METHODOLOGICAL NOTE ON NEW ESTIMATES OF THE PREVALENCE OF UNDERNOURISHMENT IN CHINA

ANNEX I

PEER REVIEWS AND RESPONSES
Dear Maximo,

I read the Note on new estimates of the PoU in China with great interest. Here are my review comments addressing your questions:

1. Do you find the procedure implemented technically sound and appropriate?
   1) Yes. A revision of the PoU for China is overdue. Anyone who has seen Chinese household consumption and health survey data knows that the coefficient of variation of the distribution in households’ socio-economic characteristics has changed a lot in the past decades.

   2) Your colleagues in the statistical team have appropriately tackled the problem that the Chinese household surveys are not uniform and coverage is not complete. Systematically combining the information from China Health and Nutrition Survey (CHNS) with information on food expenditures from the China Household Finance Survey (CHFS) is apparently the best one can do.

   3) The fitted relationship of the cubic function in equation 3 seems robust. I suggest to add statistical significance information to the estimated parameters. Some robustness checks could be performed with the estimated parameters too. However, as the results are in such low levels of PoU they probably hardly matter.

2. Do you find the results reasonable
   1) It is a large change that emerges from the updated methodology, large for China and large for the World. It requires a sound communications effort that explains the result and its foundations. But I see no alternative to take this step now.

   2) It is not clear how the estimation approach is accounting for differences in purchasing power across locations in China (assuming uniform food prices?). For instance the same levels of income in Beijing and Gansu could mean different levels of food access. It appears (based on page 3, last para, 2nd sentence), that such differences in local purchasing power are neglected. I suggest to clarify that and to discuss if this is of any relevance.

3. Do you find the results reasonable and consistent to the modelling work ZEF is doing
   1) for credible communication of the results it could help to foot note some local case studies. There must be many local studies in China that include information on food consumption change by income classes.

   2) It seems highly important to use up-to-date CV/y. China is the most salient case because of its large population and rapid development since the time of the last CV/y estimate in 1999. I wonder how big is this problem for the rest of the world? Are there other countries where outdated CV/y are still used? If so, the SOFI should put some qualifications in the report related to these countries.

   3) Doing a similar exercise for countries that need revisions would require time. I suggest that FAO make SOFI background materials available, especially a table of these CV/ys and their dates for each country –
to have an idea where else these figures may need to be updated. Local research communities can than assist with updating. This would enhance the future credibility of SOFI.

In sum, I congratulate FAO and the Statistics Team to this very appropriate plan to update and improve the PoU data. I hope these comments are helpful.

Best regards,
Joachim

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Review of the new FAO estimates for China PoU

David Laborde, Senior Research Fellow, IFPRI

As listed in Appendix 1, this review is aimed to assess the quality of the new prevalence of undernourishment (POU) estimates provided by FAO for the 2020 edition of the SOFI report.

The update of key parameters for the estimations of such an important indicator is actually quite overdue.

The existing parameters poorly capture the impressive evolution of the Chinese economy regarding the very strong and rapid urbanization, the inclusive economic growth that has contributed to the rise of income, including for poor populations, a number of economic policies aimed to limit the inequalities between urban and rural areas and the overall stability of food availability at the country level.

We synthetize a few of these evidences in section 2 of this report to show how the new POU estimates are actually much more consistent with the recent evolution than previous estimates.

Reviewing the precise methodology and datasets used by FAO, I conclude that they are both consistent with existing methodology, an important feature for cross-country comparability, an important feature of the POU, and use the best available data. I provide in section 3 an overview of the inherent data challenges linked to China and faced by any analysts of this country. This confirms the relevance of the choices made by the FAO team. Section 4 provides some specific methodological discussions. Session 5 provides a short discussion of the new FAO numbers and the research conducted under my supervision at IFPRI.

To answers the three questions asked in this review, my conclusions are:

1. Do you find the procedure implemented technically sound and appropriate
   Yes, I do. The method respects the standard of the POU methodology and fixes properly key problems in past estimates.

2. Do you found the results reasonable
   The results are reasonable based on other evidences from the literature and a set of economic indicators (extreme poverty, prevalence of stunting, food expenditure distribution).

3. Do you found the results reasonable and consistent to the modelling work IFPRI is doing under your leadership
While my own analysis is using some different approaches, I reach the same conclusions: following the very strong economic growth of the last 3 decades, and the level of inclusiveness of this economic growth, food security, measured in terms of caloric consumption, has improved drastically and is not a concern for 97 or 98 percent of the Chinese population, even when controlling for food inflation. Therefore, a POU of about 2.5% or below is relevant. However, this should not hide the fact that other forms of malnutrition are problem, or that 2.5% of the Chinese population represents about 35 million of people, both a non trivial share of global hunger (about 5 percent) or an important priority for highly vulnerable segment of the population in China, especially some rural counties where these hungry, and poor people, are concentrated.

