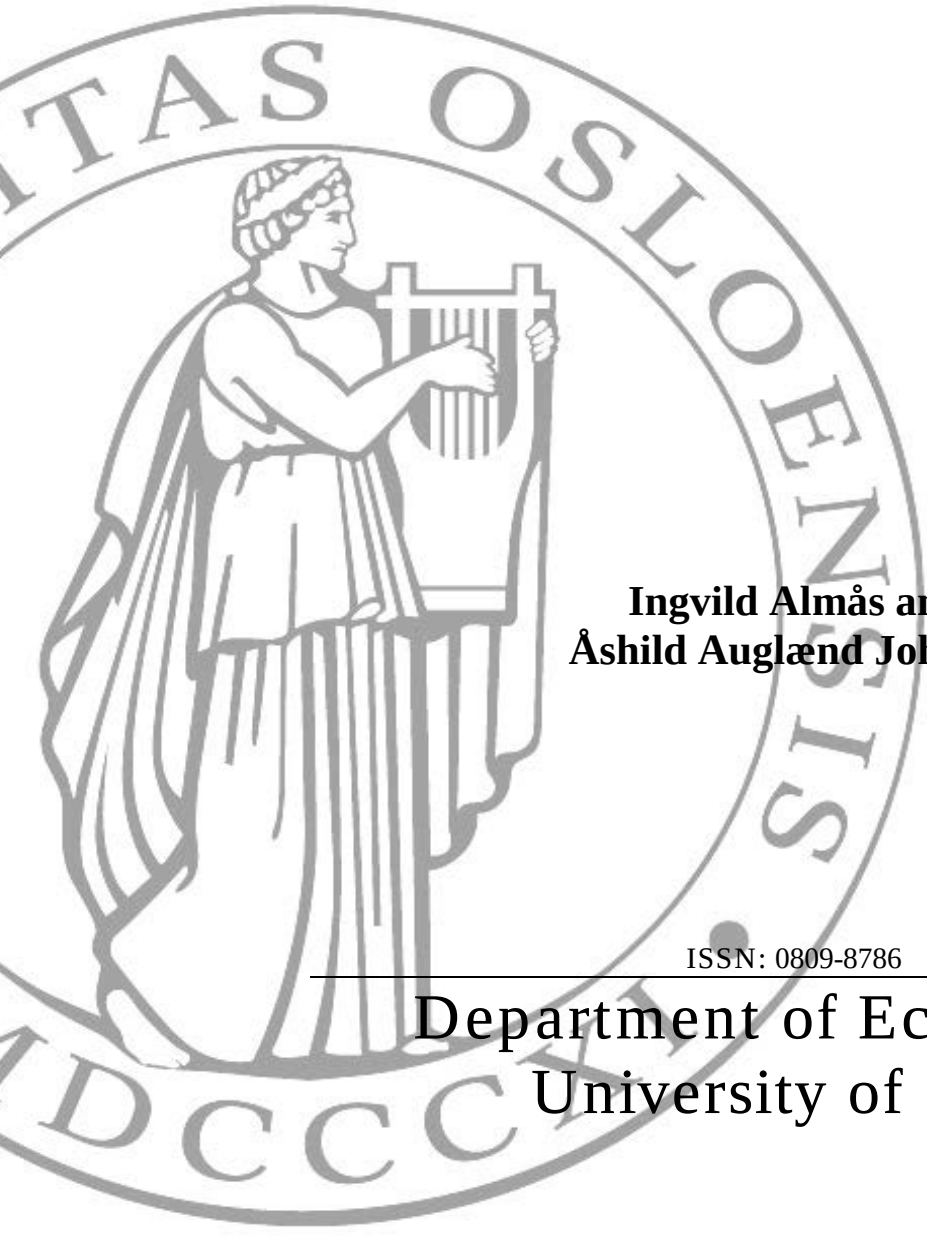
MEMORANDUM

No 06/2013

The Cost of Living in China: Implications for Inequality and Poverty



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The cost of living in China: Implications for inequality and poverty

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Memo 06/2013-v1

Abstract

China's economic development in recent decades has been tremendous, but subject to debate. This paper calculates regional prices that make incomes comparable across both time and space using the Engel-curve approach. Incomes are adjusted using these price indices, providing new estimates of inequality and poverty development. Our findings contrast with measures based on the official consumer price indices (CPIs) – in a time characterized by high economic growth, we find a larger increase in inequality and a more moderate poverty reduction than what is indicated by the CPI-adjusted measures.

(*JEL*: D1, E31, F01)

1 Introduction

Since reforms were initiated in 1978, the economic development of China has been tremendous. The World Bank reports an average growth rate of 9.9 percent, as well as a

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significant poverty reduction in this period (World Bank, 2012). However, these poverty measures are subject to debate and uncertainty (Bishop et al., 2006; Ravallion and Chen, 2007; Chen and Ravallion, 2008; Kahn et al., 1999; World Bank, 2009; Sicular et al., 2007). Since Simon Kuznets' seminal work on economic growth and inequality, it has been debated whether or not inequality and poverty increase or decrease for economies in transition (see, e.g., Kuznets (1955), Dollar and Kraay (2002), The Economist (2010), Lübker et al. (2002)). Correcting for the cost of living is essential to inequality and poverty measurement, making prices a central part of the poverty reduction discussion. Considering the differences across provinces and urban and rural China, regional price levels are likely to differ significantly in this vast and populous country.

In this paper, we identify Chinese price indices that can be used as deflators to make income comparable across both regions and time by applying a simple but empirically robust economic regularity, namely Engel's law, to household data. Subsequently, new inequality and poverty trends are calculated and compared with those based on the official consumer price indices (CPIs) and the poverty measures reported by the World Bank. We study the development of prices, inequality and poverty from 1995 to 2002, a period characterized by both the establishment of the "socialist market economy" – an official embrace of a more market-oriented economy – and high economic performance through high growth.

This paper reports three main findings. First, prices have increased more in rural areas and less in urban areas than what the official price indices suggest. Second, whereas measures based on official indices suggest that inequality has declined in the period under study, our new real income measures show an increase in inequality in this period. Third, income measures based on our prices indicate a substantially more moderate poverty reduction than both the official measures and the World Bank numbers.

Why is it necessary to produce new price indices? First, data on prices in China are scarce. To our knowledge, there are no official and available price indices that allow for cross-province comparisons, and price data on specific goods are extremely limited. The Chinese government publishes price *trends* for provinces, in addition to urban- and rural-specific CPIs. However, these are all set to 100 in the base year and, hence, they do not

reveal cross-regional price level differences.

Brandt and Holz (2006) exploit regional price data published in various yearbooks around 1990 to construct spatial deflators for rural and urban provinces (separately and combined). Using regional CPIs, they extend data from the base year, 1990, back and forth in time. This study is comprehensive and data-intensive, but the procedure has its limitations. As regional comparable micro price data for China are scarce, they have to rely on only a subset of goods and services consumed that have to be aggregated to produce a regional cost-of-living index. Methodologically, the SPI is subject to the same challenges as the CPI: Traditional procedures of aggregation fail to be consistent with consumer preferences and actual behavior (see, e.g., Neary (2004) for a discussion of the inconsistency between price indices and consumer preferences). In other words, both the CPI and SPI are biased measures of price changes.[1]

In this paper, we apply the Engel-curve approach to Chinese household consumption data. We identify prices that are comparable across both time and regions (i.e., urban- and rural-specific provincial prices for the two years under study). The Engel-curve approach is based on Engel's law, which states that a household's budget share for food is inversely related to household real income. Hence, by estimating this relationship, we can identify real income from information on budget shares.

