American Economic Journal: Macroeconomics 2016, 8(3): 113–144
http://dx.doi.org/10.1257/mac.20150074

Are Chinese Growth and Inflation Too Smooth? Evidence from Engel Curves[†]

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China has experienced remarkably stable growth and inflation in recent years according to official statistics. We use systematic discrepancies between cross-sectional and time-series Engel curves to construct alternative estimates of Chinese growth and inflation. Our estimates suggest that official statistics present a smoothed version of reality. Official inflation rose in the 2000s, but our estimates indicate that true inflation was still higher and consumption growth was overstated. In contrast, inflation was overstated and growth understated during the low-inflation 1990s. These patterns hold for the food Engel curve, and for numerous other categories, such as grain as a fraction of food. (*JEL* C82, E21, E23, E31, O11, P24)

China's growth experience over the past two decades has been an unparalleled economic miracle according to official statistics. Figure 1 plots official statistics for Chinese gross domestic product (GDP) growth, urban consumption growth, and inflation. China has grown substantially faster than any other country over this period, with average output growth over 9 percent per year and average urban consumption growth close to 7 percent per year. Growth rates have, furthermore, been remarkably stable, rarely dipping below 5 percent, even over the tumultuous last few years.

China's official inflation statistics over this period are equally remarkable. Following a bout of inflation in the early 1990s, official measures of inflation in China have been low and stable, averaging less than 2 percent and never rising above 6 percent since 1997. Moreover, there has been essentially zero inflation in nonfood products for more than a decade, according to official statistics. Since 1997, average nonfood inflation has been reported to be −0.1 percent, with a standard deviation of only 1 percent (see Figure 16). In other words, prices of nonfood goods and services have remained essentially unchanged for 14 years, according to official figures.

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† Go to http://dx.doi.org/10.1257/mac.20150074 to visit the article page for additional materials and author disclosure statement(s) or to comment in the online discussion forum.

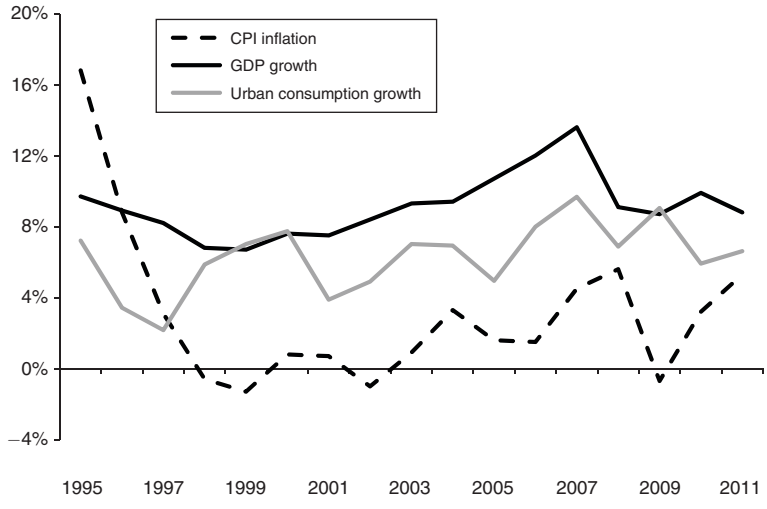

Figure 1. Official Growth and Inflation in China

While few would dispute that China has undergone a remarkable economic transformation, China's official statistics remain controversial. National accounts measurement is challenging under the best of circumstances, and all the more so in a rapidly growing economy. The "new goods" or "quality change" bias is perhaps the best known of the biases that afflict the measurement of inflation and growth. Such biases can lead standard methods to systematically overestimate inflation and underestimate GDP growth because standard methods fail to account for the fact that new products tend to be introduced at lower quality adjusted prices than the products they replace—say the replacement of last year's television model by a new and improved model.[1] Standard methods for constructing price indexes can also make inflation appear too smooth in the face of rapid product turnover, as a consequence of "product replacement bias" (Nakamura and Steinsson 2012).

Political tampering is another important concern regarding growth and inflation statistics, given the highly politically sensitive nature of these statistics. Many studies suggest that the Chinese government overstated grain production during the Great Leap Forward (see, e.g., Meng, Qian, and Yared 2014).[2] Concerns about inflation are one factor often cited as contributing to the discontent that lead to the 1989 Tiananmen Square protests. The remarkable stability of growth and inflation statistics over the past two decades has undoubtedly been an important source of popular support for the Chinese Communist Party. Li Keqiang, the current prime minister of

[1] Important papers on new goods and quality change bias include Court (1939); Griliches (1961); Nordhaus (1998); Bils and Klenow (2001); Hausman (2003); Pakes (2003); Boskin et al. (1996); Bils (2009); Moulton and Moses (1997); Abramhan, Greenlees, and Moulton (1998); Triplett (1997); and Hobijn (2002). Erickson and Pakes (2011) develop an experimental hedonic price index for televisions that accounts, among other things, for price rigidity. Goldberg et al. (2010) show that new imported varieties contributed substantially to effective price declines for Indian firms after a trade liberalization. Reinsdorf (1993) studies the related idea of "outlet substitution bias."

[2] Also, Meng, Qian, and Yared (2014) suggest that the Chinese government may have understated mortality during this period. Political pressure has also been suggested as affecting inflation statistics in some African countries (Sandefur 2013).

China, has said that Chinese regional GDP statistics are "man-made" and therefore "unreliable" and that he relies on electricity consumption, rail cargo volume, and bank lending to gauge the economy (Rabinovitch 2010).[3]

In this paper, we construct new growth and inflation statistics for China for the period 1995–2011. The approach we use is based on Engel curves—the empirical finding that as households become richer, a smaller fraction of total expenditures are spent on necessities, whereas a larger fraction are spent on luxuries. Such Engel curves have been documented in a wide variety of countries and time periods (see, e.g., Deaton and Muellbauer 1980).[4] The basic logic of our approach is to exploit shifts in observed cross-sectional Engel curves over time to "back out" a bias correction factor for inflation and growth. A simple approach would be to compare Engel curves for different years. If the Engel curve in one year is systematically shifted down relative to the Engel curve for an earlier year after controlling for the relative price of the good in question—i.e., the expenditure share is lower for a given level of measured expenditures—one might conclude that measured expenditure growth is biased downward and measured inflation is biased upward. We employ a "difference-in-difference" version of this idea.

To estimate Engel curves for China, we develop a harmonized dataset on Chinese consumer expenditures at the province and income-group levels based on Chinese urban household survey data. In line with previous work for China and other countries, we find that as households become richer, they spend a smaller fraction of total expenditures on food, and a smaller fraction of food expenditures on staples such as grain, but spend a larger fraction on luxuries such as eating out.[5]

Our bias adjusted estimates of inflation are highly correlated with official statistics. However, our estimates suggest that official statistics present a smoothed version of reality. We find that inflation was overestimated and growth was underestimated by several percentage points per year in the late 1990s. During this period, official inflation was low or slightly negative, and our Engel curve based measure of inflation is even lower (perhaps due to new goods bias). The flip-side of this is that we estimate a very high growth rate for urban consumption over this period—above 10 percent per year in each year from 1996 to 2002.

Our estimates indicate a reversal in the direction of the bias in the recent period. Since 2002, official inflation statistics have risen only modestly, but our Engel curve based inflation estimates have risen much more. Our estimates imply that urban consumption growth in China has slowed substantially over the past decade, and dipped into negative territory in 2007 and 2008. One reason for the low growth in standards

[3] Rawski (2001, 2002) presents a detailed critique of GDP statistics in China over the period 1997–2002 and, in the same spirit as the "Keqiang index," demonstrates an inconsistency between official GDP data and related data such as energy use and airline travel. Mehrotra and Paakkonen (2011) use factor analysis to summarize information from various macroeconomic indicators and compare it with official GDP from 1997 to 2009. In both cases, the biases are quite different from those we identify—though it is important to emphasize that these papers focus on GDP whereas we focus on consumption.

[4] See Gale and Huang (2007) for recent work estimating Engel curves for China.

[5] See Subramanian and Deaton (1996) for earlier evidence of systematic differences in expenditure shares across subcategories of food for households with different levels of income.

of living in 2007 that we measure may be a large negative supply shock to pork that occurred in China in that year.[6]

We should emphasize that our estimates do not necessarily imply that GDP growth in China was low in 2007. Our estimates that pertain to consumption are silent about growth in investment. Official data suggest the unusual pattern that Chinese consumption is negatively correlated with investment and other measures of economic activity (Chang et al. forthcoming; Fernald, Hsu, and Spiegel 2014). Our estimates imply an even stronger correlation in this direction. In fact, overheating due to an investment boom may have been a contributing factor to the slump we identify in 2007, by pushing prices up and crowding out consumption.

One might worry that the shifts in the food Engel curve we observe arise from demand shocks such as shifts in households' preferences for food rather than biases in official statistics. What is remarkable about the Chinese data, however, is the pervasive nature of the Engel curve shifts both within and outside of food, and the systematic patterns in these shifts both for necessities and luxuries. Estimates of our Engel curve model based only on subcategories of food (excluding the food share itself) yield similar results to our baseline pooling analysis. As do estimates based on subcategories of food-at-home (eliminating the effects of preference shifts between food-at-home and eating out). As do estimates based on subcategories of clothing, and those based on upper-level categories of consumption such as clothing and household appliances. For demand shocks to explain our findings, there would need to be demand shocks in a large number of different categories that all produced very similar Engel curve shifts.

A similar argument can be made against other concerns about potential model misspecification. The pervasive nature of the Engel curve shifts means, for example, that mismeasurement or misspecification in the effect of relative prices on expenditure shares would have to have systematic patterns across many categories of necessity and luxury goods. However, the qualitative patterns of relative price movements are quite different. For example, the evolution of the price of food relative to total expenditure is quite different from that of grain relative to total food. The nature of the model misspecification would, therefore, also have to vary in a somewhat intricate way across goods to explain the patterns we find.

We have re-estimated our model in various other ways to evaluate the importance of other forms of misspecification. We have re-estimated our model using micro-data from the China Household Income Project (CHIP) for the years 1995, 1999, 2002, and 2007. These results provide a separate check on our analysis based on a different data source. As in our baseline results, the CHIP data indicate that inflation was overestimated over the periods 1995–1999 and 1999–2002 but underestimated over the period 2002–2007. The magnitude of the underestimate of inflation over the 2002–2007 period is somewhat larger according to CHIP than our

[6] Unlike our findings for China, Hamilton (2001) and Costa (2001) do not find "excess smoothness" in the official US data based on their Engel curve analyses. Rather, they find that official statistics overstate inflation and understate growth in the United States. They interpret their findings as evidence for new goods bias. The high growth rates we estimate in the late 1990s for China may be evidence of new goods bias for China. However, the overall pattern of results we find for China is more intricate, suggesting that other sources of bias play an important role in the Chinese case.

baseline results. One advantage of the CHIP data is that we can estimate the model both including and excluding individuals with a nonlocal "hukou" to assess the role of rural-urban migration. The results based on CHIP are very similar including and excluding migrants.

