be valid (Srinivasan 2001).

In our analysis formally we can write

$$HC_{it} = T_t + bC_{it} + cV_i + e_{it} \quad (1)$$

Where HC is the annual change in the poverty headcount index (defined as the proportion of the population below the official poverty line), T covers variables that change over time but are common across provinces, that is time constants for each period, C refers to variables that change both across provinces and over time, whilst V covers variables that change across provinces but are constant over time, specified as province dummies; e is an error term, and the subscripts refer to province i and time period t.⁷ For all variables with a time dimension where averaging is needed annual figures are calculated as geometric averages.

⁵ In the mid 1990's initial estimates of surplus SOE workers nationally were between 20 and 35 million, which corresponds to 10% to 17% of total urban employment. For the Western Region by the end of 1998 306,000 SOE workers had been laid off in Shaanxi, 288,000 in Sichuan, and 137,000 Gansu (OECD 2000:37-38)

⁶ These are published only in World Bank (2001) and we have not been able to obtain access to more recent data to extend the series. Detailed provincial poverty estimates for urban areas are not available on a time series basis. The State Statistical Bureau provided the database for other provincial variables.

⁷ This approach assumes a constant slope, but a different intercept for all provinces. For ease of computation equation (1) is often estimated by taking first differences of all variables and omitting observation-specific dummies. As we wish to analyze the coefficients on the dummies we use the version set out in the text. Hsiao (1989: 29-32) proves the mathematical equivalence of both approaches.

T, V and C are all vectors. All non-constant values are expressed as percentage changes. As we take change in the poverty headcount as our dependent variable and including annual change in regional income in C allows us to estimate the poverty elasticity with respect to income as the coefficient on the income variable. For clarity of exposition we consider changes in the headcount as positive numbers, so that the expected poverty-income elasticity is here positive (rather than the usual negative formulation).

We are concerned with testing the hypotheses

- a) That economic factors can explain poverty trends;
- b) That various province-specific characteristics have an independent influence;
- c) That any of the key elasticities with respect to poverty, particularly the elasticity with respect to growth of mean income, differ significantly in the Western region from those for the rest of the country.

Under vector T we include constant terms for each of the separate time periods covered in the pooled data sample. These should pick up macro shocks exogenous and common to each province. Alternatively to reflect macro shocks, we also experiment with the use of changes in national price series such as the consumer price index in each time period, although these do not add anything to the results and are not reported.

Under vector C we include variables to reflect the changing economic characteristics of provinces over time. Of these, a-priori, the key variable is expected to be provincial per capita income growth, which is expected on the basis of results elsewhere to be strongly and positively related to poverty reduction.⁸ However a limitation of our data is that we have no information on inter-provincial migration. Hence a rise in income in province A may induce migration from B and contribute to lowering poverty in B, independent of the change in B's income. However the effect of migration within B itself in response to higher incomes in B will be picked up. Any general improvement in macro economic conditions that induces inter-provincial migration will be captured by one of the time period constants, not by the provincial income variable, so this is a possible source of bias.

In recognition of the fact that different patterns of economic growth have different poverty consequences we also test for the effect of agricultural growth. Grains are the staple crop of poor farmers in PRC and poverty should be affected by trends in both grain crop production and in producer prices. Hence we include change in an index of grain production growth per province in volume terms. In addition, to allow for relative price effects we include a terms of trade index for farmers calculated as the change in the agricultural procurement price index for each province, which is dominated by grain sales, relative to a provincial rural price index for industrial goods. However, as the rural industrial goods price index may be a poor proxy for the change in price of the poor's consumption basket, as an alternative we also try the agricultural procurement price index alone, as a measure of the direct income effect of higher producer prices. The expectation is that all of these agricultural variables will have a positive sign.⁹ Finally to incorporate the impact of provincial infrastructure we include change in a number of province-

⁸ As discussed in Dollar and Kraay (2000) there is the possibility of endogeneity, with a two-way relation between income growth and poverty reduction. We test for this using instrumental variables and find that the possibility of reverse causation from lower poverty to higher growth can be rejected at the 5% level, but not at the 10% level. Even in the presence of some weak reverse causation the basic results of our analysis are still found to hold, since when we rerun a version of the regression reported in table 6 with instrumental variables for GDP growth the dominance of the grain variable remains robust. Details of this test are in the Appendix.