Hamilton (2001) first proposed to use this identification strategy to estimate biases in the CPI. The method states that if two households with identical characteristics – observed in different periods – have the same budget share for food, they should also have the same real income. Because real income is produced by deflating nominal income by the CPI, a difference in their measured real income reveals a CPI bias. The Engel-curve approach infers the cost of living directly from consumer behavior, and welfare consistency is secured.[2]

[1] Gluschenko (2006) compares such CPI-proxied price levels with spatial indices constructed for Russian regions, and concludes that the CPI-proxied prices fail to provide precise estimates of cross-regional price variation.

[2] Through the estimation of the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer, 1980), our price indices are consistent with utility maximization under a budget constraint.

Several papers have applied Hamilton's method to estimate biases in the CPI.[3] In this paper we take this method to a cross section - systematic regional differences in measured real income reveal price level differences (see also Almås (2012)). In this field there is an ongoing debate about the price development in China, which is mostly based on urban data. The Engel approach is applied to identify urban prices in China in two other studies; Gong and Meng (2008) apply the Hamilton method to identify province specific prices for the urban part of the provinces in the period 1986-2001, whereas Nakamura, Steinsson and Liu (2012) uses the approach to identify biases in the urban CPI.[4] However, a large share of the Chinese population lives in rural areas and there are large economic differences between the urban and rural regions. We consider it to be of importance to cover both regions when studying the development of inequality and poverty in China, and in this paper we include both rural and urban households.[5]

The paper is organized as follows. Section 2 explains the methodology in detail. Section 3 discusses the household data applied in the analysis and Section 4 outlines the empirical results. Section 5 concludes the paper.

2 Methodology

Following the approach of Hamilton (2001), Engel curves for food are estimated using the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer, 1980). Household data for several provinces and municipalities in China for 1995 and 2002 are used to estimate the relationship between the budget share for food and household income. Based on the assumptions that the demand function is correctly specified, that consumer preferences are stable throughout the period, and that the micro data contain no systematic errors, a

[3] See e.g., Costa (2001), Beatty and Larsen (2005), Larsen (2007), Gibson, Stillman and Le (2008) Barrett and Brzozowshi (2010), Gibson and Scobie (2010), Chung, Gibson and Kim (2010) and Filho and Chamon (2012)).

[4] Gale and Huang (2007) are also investigating demand for food in China using Engel curves.

[5] As this paper estimates the rural-urban price gap, it speaks to the debate on the actual size of China's economy. The World Bank (2008) adjusted China's income downwards by approximately 40 percent compared to earlier international comparisons. But the World Bank International Comparison Project 2005 used micro price data collected from urban areas only, which could have lead to an overestimation of China's overall price level, and subsequent underestimation of its real income. This is the topic of several recent papers on international comparisons (see e.g., Hill and Syed (2010) and Feenstra et al (forthcoming).

set of urban and rural dummy variables reveals a set of price levels. The set includes comparable price levels for urban and rural parts of the different provinces in the different years. There are several reasons why food is an ideal indicator good (see Hamilton (2001) and Costa (2001)). First, the indicator good should be sensitive to variation in income, which is the case for food because the income elasticity of food is substantially different from unity. Second, food can be characterized as a nondurable good. Expenditures on food and consumption of food in one period are nearly identical, as opposed to a durable good, which is bought in one period but consumed throughout several periods of time. Third, the definition of food is straightforward, as opposed to other goods such as leisure.

The AIDS model is given by:

$$m_{h,p,u,t} = a + b(\ln y_{h,p,u,t} - \ln P_{p,u,t}) + \gamma(\ln P^{f}_{c,u,t} - \ln P^{n}_{c,u,t}) + \theta X_{h,p,u,t} + \varepsilon_{h,p,u,t}, \quad (1)$$

where $m_{h,p,u,t}$ is the budget share for food for household h, in province p in rural/urban area u at time t. $P_{p,u,t}$ is a price index that is homogenous of degree one in prices. $P^{f}_{c,u,t}$ and $P^{n}_{c,u,t}$ are the prices for food and non-food, respectively, in county c. $X_{h,p,u,t}$ is a vector of demographic control variables and $\varepsilon_{h,p,u,t}$ is the residual.

The identification strategy is the following: $P_{p,u,t}$ is the only variable that is specific for each province p, area u and time t, and, hence, by including dummy variables indicating area and time, $d_{p,u,t}$, we can identify the local price-level differences. The AIDS specification given by (1) can be estimated by:

$$m_{h,p,u,t} = a + b(\ln y_{h,p,u,t}) + \gamma(\ln P^{f}_{c,u,t} - \ln P^{n}_{c,u,t}) + \theta X_{h,p,u,t} + \sum_{p=1}^{N} d_{p,u,t} D_{p,u,t} + \varepsilon_{h,p,u,t}. \quad (2)$$

The price level of province p and area u at time t can then be expressed as follows:

$$d_{p,u,t} = -b\, ln P_{p,u,t} \Longleftrightarrow P_{p,u,t} = e^{(-d_{p,u,t}/b)}. \quad (3)$$

A positive dummy coefficient for province p in urban/rural area u at time t implies that the budget share for food for households in this specific province is higher than that of identical households in the base. As the budget share for food is decreasing in income, the coefficient for nominal income b is negative. Hence, if the provincial dummy is positive the price level exceeds unity, which implies that the price level of this province exceeds that of the base.

Based on these price-level estimates, we calculate province-, urban/rural- and year-specific prices. To illustrate, for Beijing we have four price-level estimates: rural Beijing, 1995 and 2002, and urban Beijing, 1995 and 2002. The identification gives comparable cost of living only up to a normalization, and we normalize so that the cost of living for all China in 1995 is equal to one.[6]

We study the development of inequality and poverty from 1995 to 2002 and report changes between these two years. We use the Gini index to measure inequality, and the Head Count and the Poverty Gap indices to measure poverty. The Head Count index reports the percentage of the sample population with income below the poverty line. The Poverty Gap index, on the other hand, gives weight according to the distance between the poverty line, i.e., it measures not only the percentage of the population that falls below the poverty line, but it is larger the further below the poverty line the poor's income is. The formulas for the Gini, the Head Count and the Poverty Gap indices are given in Appendix B.

We base our poverty estimates on two poverty lines: \$1.25/day[7] and \$2/day, measured in 1995 prices (see Appendix B for details on how these poverty lines are measured in local currency).

[6]The cost of living for all China in 1995 is given by a population-weighted sum of the price estimates over the total population in 1995: $\overline{P^{1995}} = \frac{\sum_{p=1}^{N} pop_{p,u}^{1995} * p_{p,u}^{1995} + \sum_{p=1}^{N} pop_{p,r}^{1995} * p_{p,r}^{1995}}{\sum_{p=1}^{N} pop_{p,u} + \sum_{p=1}^{N} pop_{p,r}}$.