The general approach to measuring growth and inflation we employ was pioneered by Nakamura (1996), Hamilton (2001), and Costa (2001), and employed by these authors to measure new good bias in the United States. A key idea underlying this approach is that while standard methodologies for measuring growth require the statistical agency to confront the formidable challenges associated with new goods and quality change discussed above, the Engel curve approach requires only the measurement of expenditure shares. Furthermore, disaggregated expenditures may be less likely to be subject to political tampering than headline inflation and growth statistics.

Our work is related to a growing literature that uses Engel curve approaches to infer various aspects of economic growth. Aguiar and Bils (2015) use Engel curves to derive an alternative estimate of the growth in US consumption inequality. Almås (2012) uses Engel curves to estimate biases in purchasing power parity statistics. Young (2012) uses related methods to generate alternative estimates of African growth. Bils and Klenow (1998) use Engel curve methods to test the predictions of various business cycle models.

For the case of China, Xu and Zeng (2009) (in Chinese) estimate Engel curves for food, and derive the implications for the consumer price index (CPI) bias over the 1997–2006 period, concluding that there have been no significant biases in Chinese inflation except in 1997. However, two fundamental differences between their work and ours are that they introduce an ad hoc dummy variable that accounts for shifts in the Engel curve in the post-2000 period—effectively absorbing any bias over this period, and that they do not include regional fixed effects, and instead divide the regions into two groups as a way of capturing the cross-sectional heterogeneity. Almås and Johnsen (2012) apply Engel curve methods to the 1995 and 2002 waves of the CHIP survey to construct a "regional price index," finding that inflation has been higher in rural than in urban China. Gong and Meng (2008) perform a similar spacial analysis for urban areas. Wang and Woo (2011) apply an Engel curve approach to a novel survey dataset on household income to construct alternative estimates of income inequality in China. Both Almås and Johnsen (2012) and Wang and Woo (2011) find that official statistics underestimate income inequality in the recent period. Filho and Chamon (2013) apply an Engel curve approach to infer inflation biases from the food share using micro-data from the Urban Household Income and Expenditure Survey for a subset of Chinese regions over the 1998–2005 period. Our analysis of the CHIP micro-data is methodologically similar, and we obtain qualitatively similar results to theirs for the time period they study, though we estimate a larger cumulative bias.[7] Numerous papers have carried out related exercises for other countries: Beatty and Larsen (2005) for Canada; Larsen (2007) for Norway; Gibson, Stillman, and Le (2008) for Russia; Barrett and Brzozowski

[7] This difference most likely arises because of the semi-parametric approach they use to allow to adjust for different biases across income groups. We discuss this issue further in footnote 22.

(2010) for Australia; Gibson and Scobie (2010) for New Zealand; Chung, Gibson, and Kim (2010) for Korea; and Filho and Chamon (2012) for Brazil and Mexico.

The paper proceeds as follows. Section I describes the data. Section II outlines our empirical model and the resulting estimator of biases in Chinese inflation and growth statistics. Section III presents illustrative evidence on cross sectional Engel curves in China and how they shift over time. Section IV presents our adjusted estimates of Chinese inflation and growth. Section V discusses the inflation spike of 2007. Section VI concludes.

I. Data and Institutional Background

Our main source of data is the yearbooks on urban prices and household expenditures compiled and published by the Chinese National Bureau of Statistics (NBS) based on their Urban Household Income and Expenditure Survey (UHIES). The UHIES gathers data on annual expenditures of many disaggregated product categories for Chinese urban households. Households are chosen for the survey using stratified random sampling in such a way as to make the survey representative of the total urban population. Households in the survey are asked to record income and expenditures in a diary for a full year. Officials visit sample households several times a month to review and retrieve diaries and assist households. For most of our analysis, we use province-level expenditure data based on the UHIES. In our robustness analysis, we also make use of an analogous data stratified by income group.

A general concern regarding the surveys we use is that the sampling frame used by the Chinese government may not be adequate, or that there may be systematic underreporting by some demographic groups (as there is in US consumption surveys). Piketty and Qian (2009) discuss how households that refuse to participate are typically the poorest and richest households. One advantage of the Engel curve approach to measuring growth and inflation is that it does not, in principle, require that the sample be representative or even constant over time. Under the (perhaps heroic) assumption that the model of demand is literally correct, then a nonrepresentative sample simply implies that the Engel curve will be estimated off of a nonrepresentative sample of the population—but the resulting income elasticities will still be correct. Analogously, changes in the sample will lead to movements along, as opposed to shifts in, the Engel curve.

In addition to the expenditure data, we use CPI price index data by product category to account for potential changes in relative prices across commodities (but not the overall level of inflation, which we assume is measured with error). We also incorporate a number of demographic controls in our analysis: household size, the number of people earning income (including nonwage income such as retirement earnings) per household, the number of people employed per household, the average sex ratio, the unemployment rate, the child-dependency ratio, the elderly-dependency ratio, and a measure of urban migration.[8]

[8] Since 2002, the sample frame for the urban household survey has included all residents living in an urban area irrespective of residency status (whereas before that time, a local, nonagricultural residency status (hukou) was required). In our baseline analysis, we control for this factor by constructing a migration variable that is zero before

We make use of the official CPI published by the NBS, as a basis for comparison for our Engel curve based inflation estimates. The NBS reports that the data underlying the CPI are collected from 63,000 price collection units in 500 cities and counties of the 31 provinces (autonomous regions and municipalities), which cover grocery stores, department stores, supermarkets, convenience stores, professional markets, franchise houses, shopping centers, open fairs and community service centers run by local governments. The CPI is constructed according to a Laspeyres index. We focus on the urban CPI released by the NBS, since our Engel curve estimates are constructed from urban households. However, Figure A.1 in the online Appendix shows that the urban and total CPI measures are very similar.

We also present estimates of inflation and consumption growth based on micro-data from the Chinese Household Income Project (CHIP). CHIP is a household survey that has been added to the UHIES for a subsample of that survey sample in a subsample of Chinese provinces in the years 1988, 1995, 1999, 2002, 2007, and 2008. We use data from the 1995, 1999, 2002, and 2007 CHIP surveys. We do not use data from the 1988 CHIP because rationing was still widespread in China in 1988 (see discussion below). The CHIP survey changed in 2008 to ask only about "necessary" consumption on food and "necessary" total consumption, implying that the survey responses are not comparable in this year. For this reason, we do not use the 2008 CHIP data. We use data on total expenditures and the share of expenditures spent on food from the urban households survey in CHIP. We exclude liquor and cigarettes from the food share both because there is no liquor and cigarette expenditure in the 2007 CHIP and because these categories are not a part of the food share in the UHIES.

We have extensively analyzed the data to eliminate inconsistencies and harmonize the data across years. We have also filled in gaps in digital sources from hard copy sources. The exact data sources, and the details of how we compiled the data are described in online Appendix A.

For our Engel curve approach to work, it must be the case that household expenditure shares are the consequence of optimizing decisions on the part of households. It is therefore important that household consumption decisions are not contaminated by rationing. In China, rationing was completely phased out by 1996 (and mostly phased out by the early 1990s). Price controls do not pose a problem for our approach, since we do not make any assumptions about the supply-side of the economy, but these too were mostly phased out by the mid-1990s. Concerns about rationing lead us to restrict attention to expenditure data from 1995 onward.

II. Engel Curve Estimation

The methods we use to estimate inflation and consumption growth from shifts in Engel curves are based on earlier work by Nakamura (1996), Hamilton (2001), and Costa (2001). We extend these methods to allow for pooling across Engel curves for different commodities. This pooling approach improves the precision of

2002 and after 2002 is equal to the cumulative net in-migration since 2002. This variable adjusts gradually and does not appear to be cyclical and has virtually no effect on our results. We also assess the importance of migration using data from CHIP (see description below), where we can include and exclude migrants.

our estimates, and lessens their sensitivity to idiosyncratic measurement errors and demand shocks.

Our estimates are based on the following log-linear model for the expenditure share of commodity k in region i at time t:

$$(1) \qquad \omega_{i,t}^k = \psi_i^k + \beta^k \log(C_{i,t}/P_{i,t}) + \gamma^k \log(P_{i,t}^k/P_{i,t}) + \sum_x \Theta_x^k \mathbf{X}_{i,t} + \epsilon_{i,t}^k,$$

where $C_{i,t}/P_{i,t}$ denotes real total expenditures (and $P_{i,t}$ is the true aggregate price level), $P_{i,t}^k/P_{i,t}$ denotes the relative price of commodity k, $\mathbf{X}_{i,t}$ is a set of demographic controls, ψ_i^k denotes a region-good fixed effect, and $\epsilon_{i,t}^k$ is a residual.[9]

Equation (1) describes how the expenditure share for good k varies with real total expenditures and the good's relative price. The coefficient on real total expenditures, β^k, measures the extent to which households spend a larger or smaller share of total expenditures on good k as they become richer. For example, the well-known negative relationship between the food share and total expenditures would imply $\beta^k < 0$. More generally, expenditure shares decline with total expenditure for necessities ($\beta^k < 0$) and rise for luxuries ($\beta^k > 0$).

It has been observed in many countries, both cross-sectionally, and over time, that there is a strong negative relationship between the food share and total expenditure. In other words, richer households spend a smaller fraction of their income on food. This empirical relationship was first widely recognized after the work of Engel (1857, 1895) and is referred to as an Engel curve for food.

In practice, the true price level and the true price of good k are measured with error. Let $\tilde{\pi}_{i,t}^k$ denote the measured cumulative inflation for good k in region i between periods 0 and t. Then we have

$$(2) \qquad \log P_{i,t}^k - \log P_{i,0}^k = \tilde{\pi}_{i,t}^k + \mu_{i,t}^k,$$

where $\mu_{i,t}^k$ denotes the cumulative bias in the measurement of inflation. Define measured cumulative inflation for all prices $\tilde{\pi}_{i,t}$ and the cumulative bias for all prices $\mu_{i,t}$ analogously. Using these concepts to eliminate the unobserved true prices $P_{i,t}$ and $P_{i,t}^k$ from equation (1) yields

$$(3) \quad \omega_{i,t}^k = \hat{\psi}_i^k + \beta^k \log C_{i,t} - \beta^k \tilde{\pi}_{i,t} - \beta^k \mu_t + \gamma^k (\tilde{\pi}_{i,t}^k - \tilde{\pi}_{i,t}) + \sum_x \Theta_x^k \mathbf{X}_{i,t} + \epsilon_{i,t}^k.$$

Our interest centers on the inflation bias term μ_t. It is straightforward to estimate μ_t from the Engel curve for a single product k, such as food. To do this, we simply replace the terms $\beta^k \mu_t$ by time fixed effects and then estimate the resulting equation by ordinary least squares. We can then recover μ_t by dividing the estimated time fixed effects by the estimated coefficient β^k. This is the original Hamilton-Costa

[9] A linear relationship of this type between expenditure shares and log income arises from Deaton and Muelbauer's (1980) Almost Ideal Demand System. One caveat is that the formula for the price index $P_{i,t}$ in equation (1) may differ from the one constructed by a national statistical agency. See Beatty and Crossley (2012) for a detailed discussion of this issue. In Section IVD, we use the methods laid out in Feenstra and Reinsdorf (2000) to construct inflation estimates for different income groups. Differences in inflation between different income groups appear to play little role in explaining our results.

approach (with the slight difference that they have individual level data on expenditures but price indexes that vary only by region).