1 Setting the stage: why past POU estimates are at odds with recent trends?

1.1 Economic growth, Poverty and hunger
The existing POU estimates for China are quite high, in particular in a context of rapid economic growth and poverty reduction. Indeed, as show in Figure 1, the extreme poverty rate has fallen from 31.7 percent to less than 2 percent in 14 years, while the PoU has only be halved from 16 percent to 8.7 percent. While there is a number of good, and less good reasons, to observe a difference between these two indicators, the situation in China is staggering. It should be added that China’s numbers have actually driven also the evolution of global average significantly.

Source: World Development Indicators based on FAO for the PoU and PovCalNet for Poverty, $1.90 a day poverty line.

**Figure 1 Prevalence of extreme poverty and undernourishment in China**

When comparing to the other countries, in the poverty and hunger space, the situation of China is also specific: very few countries have the current level of GDP per capita of China ($14,000 per capita, ppp in 2016) and such high level of PoU, especially when controlling for the level of income inequality.
Other countries in similar income range and similar or higher PoU are either linked to higher income inequality (captured by the Gini index), like Colombia, or are “rent” economy (e.g. oil exporter like Iraq or Venezuela). Only Thailand, that is actually suffering from some important social and ethnical division, is directly comparable to the Chinese numbers. However, Thailand did not go through for the high speed transformation that China has known in the last 15 years.

This review of various cases could be confirmed by performing a simple regression on the existing relation between PoU, on the left hand side, and the log of income per capita, the Gini index, and the initial level of hunger in 2000 considering all countries. The reported PoU for China is above the estimated value with this relation since 2010, with a steady increasing gap between the reported and estimated value.

This transformation in terms of income growth and inequality is described in Figure 2. It is important to notice that while inequalities have increased between 2000 and 2010, as captured by the Gini Index, they have been reduced since. This, combined, with the evolution of average income, tripling in 14 years, has contributed to the nearly elimination of poverty. It is quite important to notice that the last “fall” of the poverty rate (Figure 1) between 2012 and 2013 is actually driven by the use of the new household survey for China, based on an integrated sample strategy while before this change, two differentiated surveys, and sampling strategy, were used for urban vs rural population. The reduction in overall Gini and poverty is directly linked to this change, with an actual strong reduction in the Gini Index among rural households.

Source: World Development Indicators. Gini index based PovCalNet for Poverty, $1.90 a day poverty line.

Figure 2 Income Growth and Inequality

It is useful to refer to the discussions in PovCalNet on this change. The PovCalNet assessment on Chinese poverty rate (as available in http://iresearch.worldbank.org/PovcalNet/WhatIsNew.aspx) states
In the 2013 data, a large part of the decline in poverty in East Asia and the Pacific is attributable to China and Indonesia. The 2013 household survey in China is the first integrated nationwide household survey in the economy. This means that it is not comparable to previous household surveys, in which rural and urban areas were sampled separately. In addition, the most significant change in the 2013 survey relative to previous surveys was the inclusion of imputed rents in income and consumption aggregates.

Between 2012 and 2013, China’s poverty rate at the $1.90 poverty line declined by about 4 percentage points, of which half, that is, about 2 percentage points, can be traced to changes in the survey methodology. In other words, the actual poverty reduction not explained by methodological changes was 2 percentage points between 2012 and 2013 (see World Bank, 2016, Table 2B.1, p. 49).

Furthermore, the World Bank’s poverty estimates on China are based on grouped distributions, which are often not as precise as direct estimates based on the full distribution of household income and consumption aggregates. In 2013, China’s poverty headcount ratio under the $1.90 poverty line was 2.2 percent using individual record data, as confirmed by the National Bureau of Statistics, while it was 1.9 percent based on grouped data.

So, the reduction of poverty, and income inequality (linked to the CV in income) while not being a sufficient information to find the new value of the CV\(\gamma\) (called just CV in the rest of this document) is a strong indication that is should be revised downward.

Based on these assessments, it is clear that fast reduction in extreme poverty in China should also lead to a sharp decline in the prevalence of undernourishment estimates. Except if we have a significant mismeasurement of the extreme poverty line for this country, we should not see such a difference in the relative rate of decline of these two variables.

1.2 A fast urbanization
The urbanization rate of China has jumped from 36 percent in 2000 to 59 percent in 2018. Since rural areas continue to be the hotspots in terms of poverty and food insecurity\(^1\), this huge structural shift is reducing the size of the most vulnerable population. So, even at “constant” consumption pattern for a given urban and rural households, the structural shift is reducing drastically the average food insecurity of the population and we expect a decrease in the nationally representative CV. Please note that I do not recommend to use this shortcut for the “building” the new CV. I just want to emphasize that we should expect a significant reduction of CV based on the features of the urban and rural population as documented and the large shift in these two relative groups.