[7]This is often referred to as the \$1 a day poverty line.

3 Data

Household data used in the estimation are provided by the "Chinese Household Income Project" (CHIP), collected in 1995 and 2002 by an independent group of economists in collaboration with the Chinese Academy of Social Sciences.[8] The data consist of an urban and a rural part, and the households were selected from a larger sample collected by the National Bureau of Statistics.[9]

In 1995 19 provinces were selected to constitute a representative sample of the economic characteristics of China's rural regions, and the same principle was applied when selecting 11 urban provinces. Two more provinces (Xinjiang and Guanxi) were added to the rural survey provinces in 2002 to investigate issues related to ethnic minorities. We have not included these two provinces in the analysis to ensure comparability between 1995 and 2002. Chongqing was established in 1997, prior to that it was a part of Sichuan. As Chongqing is included in the 2002 data we follow the approach of Khan et al. (2005) and combine Sichuan and Chongqing in 2002. Finally, the 2002 survey data covers the migrant population, which we are unable to include in the estimation as we have no data on this for 1995. We include a map illustrating data coverage, and a discussion on the classification of rural and urban households in Appendix A.

The survey consists of one part answered by individuals and one part for the household as a whole. As we can see from Table 1 below, the average household size for rural households is larger than the urban average for both years, which is consistent with the one-child policy being less restrictive for rural households.[10] The average household size falls from 3.79 in 1995 to 3.66 in 2002.[11]

[8] The survey also covers 1988, but due to comparability issues we did not include this round in the analysis. For a complete description of the data, see Khan et al. (1998, 1999, 2005).

[9] The data oversampled urban households in 1995 and oversampled rural households in 2002. We apply urban and rural population weights specified in Table 1 (China Statistical Yearbook, 2004). Alternative weights can also be applied for 2002, but corresponding weights are not available for 1995 (see Jin et al. (2011)).

[10] There are exceptions from the one-child rule at province and county levels. Exceptions can apply if the first child has a disability, if both parents work in high-risk occupations, or if both parents come from one-child families. In rural areas, a second child is generally allowed after five years, but this sometimes only applies if the first child is a girl. Another exception concerns only ethnic minorities, who can be allowed to have a third child (see Hesketh et al. (2005)).

[11] This indicates a continuation of an earlier fall in average household size: in 1988, the average size was

Table 1: Comparison of the surveys

	1995				2002			
	IND	HH	MHH	PW	IND	HH	MHH	PW
Rural	34 739	7 998	4.35	85947	37 969	9 200	4.14	78241
Urban	21 698	6 931	3.13	35174	20 632	6 835	3.02	50212
Total	56 437	14 929	3.79		58 601	16 035	3.66	

IND: individuals, HH: households, MHH: mean household size, PW: population weights.

3.1 Implementation and Variables

The empirical strategy is implemented in the following steps. We define measures of income for rural and urban households. Then we run separate regressions for urban and rural areas, from which we identify province-specific cost-of-living indices for rural and urban areas, separately. However, since these indices are only identified up to a normalization, the urban cost-of-living index is not directly comparable with the rural index. To make these rural–urban price indices comparable, we estimate the overall rural–urban price gap by running a pooled regression. The overall urban and rural price levels are adjusted to match this price gap. This provides us with a spatial price index for all of China. We compare the change in prices over time implied by our cost-of-living index ("COL") with that of the consumer price index ("CPI"). Further, real incomes are calculated using our cost-of-living price deflator and new inequality and poverty measures are provided. Again, the measures are compared with those based on the CPI. In addition, we run several robustness checks.

Income versus Consumption

We use the value of consumption to identify income, as is standard in demand system estimation (see, e.g., Neary (2004) and Banks et al. (1997)). We consider consumption to be a better measure of well-being than income for two reasons. First, income can be erratic, especially in agricultural societies. Self-employment can involve several sources of income, which can lead to large variations in annual income. Because consumption is smoother

4.32, where the averages for urban and rural households were 3.53 and 5.01, respectively.

over the period of a year, it is more reliable in the sense that it reflects actual behavior. Second, there are no obvious reasons to underreport consumption as compared with income. With income data, the respondents might underreport income if they suspect that these data could become available to the tax authorities. Hence, we base our poverty calculations on consumption (see, e.g., Deaton and Zaidi (2002) for a discussion of whether consumption or income should be used to measure well-being). We equivalence-scale adjust all household incomes in the estimation, using the OECD scale.

Comparability

When comparing consumption across rural and urban areas and between years, the issue of comparability needs to be addressed. There is no uniformly defined consumption measure, neither across regions nor across years and, hence, we construct the consumption measure. This measure is based on market purchases, such as expenditure on food and clothing, as well as on income in-kind and self-production. There are two parts of consumption that need special attention, namely, the consumption from self-production and consumption of housing. First, self-production constitutes a substantial share of consumption; in rural areas it constituted almost 60 percent in 1995 and 40 percent in 2002. It is, however, only available in the rural survey. It is problematic to include self-production for rural households only in a pooled regression. However, excluding the value of self-production and running a pooled regression would also be problematic, because it would underestimate the value of consumption in rural and, potentially, also in urban areas. We solve this problem by running separate regressions for urban and rural households in the main estimation.

The Rural–Urban Price Gap

When estimating rural and urban cost-of-living indices separately, we need to identify the rural/urban price gap. We need to do so to operationalize one poverty line for all China. As this cannot be done in the two separate estimations, we run a pooled regression (urban and rural combined) based on market purchases and in-kind, i.e., an estimation

that excludes self-production. As self-production is only covered in the rural data, this estimation may underestimate the rural price level relative to the urban. However, because we are interested in trends and not levels, we have no reason to expect that this biases our results in any specific direction. We run several robustness checks that provide reassuring results. We have also conducted the whole analysis by including self-production in the pooled regression (denoted "COL-M") to identify the urban/rural price gap, and the main results remain with this alternative identification.

Results and Comparisons

We provide new estimates of real income by deflating household consumption using the estimated cost-of-living index, denoted "COL". The real income identified in the robustness checks is also based on the consumption variable from the main estimation, but the deflator is specific to each robustness check. For comparison, we provide another real income measure. This is simply the same household consumption measure adjusted using the official consumer price indices, and we denote this "CPI".

Robustness Checks

In the main estimation, we evaluate self-production at market value. This may lead to an overvaluation, because it may be the case that if a household received a transfer equal to the market value of home production, they would have reallocated consumption and consumed less of the self-produced good and more of other goods in the market. To check for this, we conduct a robustness analysis that takes the other extreme, namely to evaluate consumption out of home production at zero value ("COL-M"). This robustness check is discussed in Appendix E.1, and it is shown that our results are strengthened when using this specification.