Suppose, however, that we wish to estimate the bias term μ_t pooling information across more than one commodity. In this case, we wish to allow the slope of the Engel curve, β^k, to vary across commodities, while μ_t is common across all commodities. This specification no longer admits a representation that can be estimated using ordinary least squares. Hence, for the pooled specifications we consider, we estimate equation (3) using nonlinear least squares on a pooled dataset containing the expenditure shares of multiple commodities.

Since we allow for region fixed effects, the slope of the Engel curve β^k is identified from what happens to the expenditure share in one province versus another when its relative consumption increases. In other words, a good is a necessity if regions whose consumption is growing particularly quickly relative to other regions also have expenditure shares for the good that is falling rapidly. Our estimates are not, therefore, affected by constant differences in consumption preferences across regions.

III. Illustrative Evidence

To develop intuition for our main results, it is useful to plot the Engel curve for food, and observe how it has shifted over time. Figure 2 plots the share of food in total expenditures as a function of log total expenditures for different income groups in China. The top panel plots this for 1995, 1998, and 2000, while the bottom panel plots 2006 and 2008. In each case, the food share is adjusted for both movements in relative prices and an income group fixed effect using the methods laid out in Section II.[10] It is clear from the figure that there is a strong negative relationship between the food share and total expenditures across these income groups in each year. In other words, richer households spend a smaller fraction of their income on food.

A second—more curious—pattern that emerges from this figure is that the Engel curves appear to "shift" downward over time between 1995 and 2000. In other words, for a given level of total expenditures, as measured by official statistics, households appear to spend successively lower fractions of their total expenditures on food over this period. One possible explanation for these shifting Engel curves—the one we explore in this paper—is that they arise from biases in official inflation statistics. If the change in the CPI measure used to deflate the real expenditures plotted on the x-axis is overstated, this will lead the points for, say, 2000 to be plotted too far to the left relative to the points for 1995—accounting for the apparent shift. A similar pattern of shifting Engel curves in the United States led Hamilton (2001) and Costa (2001) to conclude that there was a substantial downward bias in official US growth statistics and an upward bias in the US CPI inflation rate due to new goods bias.

[10] Given the income group fixed effects in our specification in Section II, the negative slope of this relationship is identified from the fact that income groups with more rapidly growing expenditures see a larger drop in their food shares.

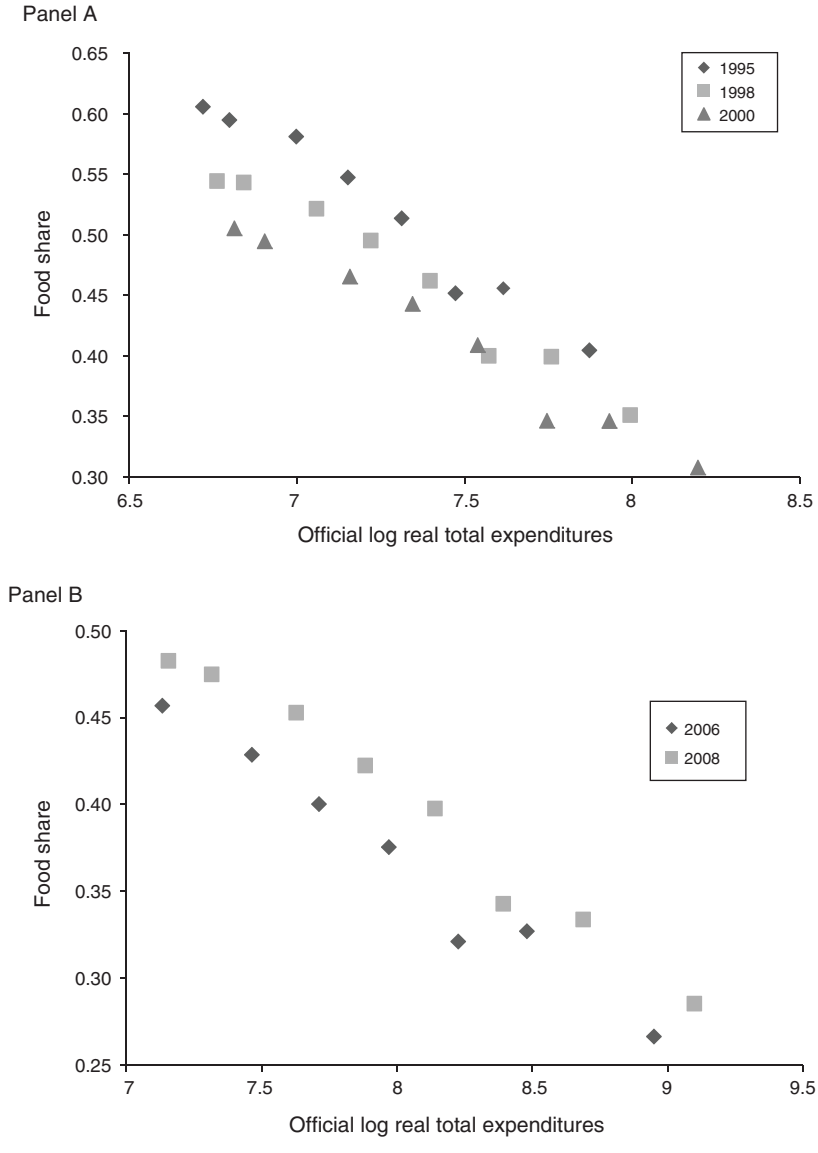

FIGURE 2. INCOME GROUP ENGEL CURVES

Notes: The figure plots the expenditure share on food for eight different income groups in China for various years. The reported food shares are adjusted for income group fixed effects (the omitted category is the second highest income group) and movements in the relative price of food using an estimate for the price elasticity of food from our baseline regional specification from Section IV. Real total expenditures are measured in 1985 yuan.

In panel B of Figure 2, we again see that the Engel curve appears to shift, but this time in the opposite direction. The Engel curve for 2008 lies above the Engel curve for 2006. This means that for a given level of total expenditures, as measured by official statistics, households appear to allocate a higher fraction of their total expenditures on food in 2008 than in 2006. This suggests that the official growth statistics were too high between 2006 and 2008, and the official inflation measures

were too low. The upward shift in the Engel curves coincided with an increase in official measures of inflation (see Figure 1). The Engel curve approach suggests that true inflation increased by even more than official measures of inflation indicate.

We can redo this analysis using regional data on expenditure shares—the main data source used in our paper. While the regional Engel curves are more noisy, the same patterns emerge. Figure 3 plots Engel curves for food across different regions in China for the same years as Figure 2, adjusted for movements in relative prices, demographic controls, and a region fixed effect using the methods laid out in Section II. The figure shows that as regions become more affluent they spend a smaller fraction of their total expenditures on food. But as in Figure 2, these Engel Curves seem to shift over time. Just as in the case of the income group analysis, the Engel curves shift downward from 1995 to 2000 (indicating an upward bias in official inflation) and then upward from 2006 to 2008 (indicating a downward bias in official inflation).

Figure 4 plots "Engel curves" for grain as a fraction of total food expenditures. Since grain is a necessity even within food, the expenditure share of grain as a fraction of total food expenditure falls as total expenditures rise. This relationship is often referred to as Bennett's Law (Bennett 1941). We simply refer to it as the Engel curve for grain. We observe a similar pattern of shifting Engel curves for grain as for the case of food. While the Engel curves for grain shift downward from 1995–2000, they shift upward from 2006–2008. That these patterns arise for grain as a fraction of food as well as for food as a fraction of total expenditures, bolsters the case that both patterns arise from a common cause—mismeasurement in official statistics. We show in Section IV that similar patterns arise for a much wider range of necessities beyond just food and grain, and that the opposite patterns arise for luxuries such as eating out and premade garments.

IV. Results on Inflation and Urban Consumption Growth

Figure 5 presents our baseline Engel curve based estimates of inflation over the period 1996–2011, based on estimating equation (3). Our baseline specification pools information from the Engel curve for food expenditures as a fraction of total expenditures with 14 separate Engel curves for expenditures on 14 subcategories of food (e.g., grain, meat, or eating out) as a fraction of food expenditures.[11] The dashed lines present two standard error bands. The standard errors are clustered by commodity to allow for arbitrary time series correlation of the error term. The estimates are plotted alongside official inflation statistics.

According to our Engel curve based estimates, official inflation statistics present a smoothed version of reality. Our Engel curve based inflation series is highly correlated with the official inflation series, but has substantially larger swings. In the late 1990s, China experienced a mild deflation according to official statistics, which

[11] The 14 subcategories of food are grain, meat, beans, starch, egg, oil, milk, baked goods, condiments, sugar, vegetables, fruit, fish, and eating out. These categories are chosen as all those for which it was possible to construct harmonized expenditure and price series over time. We do not include two amalgam categories for which we were unable to construct price indexes: "tea, liquor, and beverage" and "other food." We also exclude tobacco, which we viewed as potentially subject to very different demand shocks from the rest of the food category.

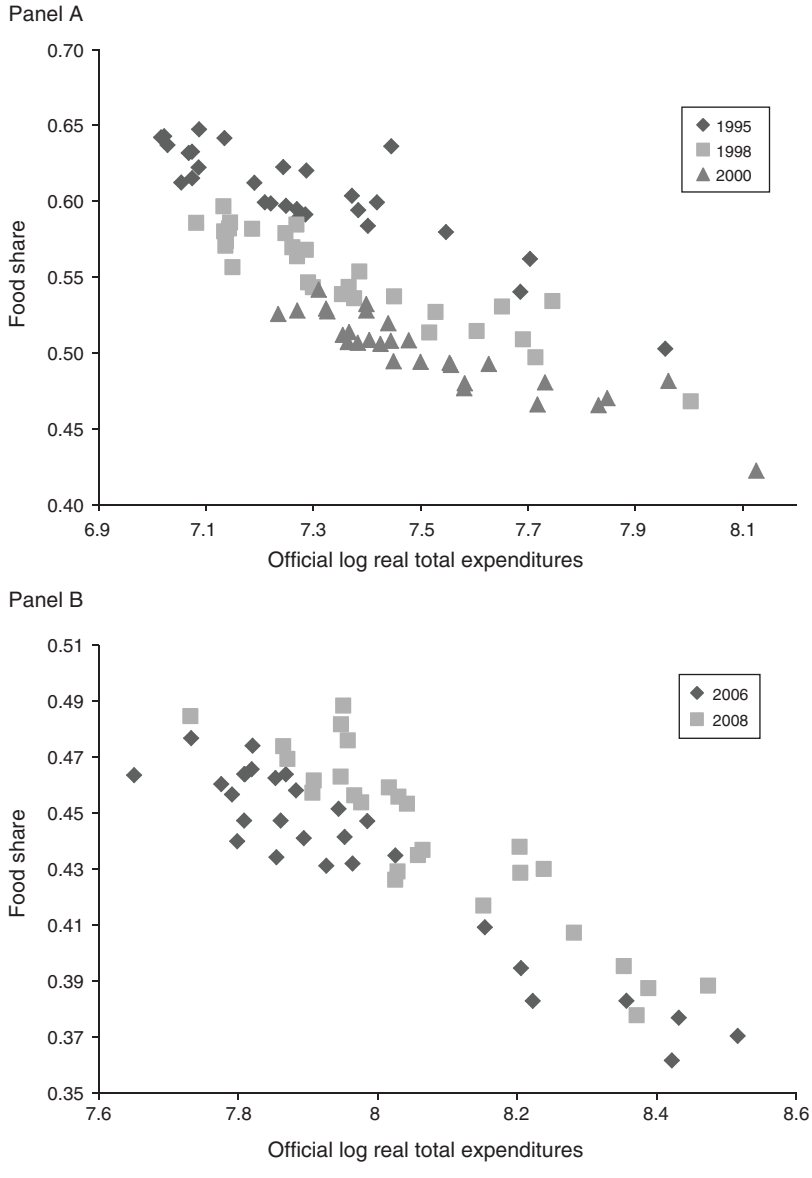

FIGURE 3. REGION ENGEL CURVES FOR FOOD

Notes: The figure plots the expenditure share on food as a function of log total expenditures for 30 different regions in China for various years. The reported food shares are adjusted for region fixed effects (the omitted region is Anhui), movements in the relative price of food, and demographic controls using estimates from our baseline specification from Section IV. Real total expenditures are measured in 1985 yuan.