1.3 Evolution of other nutrition related indicators
While it will be hazardous to simplify the discussions around various forms of malnutrition, a useful “consistency” check is to track the evolution of the stunting rate and undernourishment measured by the POU. Indeed, only very specific conditions should explain why a population is well-nourished enough to not be impacted by stunting while facing chronic hunger.

Indeed, caloric intake is in most of the cases a necessary but not sufficient condition, to eliminate stunting, therefore the prevalence of undernourishment at the national level should exceed the prevalence of stunting among the children for the same population. Deviation from these rules should occur if 1) a

\(^1\) In 2010, the first quintile of urban population was spending 38% more on food the amount spent by the first rural quintile. Even when controlling for price differences between rural and urban area, the volume of food available by the urban poor is still superior to the one available for the rural poor, based on World Bank, global consumption database.
dramatic fall in the birth rate, creating a gap between the two populations covered by these indicators, and/or 2) an intra-household allocation of food prioritizing children and pregnant women.

This “rule of thumb” between the two indicators of prevalence old for 78 percent of existing observations (year x countries) available globally over the period 1999-2019.²

Actually, most of the countries violating this rule follows some specific pattern: relatively outdated information regarding the PoU computation while new demographic surveys have helped updating stunting numbers.

Among these countries we see for instance Paraguay with CV is based on a 1997 survey (ESS Working Paper No. 14-05) and of course China as show in Table 1:

**Table 1 Prevalence of Undernourishment and Stunting in China (selected years)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Prevalence of undernourishment (% of population)</th>
<th>Prevalence of stunting (% of children under 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>16.2</td>
<td>17.8</td>
</tr>
<tr>
<td>2005</td>
<td>15.5</td>
<td>11.7</td>
</tr>
<tr>
<td>2013</td>
<td>9.9</td>
<td>8.1</td>
</tr>
</tbody>
</table>

Source: WDI indicators.

Since the PoU is a statistical construct, based on outdated survey for the last decade, while the stunting is based on actual measurements, the violation of the expected hierarchy should be a source of concern. Indeed, the second explanation discussed above (intra-household food allocation) is rarely observed, and no evidence show such a bias for China, while the birth rate for China has remained very stable around 1.66 births per women during the 1995-2015 period.

So, we conclude that existing POU estimates are too high, and the trend in declining stunting numbers³ should be reflected in updated assessments. Unfortunately, new statistics on the prevalence of stunting are not yet available to my knowledge and the 2013 remain a very high upper bound.

Zhang and al. (2018)⁴ offer a glimpse of new numbers, for 26 counties in poor areas of China, the “prevalence of stunting, was as high as 8.4%; the prevalence of underweight and wasting were 3.5% and 3.3%, respectively”. It is interesting to notice that these poor areas were displaying in 2012 a prevalence of stunting more than twice the national average (18.7% vs 8.1%). So, we should expect also a quite large reduction in new stunting statistics at the national level.

**These various elements show the absolute need to update the CV for China used in the POU computation.**

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² Computations made by the author, based on WDI data.
³ See the Bulletin of the World Health Organization, Physical growth of children and adolescents in China over the past 35 years, Xin-Nan Zong & Hui Li, Volume 92, Number 8, August 2014. 555-564
2 Available datasets to assess food insecurity in China

Assessing food consumption in China, across different strata of the population remain challenging. Even in the global consumption database (http://datatopics.worldbank.org/consumption/home), the World Bank had to rely on a “synthetic approach” since China is one of the countries for which primary information was not available, or at least shared with the World Bank. Or as indicated by the World Bank staff: “For all countries included in our calculations except China, we had access to survey micro-data. For China, survey microdata were not made available to us.” [see technical note in http://data-bank.worldbank.org/data/download/IFCSurvey/CHN2005_SYNPPP_v01_M.zip]

So, it is expected to use a mixed approach by combining at least two or more datasets to provide a consistent picture at the national level.

While some datasets on household expenditures are available (including those used by FAO, see next session), the main source of information on food consumption in quantity is the China Health and Nutrition Survey (CHNS). It is used in numerous publications (e.g. Chang and al, 2018).

Based on my knowledge of accessible information, the FAO team has mobilized and used properly the existing datasets. The descriptive statistics they generate and shared are also consistent with I have seen in the literature using the same sources.

3 FAO POU methodology: Application to China

3.1 Summary and assessment of FAO methodology

Our methodological review is based on the document “Methodological note on new estimates of the Prevalence of Undernourishment in China, Statistics Division FAO, 5 May 2020” provided as an attachment of the request for review. It is a straightforward implementation of the PoU methodology as described in ESS Working Paper No. 14-05, and therefore highly consistent with the work done for other countries.