Another main issue related to price adjustments is how to include housing consumption. There are potentially large measurement problems related to housing consumption (see, e.g., Deaton and Zaidi (2002)). The urban and rural questionnaires differ in the infor-

mation collected on housing expenses, which complicates the creation of a comparable housing aggregate. In the main estimation, we exclude housing consumption. However, we show in a robustness check that the main results are robust to including housing expenditure ("COL-H"); see Appendix E.2. In the robustness check, we follow the approach used by Khan et al. (1993, 1995, 2005) in constructing the housing aggregate.

According to this definition, the rural housing costs should be based on estimates of the rental value for owner-occupied housing. The rental value is calculated by assuming that the rental value for housing is 8 percent of the current market value of the house. Eight percent interest on housing debt is subtracted from this. The urban housing cost are based on the rental value for owner-occupied housing, plus housing subsidies. The urban rental value for housing is equal to 12 times monthly market rent, minus 8 percent interest on housing debt. Subsidies are calculated by subtracting actual market rent from monthly market rent.[12] Finally, we also include the results from including housing expenditures for the market-based expenditure approach (denoted "COL-MH", see Appendix E.3). Results from the regressions can be found in Appendix F.

Relative Prices

To control for possible systematic variation between food and non-food prices, a measure of relative prices is included in the estimation. This requires detailed price information on food and non-food for urban and rural households. Because the survey data only includes food prices for rural households, we rely on various statistical publications for price data. We combine the rural food prices in the survey data with urban food prices from the China Price Statistical Yearbook (2003),[13] which we in turn combine with non-food prices from

[12]Due to data issues, the housing variable for rural 1995 and urban 2002 have to be constructed differently. First, for rural 1995 the current market value of the house is not in the questionnaire, only in the data set and the documentation. The authors of the data set provide a variable representing the present value of the residence, and housing equity is defined as eight percent of this estimated value minus eight percent interest in housing debt. Second, according to Khan et al (2005) in a footnote on page 25, the approach used for urban 1995 proved unusable for urban 2002. The estimation of the rental value of urban housing is hence based on an alternative approach - variables such as sanitary facilities and total living area are used to estimate the current market value of the the house. Housing subsidies in kind are added to this.

[13]The 2002 data on urban food prices come from the China Price Statistical Yearbook 2003, which covers 69 food items for 36 cities. Urban food prices in 1995 are collected from the China Price Information Network, which covers 11 food items and 34 cities. The prices of these province capitals are assumed to be

the China Price Statistical Yearbook (1992)[14]; see Appendix C for details. Although the relative price measure is calculated from a price set that represents only a subset of both food and non-food consumption, this provides us with a proxy for relative prices. It is reassuring that the relative price effect in the estimation is small and, hence, our main results are not driven by inaccuracies in the relative price measurements.

Controls

Age of household head, number of adults, number of children and number of elders are included as demographic control variables.[15] From Table 1, we can see that the average number of members in a household included in the analysis is 3.1 (largest 8) for urban households and 4.3 (largest 10) for rural households for 1995. The variable for number of adults was constructed by subtracting number of children from total members of household. Children are defined as being individuals younger than 16. Elders are defined by the official retirement age in China, which is 60 for men and 55 for women. To deal with outliers, we drop the top and bottom one percent of the observations of total expenditure and food expenditure (within urban/rural provinces on an annual basis). Furthermore, if there are any other observations where age of head of household is either 0 or missing, expenditure on food is equal to zero or incomes are negative, these households are dropped.

4 Analysis and Findings

Table 2 presents the price levels estimates for 1995 and 2002. From the rural and urban price levels we can see that the ratio of urban to rural prices is 1.65 in 1995 and 1.15 in 2002. Hence, the urban-rural price gap was initially large, but decreased in the period

representative of the remaining urban areas of each province.

[14] See also Brandt and Holz (2006) for an analysis based on prices from these yearbooks.

[15] In the rural data set for 1995, all but 328 (352 in 2002) heads of households are male, while 2289 (2220 in 2002) urban heads of household are female.

1995-2002.[16]

Table 2: Price levels in 1995 to 2002

	COL 1995	COL 2002
All	1.00	1.25
Rural	0.81	1.17
Urban	1.34	1.34

Table 3 presents the changes in cost of living (COL) from 1995 to 2002. In the second column, we present the corresponding changes in the official consumer price index (CPI) for the same period.[17] The main estimation reveals an overall increase in the price level of 25 percent. This is larger than the 9 percent increase in the official CPI. As such, our estimates suggest that the CPI is underestimated. Investigating the rural and urban trends separately, we see that this only holds for rural areas. We find a substantially larger price increase for rural areas than the official measures. However, we find zero price increase for urban areas. The detailed price estimates are presented in Appendix D.

Table 3: Price change from 1995 to 2002

	COL	CPI
All	0.25	0.09
Rural	0.44	0.08
Urban	0.00	0.11

As illustrated in the second column of Table 3, official statistics report very low inflation rates from 1995 to 2002, a period that is characterized by high economic growth. This may seem surprising, because the typical finding in cross-country comparisons is that richer countries tend to have higher price levels (this is often referred to as the Penn effect because the Penn World Tables have shown this result since they first came out in 1975 (Kravis et al. 1978), or the Balassa–Samuelson effect (Balassa, 1964; Samuelson, 1964).

However, there are factors present in this period that make China's experience unique.

[16] Our rural/urban price gap is estimated to be 15.1% in 2002. Brandt and Holz (2006) estimate it to be 26.5% in 2003, Ravallion and Chen (2007) estimate it to be 41.2% in 2002, and Meng et al. (2005) estimate it to be 47.7% in 2003 (see World Bank (2009) page 52 for details).

[17] http://www.stats.gov.cn/tjsj/ndsj/2010/indexeh.htm date: 9.11.2012

This period represents enormous changes toward a more market-oriented economy through the establishment of the "socialist market economy" and an official embrace of a more market-oriented economy. In such a phase it is likely that there will be forces present that could drive prices downward (see, e.g., Prasad (2004)). Most prices were liberalized in 1993, with the exception of pharmaceutical, health care and education prices, which were still administered centrally. Price decreases were observed for tradable consumption goods, clothing and housing appliances, as well as food prices in the period 1997–2002. On the other hand, according to Prasad (2004), data indicate that an increase could be observed for non-tradeables, such as services. In this period, labor market productivity was increasing – investment was high, adoption of new technologies was widespread and there was an ongoing stream of cheap labor from the rural areas to the cities. China was opening up to trade and preparing for WTO accession by reducing tariff rates (unweighted) from 1996 to 2003 (23.6% to 11%). Competition was increasing, and there were large reforms of state-owned enterprises (SOE). All these forces could contribute to keeping costs and prices down, especially in the urban areas. While some supply-related factors and administrative price controls could explain low prices in the short run, productivity gains, tariff reductions, reforms of SOEs, technology adoption and a large rural labor supply would also contribute to keeping prices low in the long run.

Our findings indicate a larger price increase in the poorer rural areas than in the faster-growing urban areas. This also contradicts the so-called Penn effect, but is consistent with the results of structural changes described above. If fewer of the factors pressing prices down were present in the rural sector in this period, it is plausible that the prices increased more in rural than in urban areas after the liberalization. It is less likely that increased global integration and convergence with international prices in traded goods' prices affect more remote rural areas to the same extent as urban coastal regions. In a similar manner, labor migration and investment toward urban areas would not have an obvious direct downward effect on rural price levels. But as shown in Table 2, there is a substantial reduction in the urban-rural price gap in this period. This price convergence may be a result of liberalization or decreasing transport costs within China.