⁹ The terms of trade variable will only have a positive sign if the poor are net producers of foodstuffs. Given the relative absence of the landless rural poor in PRC this seems a plausible assumption for the majority.

specific measures of transport, relating to road and rail links, with the expectation that better transport communications speed up the development of market relationships and thus contribute to the reduction in poverty, so their expected signs are positive.

Under vector V we use a set provincial dummy variables to reflect the special characteristics of individual provinces that are constant over time. In addition, to allow for peculiarities in data for some provinces in some time periods we include dummies for the provinces of Anhui and Jiangxi and the municipalities of Beijing, Shanghai and Tianjin.¹⁰

Provided provincial dummies are significant explanatory variables in relation to poverty trends, we are also interested in explaining what provincial characteristics contribute to differences in poverty reduction, for a given change in economic variables. Thus we take the coefficient c on the provincial dummies in equation (1) as the dependent variable and regress these coefficients on a set of provincial characteristics. Hence we have

$$c_i = a + b_1 D_i + e_i \quad (2)$$

where a is a constant, D is a vector of variables measuring province specific characteristics and e is an error term.

Under D we try a range of variables to reflect the characteristics of provinces, both economic and geographic. We take initial income per capita at the start of the period as a general control with the expectation that the higher is income the more difficult it will be to reduce poverty, so that in our case the expected sign on initial income will be negative. We also use a measure of education attainment, which we proxy by the illiteracy and semi-illiteracy level in total population and expect that, for a given income level, higher education levels at the start of the period will have a positive effect on poverty reduction and so in our case educational attainment (as a measure of illiteracy rather than literacy) is expected to have a negative sign. We also employ a proxy for the growth of private sector activity and commercial market relations, which we measure by the share of non-farm rural employment in provincial population. In the absence of actual time series data we take this latter variable at the end of the period to capture the cumulative trend over time on the assumption that at the start of the period in all provinces the level of this variable was very low. For a given income level at the start of the period, we expect that higher private sector activity at the end of the period will have a positive effect on poverty reduction. We also attempt to capture the effect of geography, which we proxy by the proportion of mountainous counties in total counties in each province. For a given initial income it is expected that inaccessible geographic or unfavorable ecological conditions should weaken the impact of growth on poverty and this variable therefore is expected to have a negative sign. We include the squared poverty gap, as defined above in footnote 3, to test whether the severity of poverty at the start of the period has an impact on poverty reduction. Other things being equal, a higher value for the severity of poverty is likely to make it more difficult to lower poverty, so a negative sign is expected. However, as this variable is available only for 1991 not earlier, we are forced to assume that it remained constant between 1988 and 1991 in each province, which may be a strong assumption that weakens the usefulness of this variable. As a test for the impact of

¹⁰ The poverty incidence data suggests some regional one-off events affecting poverty. For instance during 1989-1991 due to floods the poverty incidence in Anhui province rose from 7.7 to 27.7, roughly a fourfold increase, whilst in the same period for Jiangxi province it dropped from 5 to 0.3. To allow for these data peculiarities we include two separate dummy variables corresponding the second period for Jiangxi and Anhui. The municipalities of Beijing, Shanghai and Tianjin have very low levels of recorded poverty so that small absolute changes in some periods can lead to very large proportionate changes in the headcount index. Period dummies are also used for these municipalities to address this.

the characteristics of the Western region as a whole, we also include a dummy for Western provinces alone.