the International Monetary Fund (IMF) attributed to commodity cost declines, tariff cuts related to World Trade Organization agreements, productivity gains from reforms to state-owned enterprises, and greater competition (IMF 2003). Our inflation series indicates that there was considerably more deflation over this period than official statistics suggest. On the other hand, in the late 2000s, inflation started to

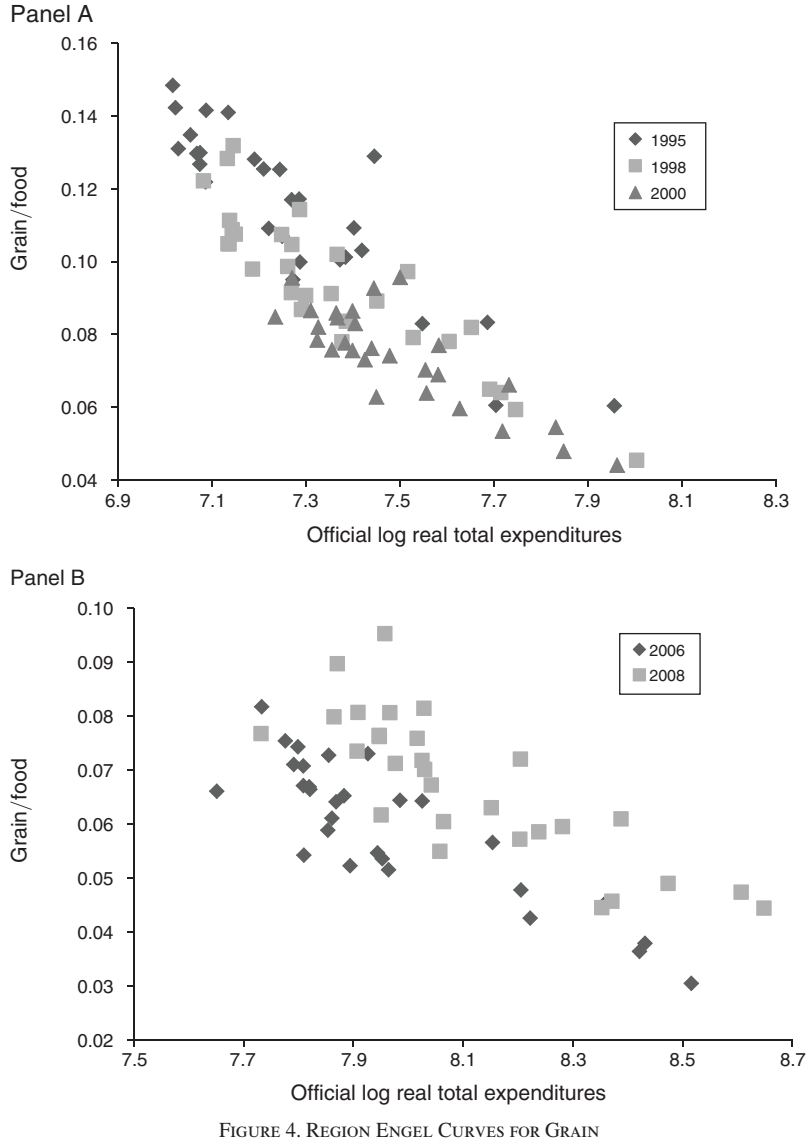

FIGURE 4. REGION ENGEL CURVES FOR GRAIN

Notes: The figure plots expenditures on grain as a fraction of expenditures on food as a function of log total expenditures for 30 different regions in China for various years. The reported grain/food shares are adjusted for region fixed effects (the omitted region is Anhui), movements in the relative price of grain, and demographic controls using estimates from our baseline specification from Section IV. Real total expenditures are measured in 1985 yuan.

rise modestly according to official statistics, peaking in 2008. Our estimates suggest that true inflation was considerably higher than official statistics indicate over this period.[12]

[12] The official inflation measure in Figure 5 is the urban CPI. However, Figure A1 in the online Appendix shows that the urban and total CPI measures are very similar. Moreover, total nominal consumption as measured in the household survey is very similar to total nominal consumption as measured by the Chinese national accounts. This is illustrated in Figure A2 in the online Appendix. The only significant discrepancy is a spike in the household survey in 2002 that may have arisen from the redefinition of some of the categories in that year.

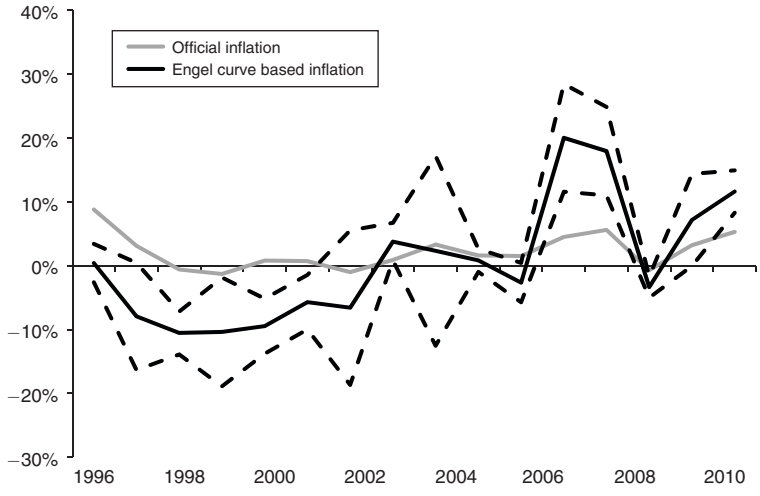

Figure 5. Official and Engel Curve Based Inflation

Notes: Official inflation is the Chinese CPI. Adjusted inflation is from a pooled specification using the Engel curve for food expenditures as a fraction of total expenditures and Engel curves for the expenditures on 14 major subcategories of food (e.g., grain, mean, or eating out) as a fraction of food expenditures. Dashed lines are two standard error bands. Standard errors are clustered by commodity.

It is important to note that the official inflation rate plays no role in the construction of our Engel curve based inflation series. Intuitively, our inflation series is backed out from expenditure data as a factor that is needed to undo shifts over time in the cross-sectional Engel curves for various expenditure shares. There is, therefore, no mechanical reason for the strong correlation we observe between the official CPI and our adjusted inflation measure.[13]

The flipside of understated inflation is overstated growth. This follows from the fact that inflation statistics are used to transform nominal growth rates into real growth rates. Figure 6 presents the implications of our Engel curve estimates for Chinese urban consumption growth. The figure shows that while official statistics suggest a highly stable, and slightly upward sloping trend in Chinese urban consumption growth over the period 1996–2011, our Engel curve based estimates of urban consumption growth indicate considerably more volatility and a marked slowdown in the late 2000s. According to our estimates, urban consumption growth in China was substantially higher than official statistics indicate in the late 1990s—above 10 percent per year in each year from 1996 to 2002 and above 15 percent per year between 1998 and 2000. Since then, growth has been lower, in particular, dipping into negative territory in 2007 and 2008.

[13] The fact that measured inflation is one of the regressors in equation (3) may give the impression that measured inflation plays a role in the construction of our bias estimates. This is not the case. We could have run regression (3) without measured inflation as a regressor. In this case, the evolution of the time fixed effects (divided by β^k) would yield the evolution of true inflation. Including measured inflation as an additional regressor simply changes the interpretation of the time fixed effects so that they yield the inflation bias as opposed to true inflation.

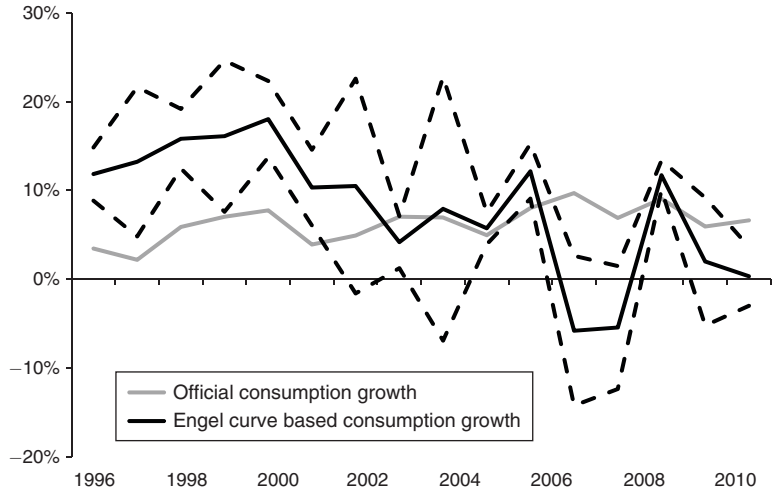

FIGURE 6. OFFICIAL AND ENGEL CURVE BASED URBAN CONSUMPTION GROWTH

Notes: Adjusted urban consumption growth is from a pooled specification using the Engel curve for food expenditures as a fraction of total expenditures and Engel curves for the expenditures on 14 major subcategories of food (e.g., grain, mean, or eating out) as a fraction of food expenditures. Official consumption growth is for urban consumption from the National Accounts. Dashed lines are two standard error bands. Standard errors are clustered by commodity.

Recall that our estimates are driven by changes over time in the expenditure shares for necessities versus luxuries. Rapidly falling expenditure shares for necessities suggest that growth is high (and inflation low, all else equal), while falling or slowly rising expenditure shares for luxuries suggest the opposite. Table 1 presents the income coefficients β^k and the price coefficients γ^k from our baseline pooled estimation of equation (3). Our estimate of β^k for food is negative, indicating that food is a necessity. Our estimate of β^k for grain and meat are also negative indicating that grain and meat are necessities within food (i.e., the share of food expenditures that go towards grain and meat fall as total expenditures rise). On the other hand, our estimate of β^k for milk, fruit, and eating out are positive, indicating that these are luxuries within food. It is crucial for our analysis that many of the coefficients on total expenditures differ substantially from zero. It is only because expenditure shares change in a systematic way with total expenditures that we are able to draw inferences about growth and inflation from variation in expenditure shares.