4.1 Inequality and Poverty

Table 4 presents changes in the Gini, the Head Count and the Poverty Gap indices for the cost-of-living-adjusted income measure (COL) and the consumer-price-adjusted income measure (CPI). The corresponding poverty numbers from the World Bank are presented in the third column.

The cost-of-living-adjusted income measure indicates an overall increase in inequality. We can see from Table 4 that both rural and urban inequality increased in the period, but rural more than urban. The CPI-adjusted income measure indicates the opposite, namely that inequality has decreased massively overall, and it has decreased in both rural and urban areas.

Investigating changes in poverty, we see that the overall picture is that the CPI-adjusted measure overstates the size of the poverty reduction compared with the COL-adjusted incomes. Looking only at the Poverty Head Count index, we see that CPI-adjusted incomes overestimate the reduction in rural poverty, while overestimating the increase in urban poverty. Comparing the World Bank indicators and COL estimates, we see that the World Bank, in general, overestimates the reduction in poverty, but to a lesser extent than the CPI estimates. The COL Head Count estimates indicate that the poverty reduction is largest among the poorest, and this is in line with the World Bank indicators. But, as already mentioned, our findings suggest that the World Bank estimates are overly optimistic and overstate poverty reduction.

The Poverty Gap index reflects the severity of poverty, and provides a similar pattern to the Head Count estimates. Compared with the COL measure, the World Bank indicators overstate the overall poverty reduction, but not as much as the CPI-adjusted incomes. As for the Head Count, the Poverty Gap index indicates that the largest poverty reduction occurs among the poorest, but it should be noted that the cost-of-living measure implies that the poorest urban residents are getting poorer.

Table 4: Change from 1995 to 2002

A. Inequality: Gini Index			
	COL	CPI	
All	0.11	-0.23	
Rural	0.28	-0.05	
Urban	0.05	-0.05	
B. Poverty Head Count: $1 a day			
	COL	CPI	World Bank
All	-0.34	-0.55	-0.48
Rural	-0.30	-0.51	
Urban	0.05	0.10	
C. Poverty Head Count: $2 a day			
	COL	CPI	World Bank
All	-0.22	-0.25	-0.31
Rural	-0.20	-0.21	
Urban	-0.09	0.02	
D. Poverty Gap: $1 a day			
	COL	CPI	World Bank
All	-0.38	-0.70	- 0.61
Rural	-0.32	-0.67	
Urban	0.09	0.00	
E. Poverty Gap: $2 a day			
	COL	CPI	World Bank
All	-0.31	-0.50	-0.46
Rural	-0.27	-0.46	
Urban	-0.05	0.06	

In the robustness tests in Appendix E, we show that our findings are not driven by the exclusion of housing or the evaluation of home production at market value. The complete poverty and inequality tables can be found in Appendix D.

Figure 1 gives an illustration of how the measures based on the official CPIs and the World Bank estimates on poverty and inequality fall below the COL-adjusted measures.

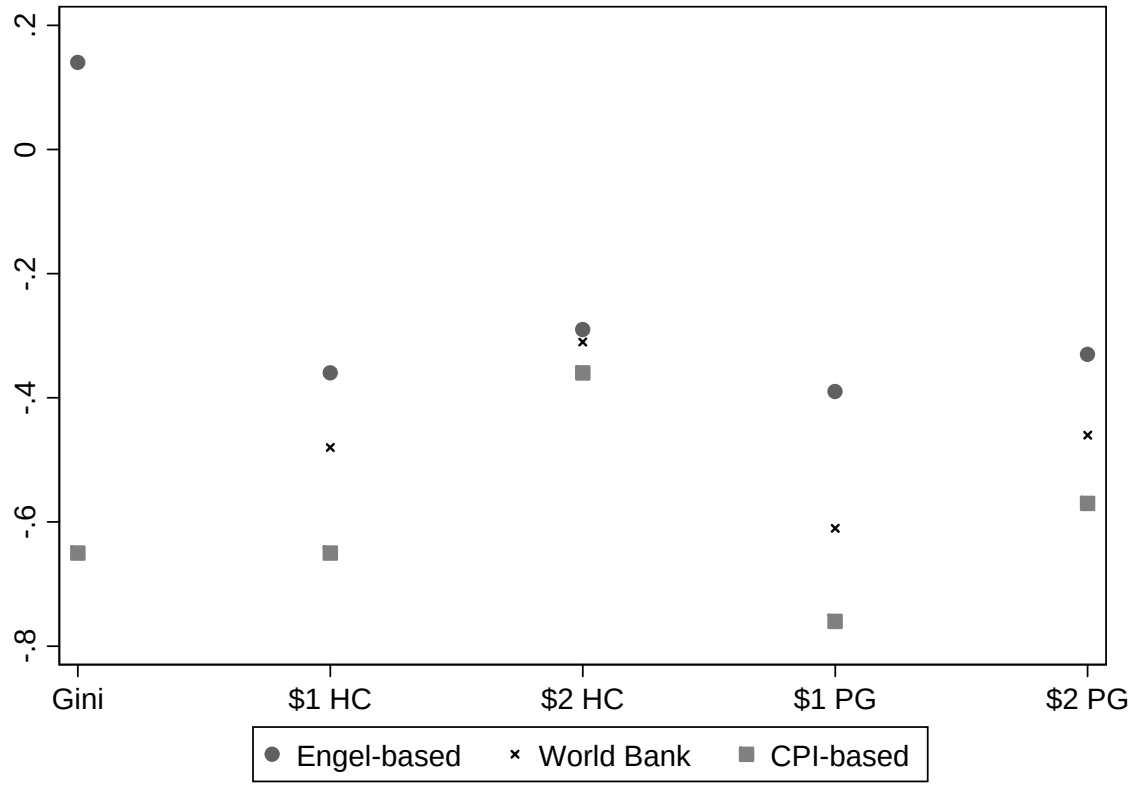

Figure 1: Changes in inequality and poverty

5 Concluding Remarks

In this paper, we identify Chinese cost-of-living indices by applying a simple but empirically robust economic regularity, namely Engel's law, to household data. Incomes are then adjusted using the identified cost of living, providing new estimates of real income. We compare the changes in prices over time implied by our cost-of-living index (COL) to that of the consumer price index (CPI). Subsequently, incomes are adjusted using our

cost-of-living price deflator and new inequality and poverty measures are calculated. As for price changes, we compare trends in poverty and inequality over the period 1995-2002 with those based on the CPI-adjusted incomes. In addition, we compare our findings with the World Bank indicators.

We find that prices have increased more in rural and less in urban areas than the official CPI measures reveal. The new real income measures reveal an increase in income inequality and a substantially more moderate poverty reduction than measures based on the official CPIs indicate. Our measures also indicate that the World Bank numbers overestimates the decline in poverty. Our findings are robust to different possible definitions of consumption value.