Finally we estimate equation (3) where we re-estimate equation (1), but this time replacing the provincial dummies with the consistently significant province-specific variables from equation (2). Hence we have

$$HC_{it} = T_t + bC_{it} + b_1D_i + e_{it} \quad (3)$$

Where D is the vector of significant constant province-specific variables.

3. Results

We commence the analysis with a simple regression of poverty reduction by province on GDP growth by province. The overall elasticity is 1.3, which is broadly comparable with experience in other countries and is lower in the Western provinces (0.8) than in the rest of the country (1.5). However, the difference between the West and the rest of the country is not statistically significant at the 10% level. Further, although the relation between per capita GDP growth and poverty reduction is significant at the 1% level, this growth explains virtually nothing of the change in poverty, as evidenced by the extremely low R-squared. These preliminary results suggest that over this period there is no evidence that the growth-poverty mechanism works differently in the West as compared with elsewhere in the country. However, they also imply that the general link between economic growth and poverty reduction across provinces in PRC is far too aggregate a relationship to reveal anything useful about the factors at work in influencing the fall in poverty in the West and elsewhere.¹¹

Table 6: Explaining changes in Poverty Headcount by province from equation (1)

Explanatory variables	Coefficients
Change in grain production	1.6* (0.3)
Per capita GDP growth	1.6 (1.3)
Change in agricultural procurement price index	1.3** (0.6)
F ratio	4.6*
Adjusted R ²	0.612
Number of observations	90

Notes: Time period and province constants are not shown. Full results are presented in the appendix (table A.2). Standard errors are in parenthesis; * indicates significance at 1% level, ** at 5% and *** at 10%. White Heteroscedasticity-Consistent Standard Errors and Covariance test is adopted to allow for heteroscedasticity. Serial correlation test, Ramsey Reset test and Normality test are all passed.

¹¹ However, as noted the fact that we have not been able to incorporate inter-provincial migration may mean that there is a bias in our estimate of the poverty-income elasticity.

Table 6 documents the results when we extend the analysis by estimating equation (1) above. The results suggest strongly that across all provinces poverty reduction has been driven primarily by the growth of grain output, with a poverty elasticity of 1.6, significant at the 1% level. When applied with a constant term, this one variable explains 20% of the change in poverty across time and provinces.¹² As expected per capita GDP growth has a positive sign with an elasticity of 1.6, however it is not significant. Multicollinearity between grain output and GDP growth does not appear to be a problem since the correlation coefficient between the two is only 0.03. Change in the agricultural terms of trade index is not significant and is not reported, however the agricultural procurement price index is significant with the expected positive sign. The transport variables, the growth of rail and highway networks suffer from multicollinearity and are not reported.¹³ Individually only one of the provincial dummies is significant, however they are found to be collectively significant at the 5% level by the Wald test. Hence we turn to equation (2) to explain the coefficients on these dummies.

Table 7 shows the application of equation (2) explaining the coefficients on the provincial dummies from equation (1).¹⁴ Equation (2.1) regresses the provincial dummies on a constant and a general Western region dummy alone (a value of unity for all Western provinces and zero for all others). The Western dummy is significant with a negative sign at the 5% level implying that, allowing for economic variables (principally growth in grain production), there is a tendency for poverty reduction to be lower in the West than in the rest of the country. Equations (2.2) and (2.3) extend this analysis by incorporating specific measurable features of Western provinces. When additional characteristics are added the Western dummy ceases to be significant and is therefore not reported in equations (2.2) and (2.3). In the former, the level of private sector activity (proxied by non-agricultural rural employment in provincial population at the end of period), the poverty gap and initial income per capita by province are all significant with the expected signs. In other words, in the different provinces, other things been equal, the higher has been private sector activity, the higher is poverty reduction, and the lower is the initial severity of poverty and the lower is initial income, the higher is poverty reduction. Equation (2.2) explains more than half of the variation in the provincial dummies. Addition of the variables for educational attainment and for geography in equation (2.3) reduces the explanatory power of the equation and neither variable is significant either individually or collectively. Since a-priori educational and geographic features of Western provinces can be expected to have an impact on poverty in addition to their direct effect on economic variables, this result is likely to reflect the inadequacy of the proxy measures used, rather than the intrinsic unimportance of these variables.