The main challenge faced by the FAO team is to obtain a revised value for the CV|y at national level, in order to compute the new PoU numbers, based on additional information (like the FBS).

As discussed above, there are strong evidences that the CV should be revised downward, leading to a much smaller PoU. Unfortunately, measuring the CV at the national level will require to have a national nutrition (or proper consumption survey) to assess the DEC at individual, or at least household level. Unfortunately, such instrument does not exist, and the FAO team has to rely on the CHFS – discussed in the previous section – as a starting point. Using the CHNS survey, they can compute the habitual DEC for the 10 provinces and 2 cities covered in 2011. Then they estimate the DEC based on the level

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5 Understanding dietary and staple food transitions in China from multiple scales
of food expenditures through a third-degree polynomial. Indeed, the food expenditure variable is available in the China Household Finance Survey (CHFS) that has an exhaustive coverage in terms of provinces and is available for several years.

The estimation obtained appears to provide a reasonable result. While acknowledging the inherent risk of using an estimated CV for various provinces, in particular those out of the CHNS sample (that provides a direct measurement of the DEC), the FAO team uses a Monte-Carlo to generate and combine individual province CV into the nation wide CV.6

This strategy is robust and pragmatic. Still, two main limits should be noted:

- The risk of a systematic bias between the CHNS covered provinces (mainly in Eastern China) and the rest of the countries (Western China). Indeed, the latter part includes some of the poorest regions of the country. Importantly, the FAO approach aimed to use the estimated model to not consider only the CHNS survey in their approach but to be able to provide estimates for the whole country. However, we still have a potential bias between the sample used for estimating equation 3 (CHNS provinces) and the Western provinces. Still, why we have have obvious reason to expect some differences in the average level of the DEC between in and out sample provinces, there is no certainty that a specific bias exist in the shape of distribution between DEC and Food expenditures. This minor limitation should be recognized and investigated in the future.

Incidentally, and for future work, having information on Sichuan and the Chongqing municipality should be of a great help since it will represent a very significant share of the missing population in the current framework (the two entities represent 110mio people). Indeed, the Sichuan region was marked by high rural poverty, mountainous/hilly landscape providing adverse conditions for the population, but poverty number sharply declined in the rural areas from 13..1 mio in 2010 to less than 1mio by the end of 2018 (Sichuan survey with the support of the National Bureau of Statistics). So tracking how the food consumption pattern, and the distribution of calories consumption has been impacted by this change should be quite useful.

- A general issue with estimating consumption per decile of the population while actually, most of the food insecure people, and those captured with the “new” PoU estimates, will be in a fragment of this group. Of course, since the PoU methodology assumes a specific shape for the DEC distribution, only the CV estimated on the whole population is required. However, it still requires a bit of carefulness when considering that we capture properly the level of hunger for the first few percentiles of the population. Put it differently, while the method is consistent with the standard PoU estimation, I will be always careful to discuss when a country has actually reach a PoU of 4%, 3% or 2%. The note discussed this issue but the users of these numbers, especially when dealing with the extreme left side of the distribution should be aware of it.

While this method may not be perfect, it the best that can be done with existing data and, more important, it is a strong improvement compared to use outdated CV, that were based on even more problematic data and estimation in the 1999 underlying survey.

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6 This last stage shows the seriousness of the work, but I will be interested to see how much difference it will create to use directly the estimated value without randomizing the error-term.
3.2 **Vulnerability to weather shocks and various disasters**

It has been argued that various regions of China are particularly exposed to weather shocks, and other disasters (like earthquakes) leading to have several dozens millions of people exposed to food insecurity on a regular basis. Assuming that these events are as frequent as noted by some observers, the existing survey should capture their effects and the CV estimated by FAO in this revision should capture such features. Therefore, the new PoU should properly capture this structural vulnerability.

3.3 **Minor comments on the technical note**

I was not able to see where the “past” PoU numbers used in the graph and table 2 of the note, i.e.:

<table>
<thead>
<tr>
<th>PoU</th>
<th>n.a.</th>
<th>10.9%</th>
<th>10.3%</th>
<th>10.1%</th>
<th>10.0%</th>
</tr>
</thead>
</table>

, come from. Existing only materials, including the PoU on FAOSTAT are different, and actually consistent with the one I am using in Figure 1. It will be useful to check these numbers and/or indicate their source properly. **This does not change any of my conclusions in any case.**

In the discussion of the food expenditures, text and graph, it will be useful to indicate if the monetary amount are current Yuan, 2011 or another monetary unit (constant etc).

3.4 **Comments for future research**

As discussed above, the provided methodology is consistent with the general PoU approach proposed to every country, therefore I will not recommend to introduce specific modifications for China in this context.