China is the most populous country in the world and has a substantial proportion of people below the different poverty lines. Hence, poverty reduction in China is of utmost importance if the World is to reach the first Millennium Development Goal of poverty elimination by 2015. Our results indicate that if one uses the World Bank measures to calculate the poverty reduction in the world, the positive contribution from China may be overestimated.

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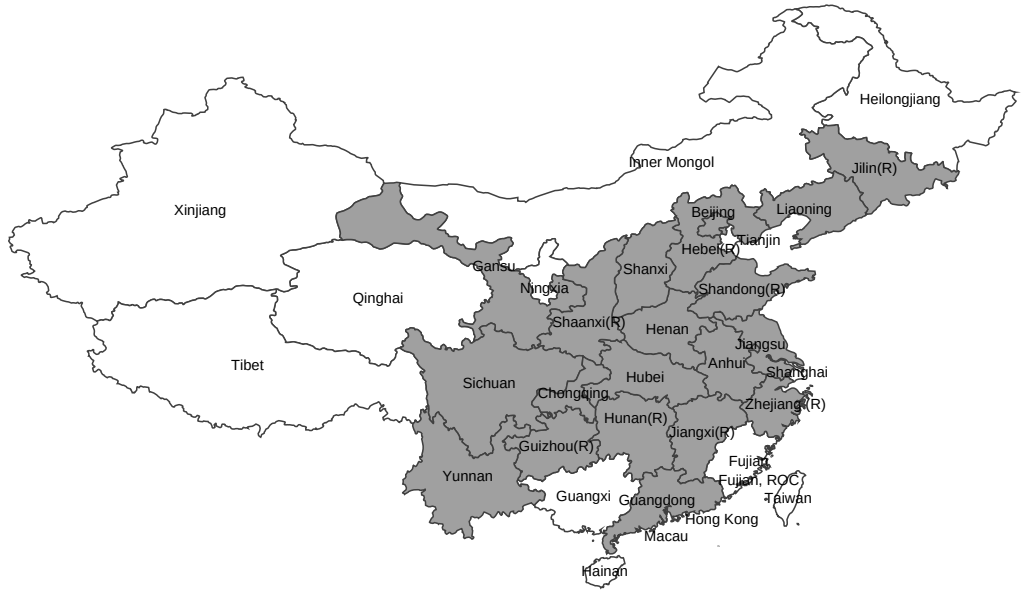
A Survey Provinces

Figure 2 illustrates data coverage of the analysis in this paper:



Gray: Data Coverage for both 1995 and 2002. (R) means data only on rural households: Guizhou, Hebei, Hunan, Jilin, Jiangxi, Shaanxi, Shandong, Zhejiang.

Figure 2: Map over survey data covered both in 1995 and 2002

From 1995 to 2002 the urbanization rate increased from roughly 30 to 40 percent. In actual numbers, this meant that the official rural population decreased from 860 million to 780 million people, while the urban population increased from 350 to 500 million people.[18] There are several sources to the increase in urban population - natural causes, people moving to the city and becoming registered citizens, and changes in classification of rural and urban areas. The National Bureau of Statistics China (NBS) changed their methodology for measuring the rural/urban population from 1995 to 2000.[19] Chan and Hu (2003) show that 22 percent of the urban population growth in the 90s was due to reclassification of rural places, 55 percent to migration and the rest from natural changes in the city population. This could possibly have an effect on our estimates. In the CHIP-data households are classified as rural/urban households according to the standards of the National Bureau of Statistics. This is the standard used by most studies, as the data to keep classifications constant are not available. The CHIP data do not have a panel structure, so there are no obvious way to keep the classification constant (see Sicular et al (2007)). The rural areas most likely to be reclassified are those with the highest growth, and hence, it should be expected that reclassification in this sense should lead to exaggerated rural-urban income differences. Benjamin et al. (2007) are able to investigate this using panel data, and they do find a relatively more stable ratio of urban to rural incomes. If this factor is of importance in our estimation, we would thus expect it to exaggerate the differences between rural and urban areas. But is should be noted that it is not very likely that the NBS would sample from rural areas that could be expected to change status in the near future, which would reduce the possible impact from this.

[18] See table 4.1 in China Statistical Yearbook (2007).

[19] In the original household registration system, the *Hukou system*, an individual would be given a permanent household registration where their parents were registered (rural or urban). Obtaining an urban hukou would be hard for rural citizens, but could for instance be achieved through getting a college degree. See Chan and Hu (2003) for more on this system in the 90s. From the Hukou-based system, a more complex census-based methodology was introduced in 2000 (see OECD (2009) for details on this). See Zhou and Ma (2003) for a report on the 2000 census and urbanization, and Sicular et al (2007) and Zhao (1999) on migrants.

B Inequality and Poverty Measures

B.1 The Gini Index

The Gini index is the most commonly used inequality measure. The formula for the Gini index is as follows:

$$G = \frac{1}{2n(n-1)\mu} \sum_i \sum_j \left| x_i - x_j \right|, \tag{4}$$

where x_s is the relevant income measure for person s.

B.2 The Head Count and the Poverty Gap Index

The Head Count index measures the number of people falling below a given poverty line, m. This can be expressed as:

$$HC = \frac{1}{N} \sum_{i=1}^{N} I(x_i < m), \tag{5}$$

where I is the indicator function that takes a value of 1 if the bracketed expression is true and 0 otherwise. N is the total population.

The Poverty Gap index, on the other hand, also takes into account how poor those below the poverty line are. It measures how much it would cost to eliminate poverty and is measured by:

$$PG = \frac{1}{N} \sum_{i=1}^{N} \frac{m - x_i}{m} I(x_i < m). \tag{6}$$

B.3 Poverty Lines

The respective poverty lines of $1 and $2 a day are converted to Chinese currency (Yuan) using Purchasing Power Parity (PPP) exchange rates. We use the PPPs provided by the International Comparison Program (ICP)/ World Bank in the 2005 round (World Bank, 2008). What is referred to as the $1 a day World Bank poverty line was considered to be equal to $1.25 in 1995. Hence, we use $1.25 and $2 as our poverty lines. The lines are somewhat arbitrary and, hence, we find it useful to look at both these lines. The implied 1995 PPP conversion rate of the 2005 PPP can be found by deflating the PPP conversion rate by inflation in China and the US, using the published CPIs for both countries, respectively. The PPP conversion factor for China equals 3.45 in 2005 (World Bank, 2008). The yearly poverty line in Yuan corresponding to $1.25 a day is equal to 1726 Yuan a year:

$$1.25 * 365 * \frac{PPP_{CHN}^{1995}}{PPP_{US}^{1995}} = 1.25 * 365 * \frac{PPP_{CHN}^{2005}}{PPP_{US}^{2005}} * \frac{\frac{CPI_{CHN}^{1995}}{CPI_{CHN}^{2005}}}{\frac{CPI_{US}^{1995}}{CPI_{USD}^{2005}}} = 1.25 * 365 * 3.45 * \frac{\frac{396.9}{464.0}}{\frac{78}{100}} = 1726. \tag{7}$$

The corresponding $2 a day line is equal to 2761 Yuan.