Figure 7 presents the evolution of the expenditure share on food as well as the share of food expenditures on grain and eating out over the period 1996–2011. Both the food share and the grain share within food declined rapidly in the late 1990s and the share of food expenditures that go towards eating out rose rapidly. These rapid changes in expenditure patterns then decelerated markedly after 2002. This suggests a marked slowdown of growth in urban consumption after 2002.

A. *Estimates Based on Engel Curves for Other Products*

Model misspecification is an important concern in assessing Engel curve estimates of growth and inflation. One might be concerned, for example, that the rapid

Table 1—Coefficients from Baseline Pooled Specification

	Average share	Income (β^k)	Price (g^k)
Food	0.40	−0.135	0.077
		(0.01)	(0.027)
Grain	0.10	−0.052	0.083
		(0.005)	(0.015)
Meat	0.21	−0.034	0.102
		(0.003)	(0.005)
Bean	0.01	−0.005	0.004
		(0.0005)	(0.0001)
Starch	0.01	−0.003	−0.001
		(0.0004)	(0.0001)
Egg	0.03	−0.012	0.008
		(0.0007)	(0.003)
Oil	0.03	−0.004	0.028
		(0.0003)	(0.0003)
Milk	0.04	0.021	0.021
		(0.002)	(0.003)
Baked goods	0.02	−0.001	0.003
		(0.00006)	(0.0001)
Condiments	0.01	−0.001	0.003
		(0.0001)	(0.0001)
Sugar	0.01	0.001	0.004
		(0.0001)	(0.00007)
Vegetable	0.10	−0.026	0.030
		(0.002)	(0.003)
Fruit	0.07	0.004	0.021
		(0.0004)	(0.0004)
Fish	0.07	−0.007	0.006
		(0.0008)	(0.0004)
Eating out	0.17	0.104	0.010
		(0.005)	(0.03)

Notes: The table reports the coefficients on total expenditure and relative prices from equation (3) in the paper for our baseline specification. Our baseline specification pools information from the Engel curve for food expenditures as a fraction of total expenditures with 14 separate Engel curves for expenditures on 14 subcategories of food (e.g., grain, mean, or eating out) as a fraction of food expenditures. The first data column reports the average expenditure share on food as well as the average expenditure on each of the 14 subcategories as a fraction of food expenditures. Standard errors are reported in parentheses.

declines in expenditure shares for food in the late 1990s reflect changing household preferences that are not accounted for by our model. To address this concern, we present results for many different product categories. The fact that we find common patterns regarding the shifts in Engel curves over time across a large number of these categories suggests that these shifts arise from a common cause—mismeasurement in official inflation statistics—as opposed to product specific changes in household preferences.

As we discuss above, our baseline specification presented in Figures 5 and 6 is based on pooled data for food and 14 subcategories of food. Figure 8 compares our baseline estimates for inflation with inflation estimates based on the food share alone and inflation estimates based on pooled data for the 14 subcategories of food alone. There is no mechanical reason why these two specifications should yield the same

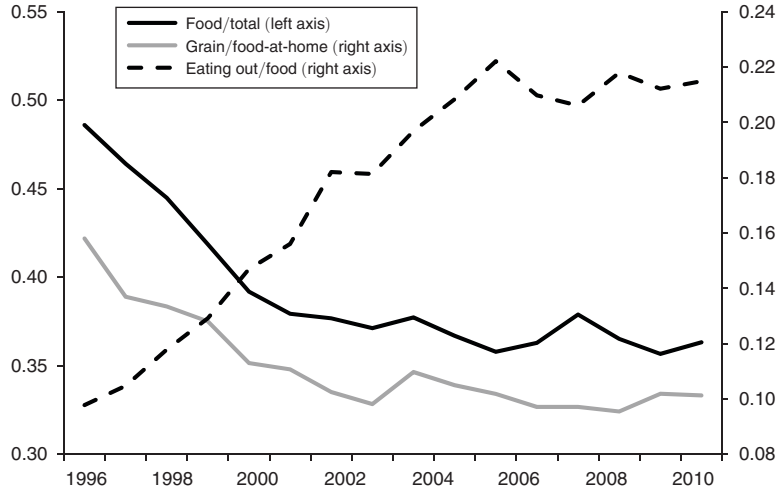

FIGURE 7. EVOLUTION OF EXPENDITURE SHARE FOR FOOD, GRAIN, AND EATING OUT

Notes: The figure plots the evolution over time of the share of total expenditures that go toward food, the share of food-at-home expenditures that go toward grain, and the share of food expenditures that go toward eating out.

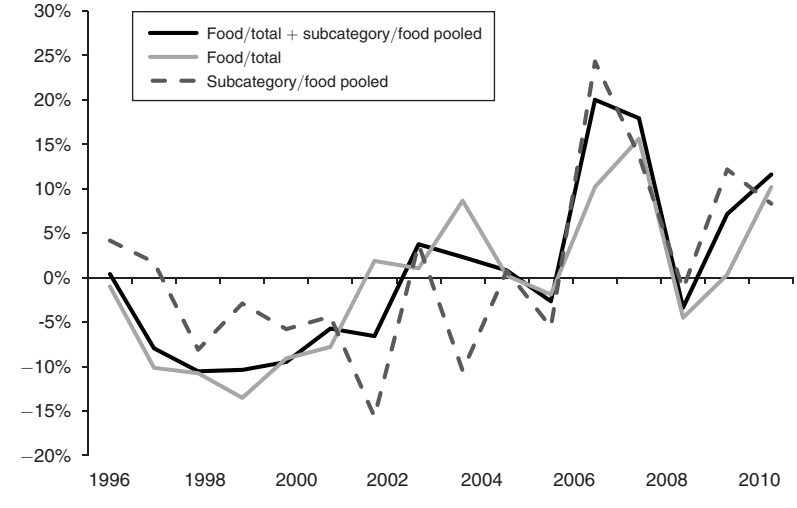

FIGURE 8. FOOD VERSUS SUBCATEGORIES OF FOOD

Notes: The figure plots results based on three specifications. The first is the baseline specification that pools the Engel curve for food expenditures as a fraction of total expenditures and Engel curves for the expenditures on 14 major subcategories of food as a fraction of food expenditures. The second specification is for the Engel curve for food expenditures only. The third specification pools the Engel curves for the expenditures on the 14 major subcategories of food as a fraction of food expenditures only.

results regarding inflation bias. Yet the figure shows that both of these components of our baseline specification yield very similar results for inflation. This similarity across the predictions of the different models is reassuring, since it makes it less likely that our results are driven by idiosyncratic demand shocks or measurement error.

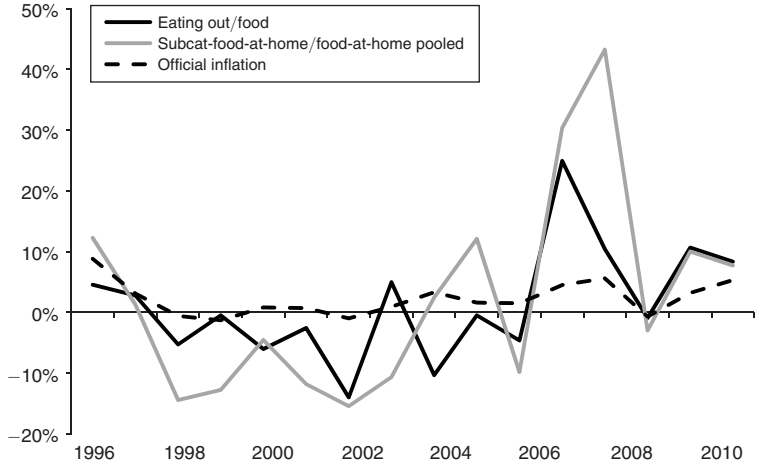

FIGURE 9. EATING OUT VERSUS SUBCATEGORIES OF FOOD-AT-HOME

Notes: The figure plots official inflation along with two Engel curve based estimates of inflation. The dark line is an estimate of inflation based on the Engel curve for expenditures on eating out relative to food, while the lighter line is an estimate of inflation based on a specification that pools 13 Engel curves for expenditures on 13 subcategories of food relative to total expenditures on food at home.

The next three figures present results based on several additional Engel curves. Figure 9 presents estimates of inflation using the share of eating out within food—a luxury—alone. It also presents estimates based on pooling across various subcategories of food at home, such as grain, meat, and vegetables as a fraction of food at home. Both of these specifications yield qualitatively similar results—larger deflation in the late 1990s and larger inflation in the 2000s than official inflation statistics.

Figure 10 is analogous to Figure 8 except that it is based on the Engel curves for clothing and subcategories of clothing.[14] The specification pooling clothing and subcategories of clothing and the specification pooling only the subcategories of clothing both yield results that are similar to our baseline results. The specification based on the Engel curve for clothing alone yields similar results for the late 1990s and late 2000s, but somewhat different results for 2000–2003. It is clear from the figure that when the Engel curve for clothing is pooled with the Engel curves for the subcategories of clothing, the Engel curve for clothing contributes very little to the pooled estimates, suggesting that there is less information about inflation in the Engel curve for clothing than the Engel curves for the subcategories of clothing.

Figure 11 presents results from a specification that pools data from the Engel curves of all of the major expenditure categories of consumption—food, clothing, household appliances and services, transportation and communication, education, recreation and culture, housing, and health care. Since one might be concerned that there is a large amount of government intervention in housing and health care, the

[14] The four subcategories of clothing are garments, clothing material, shoes and other clothing, and laundry and tailoring.

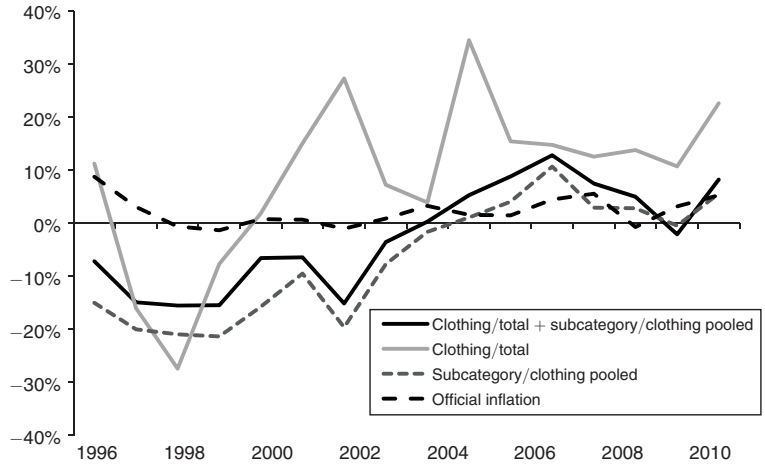

FIGURE 10. CLOTHING AND SUBCATEGORIES OF CLOTHING

Notes: The figure plots official inflation along with three Engel curve based estimates of inflation. The unbroken dark line is an estimate of inflation based on a specification that pools the Engel curves for clothing expenditures as a fraction of total expenditures and Engel curves for all subcategories of clothing. The unbroken light line is based on the Engel curve for the clothing share alone, while the dark gray dotted line is based on a pooled specification of the subcategories of clothing alone.