Still, I think that due to the size of the country, it will be worthy to do in the future some additional investigations and methodological refinements to check the robustness of the PoU approach to such a big country, with potentially localized pockets of undernourishment. I will list two of them:

1) Controlling for price heterogeneity across cities and provinces, and the strong food price inflation observed in China in the last decade could be useful. While estimating equation 3, it is not clear to me if food expenditures are converted in real terms to harmonize the volume of expenditures across provinces that face different price level and dynamics. Since the polynomial form is not directly linked to a structural demand system, it is not obvious how the price index should be used to correct the nominal level of spending. Still introducing a relative food price index across provinces in the non parametric estimation could control for this. Using a region fixed-effect could also be useful, if we consider that all deciles are facing the same price level within a region (a strong assumption in itself);

2) The current approach is aimed to obtain a CV at the country level to provide a PoU estimate at the country level, based on the nation-wide daily calories availability per capita. Since the FAO team was able to estimate CV at the province level, and assuming that FBS could be built for individual provinces, it will be quite interesting to see if applying the PoU approach at the country level, or at the province level, and then aggregating to get national numbers, generate significantly different numbers;

4 **Comparison with IFPRI analysis on SDG2**
I have conducted various research based on existing PoU estimates and looking at their potential evolution in the period 2015-2030, in particular in Laborde and al. 2016 7.

In all cases, I have projected a sharp decline of China PoU, actually having to do some “catch-up” in the 2015 to 2020 period, to reconcile income dynamics, food demand behaviour and actual calorie consumption distribution.

In all cases, my estimates were indicating a fall of PoU for China below 5 percent – the threshold where I stop monitoring PoU- before or around 2020. So, the revised numbers appear to be much better, i.e. consistent with our work, since:

- They will provide a consistent baseline for 2020 onwards
- They will avoid creating a sharp fall in the period 2015 and 2020.

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5 Appendix 1: Terms of references

The terms of reference for this review has been summarized in the email send by Dr. Torero, FAO Chief Economist on Saturday the 10th of June 2020.

Dear David:

I am writing to formally request you to review the attached technical note of the update we are doing on China’s POU. This is something extremely necessary for our POU indicator and we were able to use very valuable official data from China to this update. I will really appreciate if you can do you review taking into account the following questions:

1. Do you find the procedure implemented technically sound and appropriate
2. Do you found the results reasonable
3. Do you found the results reasonable and consistent to the modelling work IFPRI is doing under your leadership

I will be very thankful if you keep the confidentiality of this note and if you can send me your review in the following 5 days. I am sorry about this short time but we are in a very tight deadline for the technical approval of this document.

Best regards,

Maximo
Summary and responses to main points raised by peer reviewers David Laborde and Joachim Von Braun on the new PoU estimates for China.
Statistics Division FAO

Key evaluation points requested to be considered for review were:

1. Do you find the procedure implemented technically sound and appropriate?
2. Do you find the results reasonable?
3. Do you find the results reasonable and consistent with the modelling work your institutions are doing?

A brief summary of the reviews is below.

Reviewers’ responses to Point 1:

Both reviewers confirmed that the approach adopted to update the estimate of the coefficient of variation of food consumption at national level for China, based on the combined analysis of data from two different household surveys, is correct. They shared their opinion that this is the best possible strategy that can be adopted to this end given current data availability. As the survey used to provide food consumption data is only representative of provinces and cities mainly in Eastern China, specific attention was devoted to the issue of representativeness. Both reviewers confirmed that the procedure adopted to handle it is robust and appropriate.

In commenting on the appropriateness of the data used, Dr. Laborde, citing important work from the nutrition literature related to China, confirms that the China Health and Nutrition Survey (CHNS) used as a source of food consumption data is the most reliable available source of information on dietary energy consumption in China. He agrees that the decline in PoU in China can be validated against the nutrition-related statistics published in the literature based on CHNS.

Both reviewers found the methodology used to be consistent with standard PoU methodology, and highlighted the issue of the likely imprecision of PoU estimates when approaching low levels, which, however, is not an issue specific to this revision but rather a known issue with the PoU methodology, a reason why FAO does not report values below 2.5%.

Reviewers’ responses to point 2:

Reviewers endorsed the downward revision of PoU series for China based on the proposed method and data as very credible. They confirm that results are consistent with existing evidence in the literature on nutrition in China and with a set of economic development indicators (extreme poverty, prevalence of stunting, food expenditure distribution, shared prosperity).

Reviewers’ responses to point 3:

The reviewers confirmed that results of the revision of the PoU for China are well aligned with the results of their own analyses based on different econometric modelling exercises. Dr. Laborde explicitly shared that his assessments using some different approaches also reached the same conclusions.