C Relative Prices

Food price indexes are constructed from food prices using four common basic headings, namely, cereals, vegetables, meat and eggs.[20] We use the country product dummy method (Rao, 2005) to aggregate the food prices under the four basic headings into one price for food. This produces food price indexes at the household level in the rural case and at the province level in the urban case. We have no information on non-food prices from the surveys. To overcome this limitation in the data, we apply information on non-food prices from the Price Statistical Yearbook of China (1992). This book incorporates a table of item prices for 29 cities, which are assumed to be representative of the remaining urban part of the province.

The same yearbook also includes a conversion table that expresses how farm products can be transformed into industry products. The conversion table can be interpreted as a food to non-food ratio for rural areas, and we use this to estimate rural non-food prices at the county level, again using the country product dummy method (Rao, 2005).[21]

Finally, we price adjust the non-food indexes using the consumer price index (base year 1985) for urban and rural areas. The relative price control variable is constructed by combining the food price indexes from the survey and yearbook data with these non-food indexes.

[20] Whenever the basic headings include more than one good in a survey, we use the mean price per kilo over the subcategories as the basic heading price.

[21] As we have food prices for farm products in our data, this enables us to construct non-food prices. For instance, we have kilograms of wheat to kilograms of soap. Because we know the price of wheat per kilogram, we can use this ratio to approximate the price of soap for rural areas. We do this conversion for wheat, rice, sweet corn and eggs to each non-food item, and the non-food price is based on an average of these converted rates. The non-food to food items are textiles, soap, bicycles, black-and-white TVs and matches.

D Province-specific Price Levels

Table 5 presents the change in the cost-of-living index (COL) for each rural and urban province. In addition, changes in province-level consumer price indices are calculated using annual inflation rates available in the China Statistical Database 1995–2002.[22]

[22]"Consumer Price Indices and Retail Price Indices," National Bureau of Statistics Database, available online http://219.235.129.58/welcome.do

Table 5: Urban and rural provinces: COL and CPI

PROVINCE	Region	Change SPI	CPI change
Beijing	Urban	0.08	0.49
Shanxi	Urban	0.19	0.32
Liaoning	Urban	0.10	0.27
Jiangsu	Urban	-0.04	0.27
Anhui	Urban	0.00	0.27
Henan	Urban	0.19	0.23
Hubei	Urban	-0.10	0.25
Guangdong	Urban	-0.22	0.20
Sichuan	Urban	0.08	0.36
Yunnan	Urban	0.15	0.31
Gansu	Urban	0.17	0.32
Beijing	Rural	-0.47	*
Hebei	Rural	0.64	0.20
Shanxi	Rural	1.04	0.29
Liaoning	Rural	0.80	0.21
Jilin	Rural	1.60	0.24
Jiangsu	Rural	0.05	0.25
Zhejiang	Rural	-0.34	0.25
Anhui	Rural	0.90	0.24
Jiangxi	Rural	0.49	0.25
Shandong	Rural	0.00	0.30
Henan	Rural	1.36	0.27
Hubei	Rural	0.42	0.29
Hunan	Rural	0.18	0.35
Guangdong	Rural	0.10	0.17
Sichuan	Rural	0.45	0.38
Guizhou	Rural	0.42	0.39
Yunnan	Rural	1.08	0.39
Shaanxi	Rural	0.07	0.37
Gansu	Rural	0.07	0.41

**Urban and rural CPI for Beijing is reported to be the same.*

E Robustness Analysis

E.1 Estimates Based on Market Expenditures

In our main estimations, we have evaluated self-production at market value. However, it is likely that this constitutes an upper bound for the evaluation of home production. In this section, we go to another extreme, namely to evaluate the self-production at zero, i.e., we base our estimations on market purchases only. It turns out that this strengthens our results. Table 6 shows that with this specification, the cost-of-living index (COL-M) reveals a larger underestimation of the price increase for rural China, a larger overestimation of the official CPIs for urban China and a larger overall underestimation of the price increase.

Table 6: Price change from 1995 to 2002

	COL-M	CPI
All	0.65	0.09
Rural	2.07	0.08
Urban	-0.05	0.11

Table 7: Change from 1995 to 2002

A. Inequality: Gini Index			
	COL-M	CPI	
All	0.02	-0.23	
Rural	-0.04	-0.05	
Urban	0.07	-0.05	
B. Poverty Head Count: $1 a day			
	COL-M	CPI	World Bank
All	0.95	-0.55	-0.48
Rural	1.86	-0.51	
Urban	-0.20	0.10	
C. Poverty Head Count: $2 a day			
	COL-M	CPI	World Bank
All	0.40	-0.25	-0.31
Rural	0.81	-0.21	
Urban	-0.16	0.02	
D. Poverty Gap: $1 a day			
	COL-M	CPI	World Bank
All	1.60	-0.70	- 0.61
Rural	2.94	-0.67	
Urban	-0.16	-0.00	
E. Poverty Gap: $2 a day			
	COL-M	CPI	World Bank
All	0.78	-0.50	-0.46
Rural	1.53	-0.46	
Urban	-0.18	0.06	

Table 7 shows that this alternative specification also reveals an increase in inequality, but of a smaller magnitude than the main estimation. Further, Table 7 shows that the poverty results are strengthened: based on market purchases, the Engel-based approach reveals an increase in poverty in the period under study, and, hence, both the World Bank numbers and numbers based on the official CPIs provide an overly optimistic picture regarding poverty development.

E.2 Including Housing

Table 8 gives the results from the estimation including the housing expenditure (COL-H) variable constructed by following the approach described in the section on robustness checks. We can see that although the point estimates change somewhat, the main price results remain: the urban price increase is overestimated whereas the rural price increase is underestimated using the official CPI estimates.

Table 8: Price change from 1995 to 2002

	COL-H	CPI
All	0.25	0.09
Rural	0.52	0.08
Urban	-0.05	0.11

Table 9 shows the inequality and poverty results for the specification including housing. We can see that both the inequality and the poverty results hold up, i.e., the findings of increased inequality and overestimation of poverty reduction are not driven by the exclusion of housing consumption.

Table 9: Change from 1995 to 2002

A. Inequality: Gini Index			
	COL-H	CPI	
All	0.14	-0.23	
Rural	0.21	-0.05	
Urban	0.04	-0.05	
B. Poverty Head Count: $1 a day			
	COL-H	CPI	World Bank
All	-0.23	-0.55	-0.48
Rural	-0.15	-0.51	
Urban	-0.17	0.10	
C. Poverty Head Count: $2 a day			
	COL-H	CPI	World Bank
All	-0.14	-0.21	-0.31
Rural	-0.08	-0.21	
Urban	-0.20	0.02	
D. Poverty Gap: $1 a day			
	COL-H	CPI	World Bank
All	-0.34	-0.70	- 0.61
Rural	-0.26	-0.67	
Urban	-0.16	-0.00	
E. Poverty Gap: $2 a day			
	COL-H	CPI	World Bank
All	-0.23	-0.50	-0.46
Rural	-0.16	-0.46	
Urban	-0.20	0.06	

E.3 Estimation Based on Market Purchases and Housing

Table 10 gives the results in the cost of living (COL-MH) from the estimation based on market purchases and the housing expenditure variable constructed by following the approach described in the section on robustness checks. We can see that although the point estimates change somewhat from the estimation based on market purchases and no housing, again the main price results are strengthened: the urban price increase is overestimated whereas the rural price increase is underestimated using the official CPI estimates.