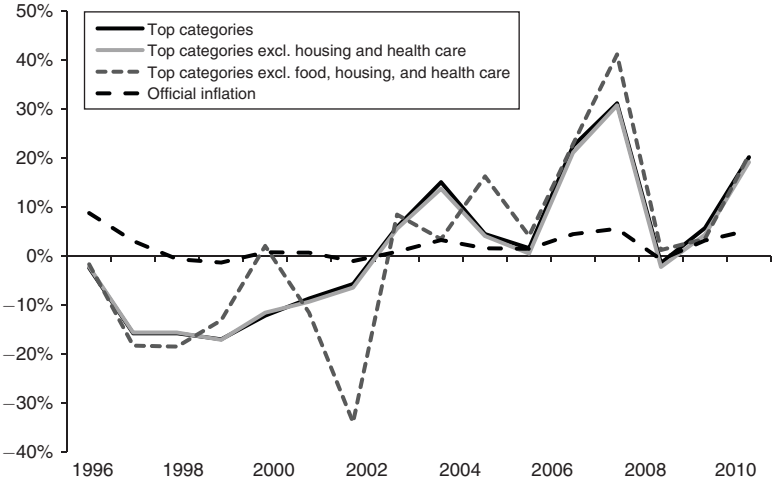

FIGURE 11. TOP CATEGORIES

Notes: The figure plots official inflation along with three Engel curve based estimates of inflation. The unbroken dark line is based on a specification that pools the Engel curves for the expenditure share of all top categories. The unbroken light line is the same except that it excludes housing and education. The dark gray broken line is the same except that it also excludes food.

figure also presents results of pooling only the first five categories. Finally, the figure also presents results excluding food in addition to housing and health care. All three of these specifications yield qualitatively similar results—larger deflation in the late 1990s and larger inflation in the 2000s than official inflation statistics.

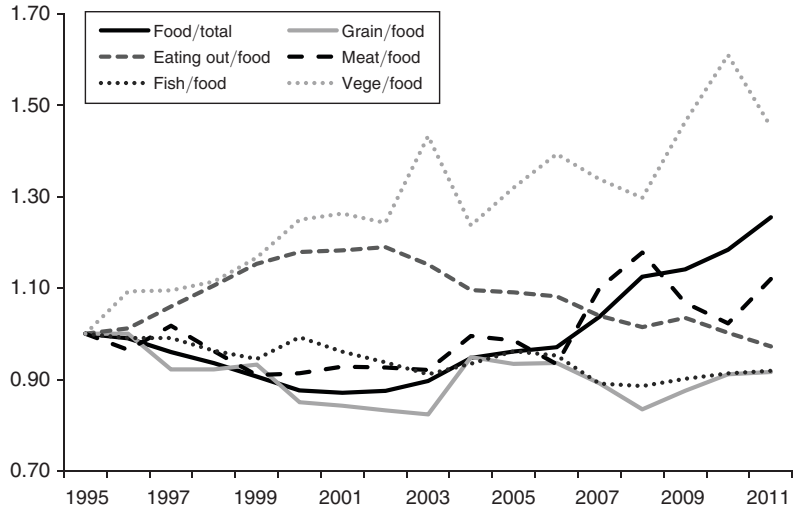

FIGURE 12. RELATIVE PRICES

Notes: The figure plots the price of food relative to total expenditure, the price of grain, eating out, meat, fish, and vegetables relative to food. All series are normalized to 1 in 1995.

B. *Relative Prices*

A potential worry with our methodology is that we might not account correctly for the effect of relative prices on expenditure shares. Figure 12 plots the evolution of the price of food relative to all goods, and the price of five large subcategories of food relative to food. These are the main expenditure categories in our baseline specification (Figure 5). These relative price series follow markedly different patterns over the time period of our analysis. The relative price of food/total and meat/food fall in the late 90s and rise in the 2000s; eating out/total does the opposite; grain/food and fish/food fall (unevenly) throughout; while vegetables/food rise (unevenly) throughout. The large amount of heterogeneity in the evolution of relative prices and the consistency of our results on inflation across many different expenditure categories makes it difficult to construct a story based on movements in relative prices that accounts for our results.

Let's nevertheless consider several concerns along these lines. First, our empirical methodology implicitly assumes that all variation in prices is due to supply shocks. If this is not the case, we may be underestimating the price elasticity of demand. For food, we estimate $\gamma^k > 0$, implying that an increase in the relative price of food raises the expenditure share of food. In other words, we estimate the price elasticity of demand for food to be lower than one. Suppose we underestimate the true price elasticity, implying that the true γ^k is smaller than our estimates suggest. In this case, our Engel curve methodology would imply even larger divergences between true and official inflation (in the same direction) to fit the observed patterns in expenditure shares.[15] A similar argument applies to the Engel curve estimates based on eating out, since the pattern of price movements for that category is opposite that of food.

[15] To see this, notice that the relative price of food is falling in the early part of our sample and rising in the later part of our sample. This implies that the relative price term is absorbing some of the rapid fall in the food share in

A different concern would be that we underestimate γ^k, perhaps due to attenuation bias (most of our estimated γ^k's are positive but small). In the case of the Engel curves for food, meat, and eating out, this could potentially help explain the overall pattern in the difference between our estimate of inflation and official inflation. But this is not the case for grain, fish, vegetables, or most of the categories outside of food.

C. *Nonuniform Bias across Product Categories and Income Groups*

A related concern is that the bias in official inflation statistics may not be uniform across sectors. In most of our specifications, we make the simplifying assumption that the inflation bias is uniform across sectors. It may, however, be that the bias in official inflation statistics is, e.g., more severe in food—perhaps because food prices are more politically sensitive than the prices of other goods. In Figure 13, we present results assuming that the entire bias is concentrated in food.[16] Under this (rather extreme) assumption, the bias we estimate is somewhat attenuated but remains substantial.

D. *Differences in Inflation across Income Groups*

The existence of Engel curves implies that households have non-homothetic utility. It is well known that in this case no single price index is the appropriate price index—i.e., the unit expenditure function—for all households. Intuitively, the price index for households with higher income will place greater weight on luxury products and the price index for poorer households will place greater weight on necessities. The CPI is often considered to be a good approximation to the price index for a household with income around the seventy-fifth percentile of the income distribution (Deaton 1998). Beatty and Crossley (2012) point out that the price index that results from the Engel curve methodology we employ yields the appropriate price index for a household at a particular level of income but that it is unclear which level of income this is. A concern with our analysis is then that the difference we document between CPI implied inflation and the inflation rate that our Engel curve methodology yields arises not because of mismeasurement but because these two indexes measure inflation for different income groups.

To address this concern, we use the methods laid out in Feenstra and Reinsdorf (2000) to calculate exact price indexes for different income groups and compare these to our Engel curve based inflation estimates. Feenstra and Reinsdorf (2000) show that an exact price index for different income groups of households whose preferences generate Deaton and Mullbauer's (1980) Almost Ideal Demand System can be constructed using the Divisia price index, which requires only data on expenditure shares and prices at the initial and final period in question for the income group in question. Figure 14 plots the resulting inflation rates for different

the early part of our sample and subsequent slowdown later in our sample. If the coefficient γ^k were smaller, this term would absorb less, leaving more to be explained by the time fixed effects, i.e., leading to a larger estimate of the measurement bias.

[16] We implement this change in specification by replacing the $\beta^k \mu_t$ term in equation (3) with $(\beta^k - \gamma^k)\mu_t$.

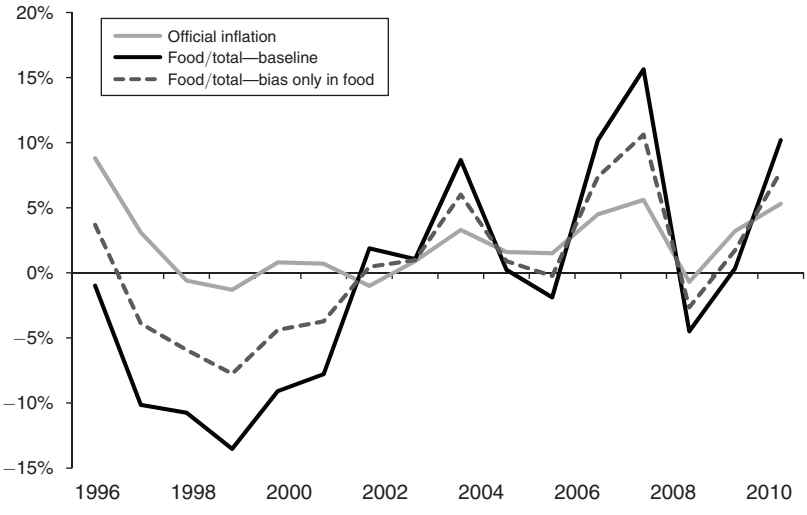

FIGURE 13. BIAS ONLY IN FOOD

Notes: The figure plots official CPI inflation and inflation estimated based on two Engel curve specifications. The first specification is the baseline version of the food/total specification (same as in Figure 8). The second version is also based on food/total, but assumes that the entire CPI bias is concentrated in food.

income groups in China along with the CPI and our Engel curve based estimate of inflation. While the inflation rate estimated using the Feenstra and Reinsdorf method is different for different income groups in China, these differences are small compared to the difference between our Engel curve based estimate of inflation and the CPI (or the inflation rate for any of the income groups). We therefore conclude that these differences in inflation between different income groups appear to play little role in explaining our results.

E. *Cross-Equation Restrictions*

It is well-known that the log-linear Engel curve relationship we present in equation (1) can be microfounded using the Almost Ideal Demand System (AIDS). This demand system implies cross-equation restrictions on the price elasticities that we have not imposed above. In this sub-section, we present a modification of our baseline estimation procedure in which we estimate the full AIDS demand system presented in Deaton and Muellbauer (1980). The precise form of the model equations and cross-equation parameter restrictions are given by equations (8)–(12) in Deaton and Muellbauer (1980). While many of these restrictions are untestable since they follow directly from the adding up the of the expenditure shares, the AIDS demand system imposes additional symmetry restrictions that we impose here, in addition to allowing for additional price terms to appear in the demand function.[17]

[17] Specifically, we estimate the equation, $\omega^k_{i,t} = \hat{\psi}^k_i + \beta^k \log C_{i,t} - \beta^k \tilde{\pi}_{i,t} - \beta^k \mu_t + \sum_j \gamma^{k,j} \tilde{\pi}^j_{i,t} + \sum_x \Theta^k_x \mathbf{X}_{i,t} + \epsilon^k_{i,t}$ and impose the symmetry restrictions $\gamma^{k,j} = \gamma^{j,k}$.