Issues highlighted and FAO responses:

In the review, two issues were highlighted that, while not invalidating the overall conclusion on validity of the revision, may require further attention. These issues are:
1) the already mentioned imprecision of PoU estimates when they generate low values (below 5%);
2) the fact that the analysis does not adjust for possible differences in food prices and/or in purchasing power across regions in China.

As for the first point, FAO shares similar concerns regarding the reliability of PoU estimates when they approach 5% or lower and has acknowledged this limitation in its publications and in discussions about the use of PoU as an SDG indicator to monitor progress towards Zero Hunger target. FAO does not report PoU values below 2.5% exactly because of the lack of precision around the estimates. However, that is a concern about the PoU method in general, and it is not specific to the application to China. In fact, this limitation was one of the motivations for FAO to develop the Food Insecurity Experience Scale (FIsev) as an alternative approach to measure food security with greater precision. Given increased availability of FIsev data for many countries, as a further validation exercise FAO compares estimates of the PoU to estimates of the prevalence of severe food insecurity (Flsev) based on the FIsev. In fact, one further evidence of the need for a revision was that the PoU was consistently much higher than Flsev for China. After this revision, they are well-aligned.

As for the second point, we agree that, if possible, an adjustment to reflect differences in food prices and purchasing power across regions would be appropriate for this type of analysis. Unfortunately, official consumer price indices and detailed food prices are not available by province from the National Bureau of Statistics in China, which prevented us from implementing such an adjustment. If anything, however, our expectation is that it might further reduce the CV, given that some of the poorer regions in China are also agricultural and rural areas, where staple foods are relatively cheaper. Moreover, various studies based on the China Household Income Project (CHIP) that have considered a similar adjustment in total expenditures have reported declining trends both in poverty and inequality, and also a reduction in regional (urban/rural) disparities (see, for reference Sicular et al. 2020).

Some useful suggestions to further improve the analysis are also provided.

Dr. Laborde proposes to review or develop case studies for regions in China that are populated but marginalized/still underdeveloped, like Sichuan and the municipality of Chongqing. We welcome the suggestions and find particularly interesting the possibility to investigate structural vulnerabilities, like those related to adverse weather events and natural disasters, and their impact on food security and distribution of food consumption in specific vulnerable regions in China.

He also proposed to adopt a bottom-up approach to estimate PoU in China in case FBS data is also available at province level. In this respect, it must be noted that FAO has long been working in this direction, proposing methods to estimate the PoU at subnational levels, and then aggregating it at national levels. Such methods, however, heavily rely on the availability of detailed, reliable food consumption data from surveys, the lack of which was one of the motivations to explore alternative methods for China. Given the importance of having access to updated food consumption data from official sources, we remain hopeful that more granular data on food consumption will become available in the future.

Finally, Dr. von Braun encouraged us to share data on CV estimates for various countries along with information about its source. It should be noted that FAO already shares data on all the parameters used to obtain PoU estimates for all monitored countries and years. We appreciate the suggestion and will work on improving the documentation on the various sources in terms of surveys, also as a way to preserve institutional memory and to increase replicability of FAO estimates to the maximum extent possible. The continued effort to improve estimates of the CV from household consumption and expenditure surveys is part of the regular process of producing PoU estimates, and specific activities
were devoted to this in preparation for SOFI 2020. Our objective is to update the CV for every country whenever we have reliable data, while continuing to explore different statistical modelling options to predict the CV using information on various socioeconomic characteristics of countries when food consumption surveys data are non-existent or unreliable.

**Conclusion**

Overall, the conclusion drawn from the peer reviews supports the downward revision of PoU series in China. The data sets and approach used, and the resulting revised estimates of PoU for China were appreciated and endorsed by the two external reviewers.
Peer review of Chris Barret, Professor of Applied Economics and Management, International Professor of Agriculture, Cornell University, on the new PoU estimates for China and responses from FAO to the reviewer

Questions:

Each reviewer was asked to reply to three main questions:
- Do you find the procedure implemented to be technically sound and appropriate?
- Do you found the results reasonable?
- Do you found the results consistent with what you know about the evolution of poverty and malnutrition in China?

Peer review and responses from FAO

Let me begin with the dominant reaction: It makes good sense to update the 1999 CV/y parameter estimate for China. The direction and significant magnitude of change make intuitive sense. And the basic strategy you follow to make this correction is clever and defensible.

I had no idea the PoU estimates relied on such old parameter estimates!!! Are there other major, populous, low-or-middle-income countries with similarly outdated parameter estimates (India? Bangladesh? Indonesia? Ethiopia? Nigeria?). I hope not. I’m sure this correction will elicit lots of questions from people and stir a bit of controversy. But you’re doing the right thing to try to get the estimates closer to correct.