¹² In contrast, GDP growth alone with a constant has an R squared of only 0.03%.

¹³ The railway growth variable is significant with a negative sign, which raises the possibility that there may be reverse causality with higher rail investment in poorer areas. Reverse causality is supported by a formal endogeneity test at the 5% level and therefore instrumental variables are employed, whose results show that when endogeneity is controlled for the rail variable becomes insignificant. The instrumental variables we select for rail growth are GDP growth, density of highway, density of railway, highway km per head and railway km per head. Using broadly similar variables Demurger et al (2001) also find that infrastructure measures are rarely significant in explaining growth trends across provinces.

¹⁴ As a check on the results in table 7 we also run equation (2) with the dummy coefficients from a different specification of equation (1) in which period dummies are omitted and provincial dummies alone are included. The new results are very similar to those of table 7.

Table 7: Explaining provincial dummies using equation (2).

Explanatory variables	Equation 2.1 ^a	Equation 2.2	Equation 2.3
Constant term	-1.4 (2.8)	0.2 (4.3)	1.4 (7.9)
Western dummy	-8.8** (3.5)		
Private sector activity		1.6* (0.5)	1.6* (0.5)
Poverty gap		-3.7** (1.6)	-3.6*** (2.1)
Initial income		-0.007*** (0.003)	-0.007*** (0.004)
Educational attainment			-0.08 (0.4)
Geographic conditions			0.008 (0.08)
F-ratio	4.7**	11.6*	6.0*
Adjusted R ²	0.114	0.522	0.473
Number of observations	30	30	30

Notes: Unless otherwise indicated all equations pass serial correlation test, heteroscedasticity test, Ramsey R reset test and normality test. Standard error is in parenthesis; * indicates significance at 1% level, ** at 5% and *** at 10%.

a) Heteroscedasticity is detected and White consistent error correction is applied

Finally we estimate equation (3) using the variables private sector activity, initial income and severity of poverty in place of the provincial dummies. We test for the stability of the coefficients between equations (1) and (3) and find that by the Hausman test the hypothesis that they are equal cannot be rejected at the 10% level. The results of this analysis are reported in table 8.

The most important aspect of this result is that whilst the coefficient on provincial GDP growth is 1.6 in both equations, in equation (3) it becomes significant at the 5% level, whilst it was insignificant in equation (1). The measures of private sector activity and of the severity of poverty are significant with the expected signs, although the latter is only weakly significant.

Table 8 Explaining change in poverty headcount by province using province characteristics in place of province dummies (equation 3)

Explanatory variables	Coefficients
Change in Grain output	1.4* (0.3)
Per Capita GDP growth	1.6** (0.7)
Change in Agriculture Procurement index	1.2** (0.5)
Flood dummy for Anhui	-52.8* (18.4)

Flood dummy for Jiangxi	75.5* (17.0)
Municipalities dummy 1	37.5** (15.0)
Municipalities dummy 2	-47.2* (14.9)
Initial income	-0.007 (0.005)
Severity of Poverty	-4.0*** (2.1)
Private sector activity	1.8* (0.6)
Time Constant period 1	-2.1 (8.7)
Time Constant period 2	-5.7 (8.7)
Time Constant period 3	-25.3** (12.5)
F-ratio	16.4*
Adjusted R ²	68.2
Number of observations	90

The equation passes serial correlation test, heteroscedasticity test, Ramsey R reset test. Standard error given in parenthesis, * indicates significance at 1%, ** at 5% and *** at 10%. Normality test is rejected arguably due to the omission of some variables.