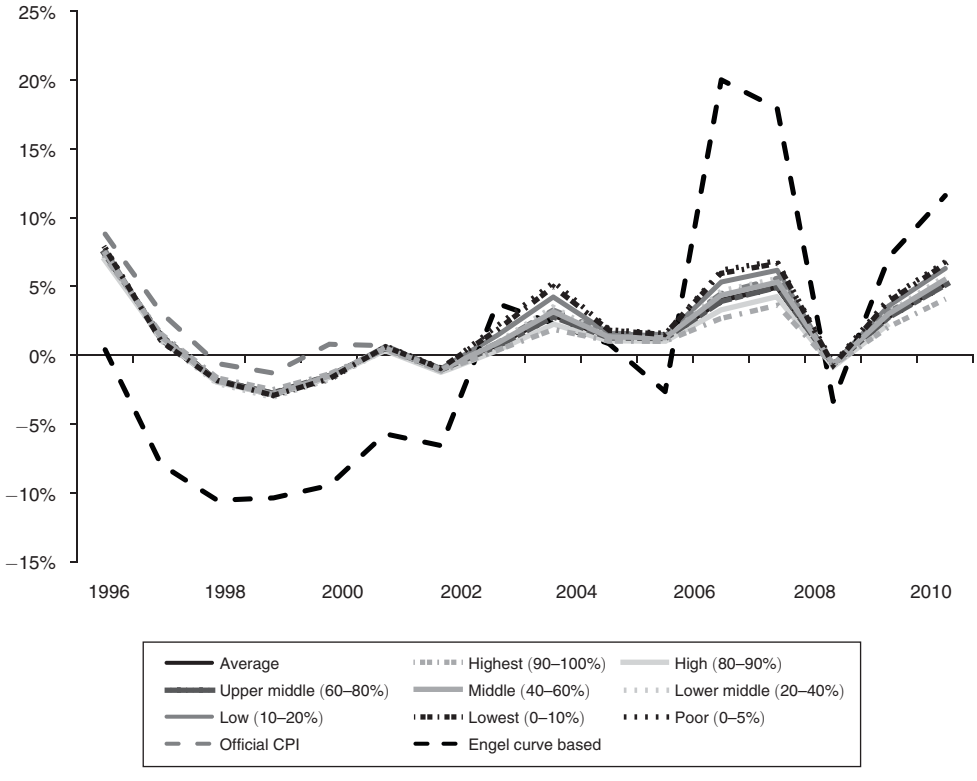

FIGURE 14. INFLATION FOR DIFFERENT INCOME GROUPS

Notes: The figure plots our estimate of inflation based on Engel curves, the official CPI as well as inflation rates for different income groups calculated using the Divisia index shown by Feenstra and Reinsdorf (2000) to be an exact price index for the Almost Ideal Demand System. The percentages in the labels refer to the range of the income distribution covered by each line.

One well-known issue with the AIDS demand system that arises in our analysis is that the full-blown AIDS demand system involves estimating a huge number of cross-price elasticities. We therefore implemented this procedure for the subcategories of food, using slightly consolidated categories: grain, meat, vegetables, fruit, eating out, and "other food." (Using all 14 subcategories of food generates more parameters than we have observations.) We estimate the model using the expenditure shares of these items as a fraction of total expenditure; where nonfood items are included in the "outside" category.[18]

Figure 15 depicts the results of this estimation procedure. The results are compared to those based on pooling the 14 different subcategories of food as a fraction of total food expenditure (Figure 8). The results are qualitatively similar, though the estimated inflation bias is somewhat larger for the specification imposing the AIDS parameter restrictions in certain years. The additional price terms and parameter restrictions imposed by AIDS evidently work against explaining the Engel curve

[18] The price of other food is aggregated using a Fisher Index.

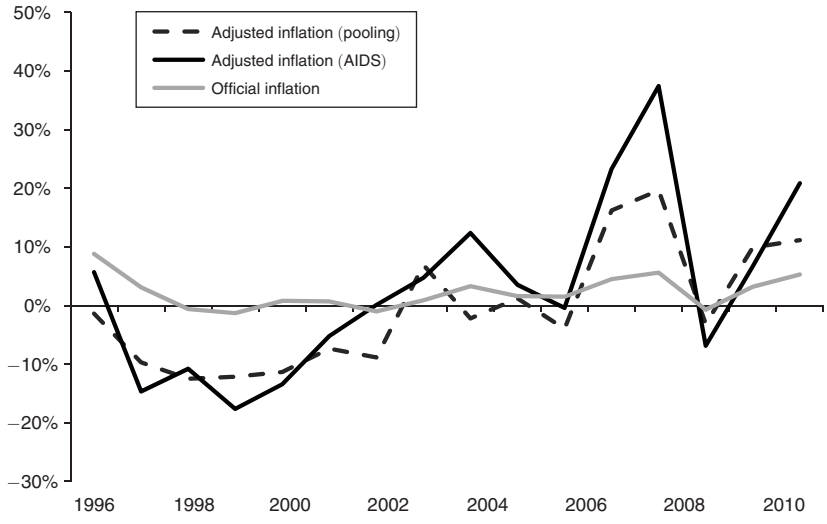

Figure 15. AIDS and System Estimation

Notes: The figure plots official CPI inflation and inflation estimated based on two Engel curve specifications. The AIDS specification imposes symmetry restrictions and includes the full set of relative price terms implied by that demand system. The pooling specification estimates the Engel curve using our baseline pooling approach. Both specifications use the five largest subcategories of food, namely grain, meat, vegetable, fruit, and dining out, plus an additional "other food" subcategory.

shifts in the recent period using observed movements in prices. The inflation bias required to explain the Engel curve shifts is, therefore, even larger than in our baseline specification.

F. *Urban Migration*

China has experienced a substantial amount of urban migration over the past 15 years. Urban migrants are typically poorer than the existing urban population. Could urban migration explain our results? Poor urban migrants will likely have a higher food share than the existing urban population. But they also have lower total expenditures. An influx of poor urban migrants will therefore move the province in question along the Engel curve, as opposed to shifting the Engel curve itself. It is therefore not clear that the presence of urban migration affects our baseline results.[19]

However, to assess the role of urban migration directly, we re-estimate our model using micro-data from CHIP, both including and excluding migrants. We do this using the 1995, 1999, 2002, and 2007 CHIP surveys. To estimate equation (3), we merge the CHIP data with the regional price data that we use in our baseline analysis. Our Engel curve analysis for the CHIP data is based on the food share alone, since this is the commodity for which consistent expenditure share data are available in CHIP.

[19] Also, we include cumulative net in-migration by province in our dataset as a covariate in our baseline Engel curve estimation.

Table 2—Income and Price Elasticities for Food Expenditures

	Regional analysis	Income group analysis	CHIP
Panel A. Linear-log			
Income elasticity	0.66	0.71	0.68
	(0.01)	(0.01)	(0.004)
Price elasticity	−0.61		−0.83
	(0.03)		(0.05)
Panel B. log-log			
Income elasticity	0.63	0.71	0.58
	(0.03)	(0.01)	(0.01)
Price elasticity	−0.66		−0.65
	(0.07)		(0.12)

Table 2 compares our estimates of the income and price elasticities from the CHIP data to our baseline estimates.[20] The estimated income elasticity for our baseline specification (panel A) implies that a 1 percent increase in real total expenditure is associated with a 0.66 percent increase in food purchases, all else equal. Costa (2001) and Tobin (1950) report similar values of the income elasticity of food for the United States, while Hamilton (2001) reports a substantially lower value. The food price elasticity of −0.61, indicates that food is inelastically demanded. The CHIP estimation yields a very similar income elasticity and a price elasticity that is somewhat more negative. Table 2 presents results based on two alternative estimation approaches as well: the log-log version of our baseline approach; and data aggregated at the income-group as opposed to province level. Both approaches yield similar results to our baseline specification.[21]

Despite its limited time-series coverage, CHIP has the advantage that it is based on a separate consumption survey, and also a different methodology—individual data as opposed to data aggregated at the regional level.[22] Table 3 compares the inflation bias estimates based on the CHIP data to our baseline estimates for the three time spans over which the CHIP bias can be calculated: 1995–1999, 1999–2002, and 2002–2007. The CHIP estimation yields similar qualitative results to our baseline analysis: a large positive inflation bias for 1995–2002, which becomes progressively smaller, and then negative for the 2002–2007 period. Whether or not migrants are included has essentially no impact on the CHIP estimates. This is consistent with

[20] The formula for the expenditure elasticity in the linear-log case is $1 + \beta^k/\omega^k$, while the corresponding price elasticity formula is $-1 + (\gamma^k - \hat{\psi}^k\beta^k)/\omega^k$, where ω^k is the average of the national expenditure share for product k over the 1995–2011 period. In the log-log case, the expenditure elasticity is given simply by β^k, while the price elasticity is given by $-1 + \gamma^k - \hat{\psi}^k\beta^k$.

[21] The income groups are: poor, low income, lower middle income, middle income, upper middle income, high income, and highest income. The price elasticity cannot be identified in this specification because we do not observe separate price indexes for the different income groups. Hence, we set the coefficient on the price term in this specification equal to its counterpart from the province level analysis.

[22] Although, more disaggregated data may not be an advantage in this case. Filho and Chamon (2013) find that the Engel curve shift is larger for poor than rich households in the UHIES micro-data, and conclude this implies a larger inflation bias for poor households. In our baseline analysis, we use province level data as opposed to household micro-data. The differences they observe across income groups appear small for our province level analysis, probably because our regional Engel curves are estimated over a much smaller range of incomes. Also, the difference that Filho and Chamon (2013) discuss does not appear to occur between 2002 and 2007.

Table 3—Inflation Bias Based on CHIP with and without Migrants

	Annual bias		
	1995–1999	1999–2002	2002–2007
Food/total CHIP with migrants	0.061	0.028	−0.064
	(0.006)	(0.003)	(0.007)
Food/total CHIP without migrants	0.062	0.028	−0.069
	(0.006)	(0.003)	(0.007)
Food/total from main dataset	0.113	0.050	−0.014
	(0.009)	(0.006)	(0.007)
Baseline estimates from main dataset	0.096	0.055	−0.028
	(0.013)	(0.009)	(0.005)

Notes: The table reports the average annual inflation bias between different years. For example, an estimate of 0.061 implies that official inflation was overstated by 6.1 percent per year over the period in question. The first three rows of estimates are based on the Chinese Household Income Project (CHIP). The first row includes urban migrants—households for which the household head does not have a local, urban hukou. The second row excludes these households. The third row presents results based on the food share data from our main dataset. The fourth row presents results based on our baseline, pooled specification using data from our main dataset.

the argument we describe above that migration causes a movement along the Engel curve as opposed to shifts in the Engel curve.

G. *Additional Robustness*

We have carried out three additional robustness checks that are presented in online Appendix B. First, we have re-estimated our model allowing for separate Engel curves for the pre-2002 and post-2002 periods. This exercise addresses the concern that the slope of the Engel curve may have changed over time as Chinese consumption grew. Second, we re-estimated our model using a simple generalized least squares specification that accounts for heteroskedasticity across products (i.e., the fact that a product with a 20 percent expenditure share is likely to have more volatility in absolute terms than a product with a 5 percent expenditure share). Third, we estimated a log-log specification of the Engel curve. These robustness exercises all yield the same qualitative results as our baseline analysis: a positive inflation bias in the 1990s and early 2000s and a negative inflation bias thereafter.