Reply from FAO: Not really. For most other countries we do have had access to the latest official household surveys that collect food consumption data and use them to update the cv/y.

The remaining issues that I hope your team can work on over the coming year or two would include:
1) If you haven’t already, update/correct the past series for your revisions to this parameter and note clearly where the discontinuity begins (ideally, there isn’t one and you can smooth back to 1999).

Reply from FAO: We conducted as thorough a review of available household surveys from china as we could, in search for food consumption/food expenditure data. Unfortunately we haven’t been able to identify sources other than the china household finance survey (chfs), which we used, but which was first conducted in 2011, and the china health and nutrition survey (chns), which runs back to 1989 but only covering a subset of provinces.

2) I’m struck by the absence of adjustment for spatial price variation. The provinces omitted from CHNS are disproportionately distant from major ports. My limited understanding of the geography of Chinese agriculture suggests that this will have pretty dramatic effects on the relative price ratios between nutrient dense plant-based foods, starchy staples, and animal source foods. The method you use to project from the food expenditures (FE) in the CHFS data to the DEC in the CHNS data assumes a constant income-price relationship between the non-CHNS provinces and the CHNS provinces. I suspect that this hypothesis is demonstrably false. Is it possible to obtain (or construct) and correct for spatial food price variation? That should improve precision and reduce bias in your estimates.

Reply from FAO: We are working on this. We are trying to reconstruct proper food price indices at provincial level, but face the challenge that the relevant food basket should also vary by income decile. Unfortunately, apart from the chns, we lack details of actual food items purchased by hhs. Ideally, we need to model the “price of a calorie” and are assuming that, in this respect, differences in
the way in which the poor get to fulfill their food needs in terms of calories, as opposed to the food purchase behavior of the rich, dominates, so that the food purchase behavior of people in the lowest income deciles in the covered provinces is representative of the condition of the equally poor in the other provinces.

3) I like your clever approach of adding an error term to your DEC estimates and calibrated to the standard deviation of your prediction errors. But why don’t you also correct for the forecast bias apparent in Figure 2? Eyeballing those plots, it looks like the mapping between the actual (CHNS) and CHFS-based forecasts don’t have intercept 0 and slope 1. You can run the simple regression CHNS-DEC_dp = a + b * CHFS-DEC_dp + e where CHNS-DEC_dp is the CHNS value for decile d in province p, what you assume to be the true value, and ^CHNS-DEC is the DEC value predicted using the CHFS FE data, and e is the error term on that forecast evaluation regression. Then generate the predicted ^CHNS-DEC_dp values using that regression and append random draws from the residual vector to generate a forecast-error-corrected variant of your estimates.

Reply from FAO: this is an interesting idea we hadn’t considered, which is worth exploring in a future refinement of the approach. As we are using the predictions to only model the cv (rather than having an interest in the actual levels of predicted food consumption) we assume the possible bias in the average level would have no consequence on the cv (especially if the bias is linear in the level of expenditure). In short, I suppose what you propose won’t change the essence of the results, but can certainly bring more insights.

A few things I’m unclear on:

1) Do the MDER estimates account for heterogeneity in age, sex, BMI and physical activity level or are these fixed across subpopulations? MDER obviously depends also on factors such as prevalence of parasite infection (as a drain on dietary energy) that are increasingly available and in principle could be merged into the World Population Prospects data layers. I raise this because there is obviously heterogeneity in any subpopulation as to a true, individual-specific MDER. For your purposes, I think you want to estimate and use the median MDER for each subpopulation over which you generate estimates. This parameter will obviously matter a lot, so it merits careful technical attention (which I’m sure it’s received ... the question is how recently it’s been revisited, given rapid emergence of new data products).

Reply from FAO: the mder is a single parameter which applies to the entire population. It reflects the lower bound of the range of dietary energy requirement that are compatible with active and healthy life. The range is induced by differences in sex, age, ideal body mass (proxied by attained height) and physical activity levels.

The role of health conditions (as linked to the possible presence of parasite infections) is captured by an adjustment factor that, currently, we proxy with the latest child mortality rate as we only apply the pou to national populations.

In principle, we could apply the pou method to any population (including sub-national) for which we can estimate the dietary energy consumption distribution and for which we have details of the population composition, in which case we could, for example, make a more sophisticated use of data on actual physical activity levels as reflected in occupations, or prevalence of diseases, and other aspects that make the MDER of the specific sub-national population different from the average.

Let me stress, though, that thus far, the main problem that has prevented us from trying to push the disaggregation of the pou to the subnational level is the low precision of household food consumption data: while we can try and get as sophisticated as we can in pinpointing the mder, measurement error around the food consumption data will dominate. In pursuing additional details around the MDER my impression is that we would risk to get “precisely wrong” rather than “approximately right”, which remains our dominating objective.
2) I’m struck that DEC accounts “for household and retail level waste”. That notably omits pre-retail food loss and waste, which FAO has done much to quantify in the last couple of years. Is that already accounted for in the dietary energy supply? If so, you might want to flag this for the careful reader. If not, how do you address it?