Equation (3) has a larger number of degrees of freedom than equation (1) and therefore is potentially a more efficient form of estimation. This may account for the significance, as expected, of the income growth variable. The stability of the coefficients between equations (1) and (3) despite the fact that the province characteristics included in (3) explain no more than 50% of the variation in the dummies is likely to be due the fact that the factors causing the other 50% variation are uncorrelated with the key variables in equation (1).

4. Conclusions

How can we interpret these results in terms of performance in poverty reduction across provinces since the late 1980's? All of the basic hypotheses listed above are supported. Economic factors can explain poverty trends in a plausible way, whilst provincial characteristics influence the impact of economic variables. Also Western provinces as a group do seem to have characteristics that differentiate them from the rest of the country. More specifically several basic points should be stressed.

1. Economic growth – that is the rise in average incomes per province - is associated with falling poverty in the same province. However the relationship explains little of the fall in poverty and its significance is not robust.
2. Change in grain production and to a lesser extent changes in prices paid to farmers are the key factors in rural poverty reduction and the former alone explains nearly 60% of the variation in poverty across provinces.

3. Where new job creation by the private sector over the period studied has been fastest, poverty reduction has been most rapid.
4. Specific characteristics of Western provinces, whether due to topography, education levels, infrastructure or general inaccessibility to national markets, do appear to contribute to a lower impact of economic variables, like grain production, on poverty reduction. However, it is difficult to capture these specific characteristics quantitatively.

Hence as expected an environment of rising incomes and job creation has appears to have had a positive effect in terms of poverty reduction. However the results clearly suggest that the key factors in explaining rural poverty reduction have been the growth of grain crops (with a poverty elasticity of 1.6) and to a lesser extent the movement in prices faced by farmers (with a poverty elasticity of 1.3). In PRC agriculture remains the major source of income for the rural poor and in the Western provinces during the 1990's it was a higher proportion of provincial GDP than elsewhere in the country. Grain production is the main income source for most of the rural poor in the Western region, since the better-off will be able to diversify, for example by investing in livestock or tree planting; hence how grain production and producer prices change will be the dominant factor in determining poor households' position in relation to the poverty line.¹⁵ During the 1990's the rural poor should have been helped substantially by the liberalization of the grain market and the reduction in the implicit tax on farmers imposed by procurement prices set below market levels (Rozelle et al 2000). Compulsory grain procurement quotas for sales at controlled prices were also waived for the poor. Hence the ending or reduction of this implicit taxation can be seen as a major step forward in terms of poverty alleviation and in recent years procurement prices have been above rather than below approximate market-clearing levels (Martin 2001).

However, the results also suggest that there are specific features of the Western provinces that weaken the impact of positive economic trends on poverty. In the West there are serious pockets of rural poverty, where poor groups have remained relatively untouched by the general rapid rise in prosperity. This implies that the simple assertion that economic growth will take care of the poverty problem in the West is likely to be optimistic, at least in the short term. The results are consistent with the argument that, in the areas of serious pockets of poverty, location disadvantages may both lower returns to factors based there and impede links with the wider regional and national markets.¹⁶ In terms of migration, lack of inter-provincial migration data precludes the inclusion of an explicit migration variable, however the relatively weak link between growth of general economic activity and poverty reduction suggests only a weak impact of intra-provincial labor mobility on poverty reduction over the period covered.

Our analysis examines past trends in poverty in PRC to understand what factors have contributed most to poverty reduction. By establishing a relationship between poverty estimates and economic variables we have provided some support for the plausibility of the official estimates of provincial poverty. Further, the main finding that movements in grain production and to a lesser extent prices have been the key factors in explaining the past behavior of poverty indicators is of immediate policy relevance given PRC's recent WTO accession and the possible impact this may have on the domestic grain market. However, despite the close association between past trends in the grain market and the reduction in poverty we have to be cautious in

¹⁵ In an analysis of household survey data from four provinces in South-west PRC, Jalan and Ravallion (2000) find grain yields to be strongly and negatively related to levels of poverty.