V. The 2007 Inflation Spike

Our revised estimates of Chinese growth and inflation suggest a substantial slowdown in consumption growth in 2007 coinciding with a large inflation spike. Chinese official statements in 2007 are consistent with these findings. In May 2007, Premier Wen Jiabao appeared publicly on television to address widespread inflation concerns. He stated: "the pork price hike should have a limit, because some urban residents can't afford it." Subsequently, he said: "Prices have been on the rise these days, and I'm aware that even a one-yuan increase in prices will affect people's lives."

There are various other signs that the Chinese government recognized the impact of these inflation pressures on consumption growth. The Chinese government

convened an emergency cabinet meeting ordering local governments to increase food assistance to low-income families and to encourage pig rearing through grower subsidies. This led, for example, to Guangzhou Province promising to give a monthly payment of 20 yuan for every low income family during May, June, and July to help offset the higher prices of pork and non-staple foods.[23]

The Minimum Living Standard Allowance (MLSA) is a government subsidy program that has been in operation on a national scale since 1997. Over this time period, the Ministry of Civil Affiars has made five announcements in which it discusses increasing the MLSA. Four of these five announcements were in 2007 and 2008. Three of the announcements made specific recommendations to increase the MLSA by a combined total of RMB 40—a significant increase relative to the previous level of roughly RMB 170. The announcements stated that these increases were intended to offset increasing food prices.[24] Similarly, the Ministry of Civil Affairs announced on July 4, 2007 that local governments should establish or improve their "Temporary Relief" programs, which are intended to provide support to low-income families suffering temporary economic difficulties.[25] The number of people receiving "Temporary Relief" rose sharply in 2007, in line with this announcement.[26]

Pork prices played an important role in the inflation of 2007. Figure 16 depicts official measures of overall inflation alongside those for meat, food, and nonfood. According to official measure, the 2007 inflation spike was driven primarily by an increase in food prices; and within food, that meat and in particular pork price increases were particularly large.

A Sept. 18, 2007 article in *The Economist* states:

> *There is no doubt that the August consumer price inflation figure of 6.5 percent, well above many analysts' expectations, was once again driven primarily by movements in the cost of pork. Exacerbated by an outbreak of porcine reproductive and respiratory syndrome ("blue-ear" disease) that has affected pig supplies, the usual cyclical volatility in pork prices has reached new highs, pushing the year-on-year increase in meat and poultry product prices to 49 percent in August. Pork alone accounts for around 4 percent of the basket used for the consumer price index, so movements in its price have a direct feed-through into inflation.*

[23] See http://www.thepigsite.com/articles/2014/the-story-behind-chinas-rising-pork-prices.

[24] On August 14, 2007, the government announced that the subsidies would be increased by at least RMB 15 per person per month for urban residents, and on September 24, 2007 the government announced that the subsidies would be increased by another RMB 10 per person per month for the next three months. On February 4, 2008, the government announced that the 2007 increases in subsidies still applied in 2008, and that as of January 1, 2008, there would be an additional RMB 15 increase in the urban MLSA and a RMB 10 increase in the rural MLSA. The remaining two announcements were less specific. On June 14, 2007, the government noted that local governments should continue to focus on making appropriate increases in the urban minimum living subsidy level. On November 12, 2001, the government announced that local governments at all levels should continue to focus on making appropriate increases in the MLSA. These announcements were obtained from the official website of the Ministry of Civil affairs http://dbs.mca.gov.cn/article/csdb/.

[25] Since 1992, there has been only one other announcement regarding the "Temporary Relief Program" by the Ministry of Civil Affairs. The other announcement followed the 2008 earthquake in Sichuan province, which killed 70,000 people.

[26] Statistics on the number of people receiving "Temporary Relief" are available from the main statistical yearbook of the Chinese NBS.

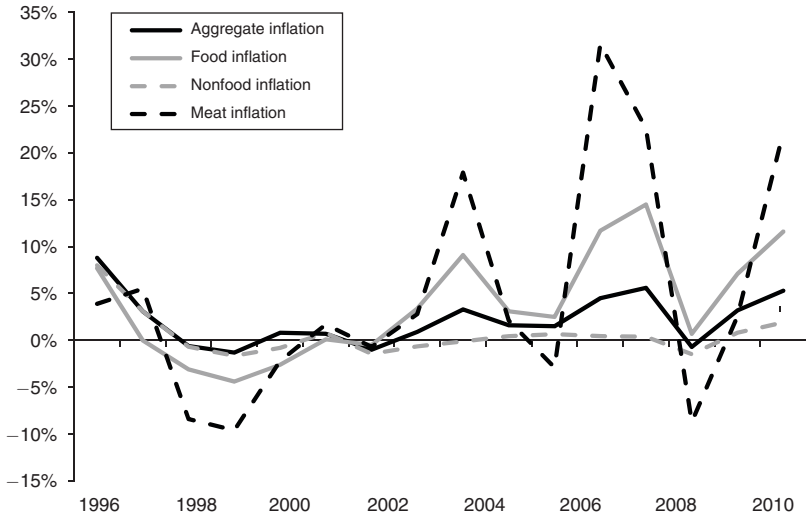

Figure 16. Food and Meat Inflation

The "blue-ear disease," which is discussed above as a major source of the pork price increase, was observed in 26 of 33 Chinese provinces. The disease led household pig farmers, who provide more than 50 percent of Chinese meat, to leave the market in large numbers, leading to a substantial decrease in the supply of pork. *The New York Times* reported that, "International health experts are already calling this one of the worst disease outbreaks ever to hit Asia's livestock industry. …Officials in Beijing worry that widespread pork shortages and soaring food prices could prompt panic, unrest or inflation, undermining a sizzling economy" (Barboza 2007).

Pork prices are notoriously volatile. Figure 17 depicts the hog price cycle since 1995. The dark line depicts the change in the wholesale price of hogs (the price the slaughterhouse pays to farmers) while the lighter line depicts the change in Chinese pork production. Since 1995, there have been numerous hog price cycles. The figure shows a sharp decline in pork production and a sharp increase in hog prices in 2007.

Grain price inflation was another contributing factor to both rising pork prices and inflation more generally. Grain is an input into the production of many food products, including meat, poultry, and eggs. *The Economist* notes that the rise in grain prices arose partly as a conseqence of "industrial demand, in the form of soaring demand from biofuel producers." Indeed, China declared a moratorium on ethanol production in 2007 because of the belief that ethanol production was leading to rapidly rising food prices.[27] China's rapid investment growth during this period no doubt also contributed to rapid commodity price inflation (note that rapid investment growth is not inconsistent with the slow consumption growth we estimate given China's investment-led growth model).

[27] See http://www.resilience.org/stories/2007-09-09/low-grain-harvest-rising-food-prices-and-china\%C3\%A2\%E2\%82\%AC\%E2\%84\%A2s-ethanol-plan.

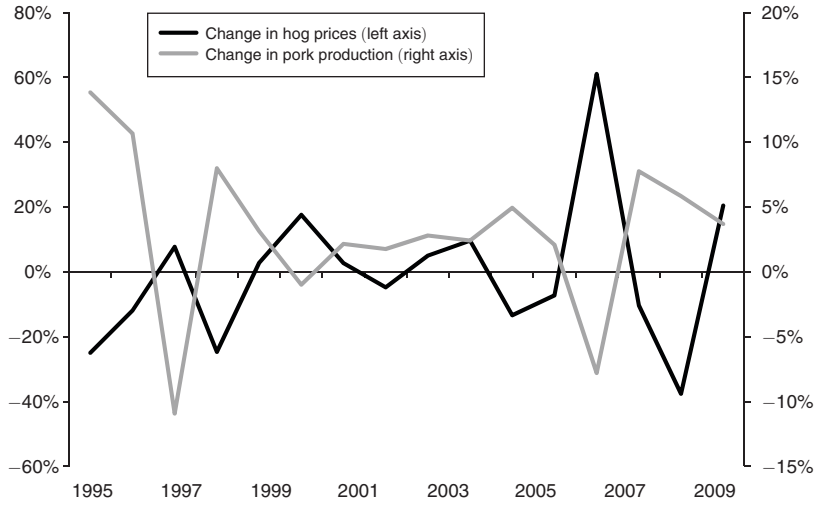

FIGURE 17. CHANGES IN PRICES AND PRODUCTION OF PORK

Finally, grain prices were also driven up by the drought of 2006–2007. This drought was one of the most severe over the past two decades, and had the most severe effects on the availability of livestock drinking water of any drought over our sample period.[28] In summary, a variety of supply-side forces, in conjunction with rapid growth in demand for commodities from China's investment sector were likely behind the 2007–2008 inflation spike and slowdown in consumption growth.

VI. Conclusion

We use an Engel curve approach to derive new estimates of Chinese growth and inflation. Our approach makes use of systematic discrepancies between cross-sectional and time-series Engel curves in China. Our estimates suggest that official statistics present a smoothed version of reality. We find that inflation was overestimated and growth underestimated by several percentage points per year in the late 1990s. In contrast, since 2002, official inflation statistics have risen only modestly, but our Engel curve based estimates have risen much more. Our estimates imply that growth was substantially lower than official statistics suggest since 2002, and actually dipped into negative territory in 2007 and 2008.

The qualitative patterns we identify emerge for a wide range of expenditure categories both within and outside of food. The pervasive nature of the empirical patterns we identify, despite considerable variation across product categories in other factors such as price trends, helps buttress the case that the patterns we observe arise from mismeasurement of official statistics as opposed to idiosyncratic factors within individual consumption categories.

[28] See the last table of http://www.mwr.gov.cn/zwzc/hygb/zgshzhgb/201311/P020131104379205206821.pdf (in Chinese).

Our finding that the 2007–2008 period was one of low consumption growth is consistent with Chinese official statements during this period, as well as the Chinese government's unusual decision to increase subsidies to the poor in 2007 and 2008 to offset the rising cost of food. A severe outbreak of the "blue-ear disease" among Chinese hogs led to a dramatic increase in the price of pork and a substantial decrease in pork production. This, in conjunction with other adverse supply shocks to agriculture and increased demand for commodities from China's investment sector, were likely behind the large increase in inflation that we identify—which is only partially reflected in official statistics.

While we present no direct evidence on this topic, we suggest two possible interpretations of our finding that Chinese official statistics are "too smooth." First, they may reflect political motivations to report low and stable inflation and high and stable growth statistics. Second, they may reflect true difficulties measuring inflation. The analysis in Holz (2013) suggests that this second reason may be the more likely explanation. The rapid pace of development in China, implies measurement is likely to be particularly difficult. Inflation that is "too smooth" is exactly what would be predicted by the product replacement bias discussed in Nakamura and Steinsson (2012), for a country with a high rate of product turnover. It might seem strange that a government would ever substantially overstate inflation (as we suggest was the case in China in the late 1990s). Recall, however, that this is exactly what would occur in a country with a large "new goods bias." The rapid rate of product innovation in China during the 1990s implies that the new goods bias was likely very large. Measurement issues associated with a combination of "product replacement bias" and the "new goods bias" therefore have the potential to explain the patterns we identify in the data.

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