Table 10: COL change from 1995 to 2002

	COL-MH	CPI
All	0.62	0.09
Rural	2.46	0.08
Urban	-0.12	0.11

Table 11 shows the inequality and poverty results for the specification based on market purchases and housing. We can see that both the inequality and the poverty results hold up, i.e., the findings of increased inequality and overestimation of poverty reduction are not driven by the exclusion of housing consumption and the valuation of self-production at market value.

Table 11: Change from 1995 to 2002

A. Inequality: Gini Index			
	COL-MH	CPI	
All	0.02	-0.23	
Rural	0.04	-0.05	
Urban	0.03	-0.05	
B. Poverty Head Count: $1 a day			
	COL-MH	CPI	World Bank
All	1.14	-0.55	-0.48
Rural	3.02	-0.51	
Urban	-0.36	0.10	
C. Poverty Head Count: $2 a day			
	COL-MH	CPI	World Bank
All	0.47	-0.25	-0.31
Rural	1.06	-0.21	
Urban	-0.22	0.02	
D. Poverty Gap: $1 a day			
	COL-MH	CPI	World Bank
All	2.04	-0.70	- 0.61
Rural	5.54	-0.67	
Urban	-0.37	-0.00	
E. Poverty Gap: $2 a day			
	COL-MH	CPI	World Bank
All	0.93	-0.50	-0.46
Rural	2.28	-0.46	
Urban	-0.30	0.06	

F Regressions

Table 12 contains the following regression specifications (dependent variable: budget share for food):

(1) Rural main regression, self-production and inkind included

(2) Rural regression, self-production, inkind and housing included

(3) Urban main regression, inkind included

(4) Urban regression, inkind and housing included

(5) Pooled main regression

(6) Pooled regression, including housing (both urban and rural households)

Table 12: Regression Table Main (OLS, robust errors)

	(1)	(2)	(3)	(4)	(5)	(6)
	COL	COL-H	COL	COL-H	COL-M	COL-MH
Log of Income	-0.12***	-0.11***	-0.24***	-0.21***	-0.19***	-0.16***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Log of Relative Prices	-0.02	-0.03**	-0.08	0.01	0.07***	0.06***
	(0.011)	(0.011)	(0.050)	(0.043)	(0.011)	(0.009)
Adults	-0.02***	-0.01***	-0.05***	-0.04***	-0.03***	-0.03***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Children	-0.00***	0.00	-0.04***	-0.03***	-0.02***	-0.02***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Elders	0.01***	0.01***	0.01***	0.01***	0.02***	0.01***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Age Head of Household	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	1.46***	1.27***	2.61***	2.23***	2.03***	1.74***
	(0.031)	(0.030)	(0.031)	(0.028)	(0.018)	(0.017)
Adjusted R^2	0.249	0.323	0.549	0.551	0.433	0.421
Observations	15157	15411	11982	12046	27145	27466

G Poverty and Inequality: levels

Table 13: Gini

	Year	Nominal	COL	COL-H	COL-M	COL-MH
All	1995	0.43	0.36	0.41	0.32	0.32
All	2002	0.33	0.40	0.46	0.33	0.33
Rural	1995	0.29	0.36	0.46	0.32	0.31
Rural	2002	0.28	0.47	0.55	0.31	0.32
Urban	1995	0.30	0.26	0.26	0.26	0.27
Urban	2002	0.28	0.28	0.27	0.28	0.28

Table 14: Head Count Poverty Index

	$ a day	Year	NOM	COL	COL-H	COL-M	COL-MH
All	1	1995	0.57	0.44	0.36	0.25	0.21
All	1	2002	0.26	0.29	0.28	0.48	0.45
Rural	1	1995	0.78	0.57	0.45	0.22	0.15
Rural	1	2002	0.38	0.40	0.38	0.63	0.59
Urban	1	1995	0.06	0.11	0.13	0.31	0.37
Urban	1	2002	0.06	0.11	0.11	0.25	0.24
All	2	1995	0.75	0.71	0.60	0.55	0.51
All	2	2002	0.56	0.55	0.51	0.77	0.75
Rural	2	1995	0.95	0.83	0.65	0.49	0.42
Rural	2	2002	0.75	0.66	0.60	0.88	0.86
Urban	2	1995	0.25	0.42	0.47	0.71	0.75
Urban	2	2002	0.26	0.38	0.38	0.60	0.59

Table 15: Poverty Gap Poverty Index

	$ a day	Year	NOM	COL	COL-H	COL-M	COL-MH
All	1	1995	22.85	15.15	14.76	6.22	5.05
All	1	2002	6.85	9.36	9.72	16.17	15.33
Rural	1	1995	31.74	20.50	19.73	5.73	3.27
Rural	1	2002	10.53	13.91	14.53	22.55	21.40
Urban	1	1995	1.12	2.07	2.62	7.41	9.39
Urban	1	2002	1.12	2.26	2.21	6.23	5.87
All	2	1995	39.46	31.50	27.20	19.26	17.02
All	2	2002	19.93	21.74	20.88	34.23	32.86
Rural	2	1995	53.1	39.95	33.05	17.10	12.64
Rural	2	2002	28.54	29.04	27.64	43.33	41.48
Urban	2	1995	6.14	10.87	12.92	24.53	27.72
Urban	2	2002	6.5	10.37	10.34	20.06	19.43

H Elderly households

In the main regressions we equivalence adjust incomes, but we also control for the number of adults, children, elderly and the age of head of household. To further check the robustness of our results, we here include an alternative control for elderly households. We specify a dummy variable that takes the value 1 for single households consisting of either a man older than 60 or woman older than 55 and for two-person households where the man is older than 60 and the woman older than 55. Table 16 contains the results from three regressions, all having the budget share for food as dependent variable. We look at the robustness of our results by comparing the results from our previous elderly variable to those using a dummy for elderly. The results indicate that our findings are robust to this alternative specification.

(1) Pooled main regression, with dummy for elderly
(2) Rural main regression (self-production and in-kind included), with dummy for elderly
(3) Urban main regression (in-kind included), with dummy for elderly

Table 16: Regression Table Elders (OLS, robust errors)

	(1)	(2)	(3)
	COL-M	COL	COL
Log of income	-0.19***	-0.12***	-0.24***
	(0.002)	(0.003)	(0.002)
Log of relative prices	0.07***	-0.02	-0.07
	(0.011)	(0.011)	(0.051)
Elderly households	0.03***	0.02	0.01**
	(0.005)	(0.010)	(0.005)
Adults	-0.03***	-0.01***	-0.05***
	(0.001)	(0.001)	(0.002)
Children	-0.02***	-0.00*	-0.04***
	(0.001)	(0.001)	(0.002)
Age head of household	0.00***	0.00***	0.00***
	(0.000)	(0.000)	(0.000)
Constant	2.02***	1.45***	2.58***
	(0.018)	(0.031)	(0.031)
Adjusted R^2	0.431	0.246	0.547
Observations	27145	15157	11982