¹⁶ This has been rationalized in terms of a theory of spatial poverty traps, arising from negative locational externalities (Ravallion and Jalan 1999). This argues that growth in an area can be explained not just by the factor endowments of households and firms resident there but also by 'geographic capital', defined as location-specific physical assets, like roads or water.

concluding from this that future poverty alleviation efforts in the Western region should be based principally on support for grain farming.

First, there is strong evidence that many poor grain farmers below or close to the poverty line are highly vulnerable to adverse climatic shocks. Clear evidence of this vulnerability is provided by the poverty monitoring surveys conducted as part of the World Bank Western Region Poverty Reduction Project (State Statistical Bureau, 2001). From these surveys it is clear that in many villages the drought of the year 2000 saw a significant rise in poverty, particularly in Inner Mongolia, with the rise higher in the control group of villages not part of the project; for example in the non-project villages in Inner Mongolia in one year the headcount rate of poverty rose by 3.5 percentage points.¹⁷ This argues for the importance of reducing dependence on rain-fed agriculture.

Second, not all of the land area of the Western region is suitable for grain cultivation and in parts of the Northwest, in particular, a shortage of water is a key constraint. Arable land is only 8% of the total land area in the Northwest and 10% in the Southwest (Demurger et al 2001:12-13). Where the rural poor are pastoralists, as opposed to farmers, specific problems relate to provision of shelter and fodder for animals and credit to purchase replacement livestock. Such groups are net purchasers of grains and will be harmed not helped by a rise in their relative price.

Third, it has been argued that PRC does not have a long run comparative advantage in land-intensive agricultural goods like grains. There is evidence that PRC is becoming a relatively high cost producer for some, but not all, grains (Lu 1998). There are a range of estimates for current protection levels for the grain sector, but a frequent assumption is that with WTO accession domestic grain prices will fall due to rising imports. Given that Chinese prices for wheat, maize and soybeans were well above world levels in 2000 this suggests that there are efficiency gains to be had by importing a higher proportion of grain needs and shifting domestic resources into other lines of activity.¹⁸ Thus if one disregards poverty concerns there is an efficiency argument for not creating high subsidy levels for grain producers by supporting prices that are substantially above world levels.

These three arguments together provide a strong case that in the longer term poverty reduction strategies must involve a diversification of activities for the poor away from grain farming to other crops (for example fruit and vegetables which are less land-intensive), as well as a movement out of the low productivity geographical areas in which 'ecological poverty' is present.¹⁹ However, there are also important short-term adjustment issues to be considered, since we have shown that poverty is strongly influenced by grain volume and price trends. Whilst supporting grain prices at levels well in excess of the long-run import price adjusted for transport and

¹⁷ The survey also confirms that location matters since poverty rates in villages tend to rise with distance from county towns and markets and to be higher for villages inaccessible by road.

¹⁸ The precise trajectory of prices in the coming years is still uncertain, but the terms for WTO accession allow PRC to retain the 'tariff rate quota system' and a relatively high bound tariff for grains (excluding soybeans) of 65%. This means that provided imports reach the minimum quota level the 65% import tariff will become operative generating a relatively high level of protection for marginal domestic production. Projecting the underlying historical demand trend suggests that there is a strong probability that imports will exceed the quota for wheat and maize in most years up to 2010 and a weaker chance for rice. The implied import tariffs after WTO accession for all three goods are significantly higher than the current levels (Martin 2001).

¹⁹ Official policy is to concentrate poverty assistance in specific areas. State Council (2001:41) states that "From 2001-2010, the Chinese government will concentrate its poverty alleviation efforts on the ethnic minority areas, the old revolutionary base areas, border areas and destitute areas in the central and western regions. Some counties will be designated for special help. The government will use its financial, material and human resources in a concentrated way in the comparatively concentrated poor areas. A unified plan will be drawn up, which will be carried out on a yearly basis."

marketing costs is not economically efficient and may also lead to high leakage in the form of subsidies for larger and better-off farmers, the impact of shortfalls in revenue from grains on the poor cannot be ignored. This suggests the need to ensure that at the very least procurement prices paid to farmers do not fall below a minimum floor level and that poverty alleviation measures encourage the rural poor to diversify their activities.

Appendix 1 Data and further results

Table A.1 Definitions of Main Variables and Data Sources

Name of Variable	Definition	Source ^a
Grain output	Volume index of grain production	State Statistical Bureau provincial database
Per capita GDP	Provincial income per capita	State Statistical Bureau provincial database
Terms of trade for agriculture	Change in the agricultural procurement price index per province relative to the change in rural price index for industrial goods per province	State Statistical Bureau provincial database
Agricultural Procurement price index	Agricultural procurement price index per province	
Non-state sector in industrial production	Share of non-state firms in industrial output by province	State Statistical Bureau provincial database
Initial GDP per capita	GDP per capita by province at the start of the period	State Statistical Bureau provincial database
Severity of Poverty	By province the summation for all those in poverty of $((pl-y)/pl)^2$ divided by the total population, where y is the income of a poor person and pl is the poverty line.	World Bank (2001)
Density of Railway	Ratio of railway length in kms to total province area in kms ²	State Statistical Bureau provincial database
Density of Highway	Ratio of highway length in kms to total province area in kms ²	State Statistical Bureau provincial database
Railway length	Distance covered in kms by province	State Statistical Bureau provincial database
Highway length	Distance covered in kms by province	State Statistical Bureau provincial database
Railway per head of rural population	Distance covered in kms divided by rural population by province	State Statistical Bureau provincial database

Highway per head of rural population	Distance covered in kms divided by rural population by province	State Statistical Bureau provincial database
Private sector activity	Share of non-farm rural workers in total population by province	State Statistical Bureau, First National Rural Survey available at www.stats.gov.cn
Education attainment	Share of population classed as illiterate and semi-illiterate in total population by province	State Statistical Bureau Fourth National Population Census available at www.stats.gov.cn
Geographic conditions	Share of mountainous counties in total counties by province	World Bank (2001)

Note a) Unless stated otherwise data come from an ADBI data-base on PRC's Regional Economy purchased from the State Statistical Bureau.

Table A.2 Explaining change in poverty headcount by province: full results equation (1).

Explanatory variables	Coefficients
Change in Grain production	1.6* (0.3)
Per capita GDP growth	1.6 (1.3)
Change in Agriculture Procurement index	1.3** (0.6)
Constant term for period 1	-4.0 (14.6)
Constant term for period 2	-4.9 (12.9)
Constant term for period 3	-26.8 (24.7)
Flood dummy for Jiang Xi	84.1* (22.5)
Flood Dummy for Anhui	-61.9* (15.2)
Municipality dummy 1	48.4* (13.7)
Municipality dummy 2	-35.9** (17.1)
ANHUI	0 (reference point)
BEIJING	-3.3 (15.0)
FUJIAN	5.1 (9.0)
GANSU	-12.5

	(12.9)
GUANGDONG	12.1 (14.7)
GUANGXI	1.4 (15.2)
GUIZHOU	-18.0 (13.9)
HAINAN	-22.4*** (12.1)
HEBEI	-15.1 (10.4)
HEILONGJIANG	-23.3 (17.3)
HENAN	-8.6 (10.3)
HUBEI	-2.0 (12.6)
HUNAN	13.0 (13.5)
JIANGSU	9.0 (13.7)
JIANGXI	-10.8 (22.7)
JILIN	-13.0 (10.7)
LIAONING	-0.6 (11.8)
MONGOLIA	-17.1 (11.3)
NINGXIA	-11.1 (9.4)
QINGHAI	-9.4 (14.4)
SHAANXI	-4.4 (10.3)
SHANDONG	1.3 (8.7)
SHANGHAI	23.6 (17.0)
SHANXI	-2.0 (14.7)
SICHUAN	1.2 (12.2)
TIANJIN	10.8 (15.4)
TIBET	-13.6 (8.4)
XINJIANG	-14.7 (10.6)
YUNAN	-13.0

	(8.3)
ZHEJIANG	0.3 (28.8)
F-ratio	4.6*
Adjusted R-squared	61.2
N	90

Standard error in parenthesis, * indicates significance at 1%, ** at 5% and *** at 10%. White Heteroscedasticity-Consistent Standard Errors & Covariance is adopted to allow for the heteroscedasticity. Serial correlation test, Ramsey R reset test for specification and Normality test are all passed.

For provincial dummies, Anhui Province is taken as the reference point hence the coefficients of all other provincial dummies measure the difference of the province-specific effects between the corresponding province and Anhui.

Endogeneity Test.

The possibility of reverse causation from poverty reduction to higher economic growth, is raised by the extensive literature on the impact of initial income distribution on subsequent economic growth. Where such a relationship exists it raises the possibility of endogeneity in our model with regional poverty reduction in part causing regional growth. To test this hypothesis we apply a set of instrumental variables that might be causes of growth, yet should be unrelated to changes in regional poverty. As instrumental variables we use the share of the state in industrial production, the initial income level, change in the share of foreign trade and the share of foreign trade itself, all at the regional level. Of these only the share of the state in industrial production is significant individually (at the 1% level), although the others are collectively. It is arguable that the change in the share of foreign trade in GDP may be related to poverty reduction, for example if it involves the growth of labor-intensive activities. However there seems no reason a-priori why the share of state activity would be systematically related to the change in poverty. Hence as this latter variable is the most strongly significant in the regional growth equation this equation can be treated as reflecting broadly adequate instrumental variables.

We run an OLS regression of provincial GDP per capita growth on these instrumental variables, which gives an adjusted R-squared of 37% and an F statistic of 13.4. This result is strong enough to suggest that these variables can act as a suitable set of instruments.

Subsequently we run the instrumental variable (IV) regression, where the growth variable is taken as endogenous. For comparison, we also run the OLS version of the same equation. Table A.4 gives the results.

Table A.4 Instrumental Variable Analysis for Growth-Poverty Reduction.

Variables	OLS version	IV version
Grain output	1.6* (0.3)	1.3* (0.5)
GDP per capita growth	1.7** (0.8)	5.6 (4.4)
Constant term for period 1	18.0* (6.2)	2.1 (16.8)
Constant term for period 2	-3.0 (7.5)	-27.8 (26.8)

Constant term for period 3	-17.6*** (10.3)	-61.4 (52.0)
Dummy for An Hui	-46.0** (19.9)	-32.1 (30.3)
Dummy for Jiang Xi	72.9* (18.3)	77.3* (21.7)
Municipalities	57.7* (13.5)	70.8* (20.0)
Term of trade for Agriculture	1.1** (0.5)	0.6 (0.7)
Severity of Poverty	-4.5*** (2.3)	-1.1 (3.9)
Private sector activity	0.03 (0.4)	-0.1 (0.5)
Adjusted R-squared	62.4	45.4

It can be inferred here that in the IV version grain output continues to be highly significant, although with a smaller coefficient than in OLS analysis, however the significance of growth variable disappears, even though this variable has a much larger coefficient. The significance of other control variables like the agricultural terms of trade, poverty severity and private sector activity also disappears, presumably due to the larger disturbance term in the IV analysis.

We conduct a formal endogeneity test by replacing the growth variable with the growth predicted by the instrument variables and by plugging the error term (ET) of the growth prediction equation into the OLS version. The ET has a positive coefficient of 1.4 at the significance level of 10%, indicating the presence of a weak endogeneity.

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