Reply from FAO: Indeed, pre-retail food losses and wastes are already factored in the dietary energy supply computed through the food balance sheets.

3) You’re matching on income deciles within province for CHFS and CHNS, if I understand correctly. Are incomes captured sufficiently similarly across the two sampling protocols and survey instruments that you are reasonably confident in these matches?

Reply from FAO: The good predictive ability for the common year 2011 make us confident we got a good match. The chns has a precompiled, derived per capita household income level variable, while for the chfs we aggregate consumption expenditures. Unfortunately, differences in the survey instrument do not allow further improvements on this aspect at this stage. Our next goal is to finally get our hands on the actual microdata from the survey conducted by the bureau of statistics.

I hope these quick reflections on this note prove helpful to you and your team. Again, congrats on a good step forward. Hopefully, I’ve given you some useful thoughts on further feasible improvements.
Questions:

Each reviewer was asked to reply to three main questions:

- Do you find the procedure implemented to be technically sound and appropriate?
- Do you found the results reasonable?
- Do you found the results consistent with what you know about the evolution of poverty and malnutrition in China?

Peer review and responses from FAO

Thank you for inviting to review the Methodological note on new estimates of the Prevalence of Undernourishment in China. This is a great example of FAO methodology or (indirectly) estimating the insufficient dietary intake. I found the paper to be very transparent, presenting the methodology employed clearly and succinctly, and arriving at the result which is plausible and consistent with poverty figures. I've recently started working on China, so also from a purely selfish perspective, I thank you for the opportunity to learn about nutrition across the country, and about FAO's estimates over the years.

The following are some reflections and questions that the paper sparked, as well as some suggestions that may strengthen the paper as it goes to its final version. I merged questions 2 and 3 since they seem to be quite close to each other.

Do you find the procedure implemented technically sound and appropriate

The problem: The latest estimates of undernutrition for China were from 1999, based on the estimation of the Coefficient of Variation of daily energy intake, across socioeconomic groups (CV/y). The most recent survey that can be used to update this estimate is the CHNS 2011. The problem is that the survey is already 9 years old, and it covers only 12 of the 31 jurisdictions of Mainland China.

Therefore, the authors use the CHFS with national coverage, AND data from both 2011 (needed to link with the CHNS) and 2017 (most recent). Since the CHFS survey does not have sufficiently granular data on food consumption to estimate the daily energy intake directly, the authors need to estimate the relation between DEC and food expenditure in CHNS to take it to CHFS, to expand coverage, and produce more recent estimates. Comparing with the previous estimates based on 1999 data, the estimates suggest that the CV/y, and thus the prevalence of undernutrition to be significantly lower than these previous estimates.

From food expenditure to habitual energy consumption

To estimate habitual DEC for the provinces for which the information is missing, the authors estimate a relationship between average DEC and FOOD_EXP by deciles in the 12 provinces, and projecting this to the remaining jurisdictions. As indicated by the paper, the missing provinces are located in the North and Western regions of mainland China, which have lower per capita income that the included areas.

Given that both surveys also have information on age-gender, why are these variables not included in the model? Over and above the differences in demographic composition across per capita food expenditure, the excluded areas might present age-gender differences that are being ignored in the model. Based on NBS data, it seems in that the excluded provinces (and particularly those in the Northwestern regions) children dependency ratio is higher, and old dependency ratio lower, than in

Reply from FAO: interesting observation. I suspect it would be relevant if, rather than simply by jurisdiction, sizable differences in age-gender composition exist between households of the same income decile group across jurisdictions. I am afraid demographic data may not be available by income decile.

In addition, wouldn’t these extra variables on demographic composition provide more variability to the estimates that are needed to estimate dispersion measures such as the CV? This might reduce the importance of the added error term to the predicted estimates.

Reply from FAO: in principle, and if available by income decile, yes. Otherwise, differences in demographics that are correlated to income decile will be confounders.

Validation of the CV|y. The authors validate the model to estimate DEC using 2011 in the provinces covered by CHNS. Could you do the same validation exercise with CN|y? In other words, could you present the implied CV|y obtained based on deciles/province DEC estimates + error, with the obtained by direct measurement in these provinces? How big is the bias? It would be good to see confirmation that the lower variability relative to 1999 values is not an artifact of the indirect estimation method employed.

Reply from FAO: this is actually something we need to do.

From DEC and CV|y to undernutrition
The beauty of the FAO model is that it is using a uniform methodology that has minimum data requirement and can be applied to all countries with just mean coming from food balances and CV used form the most recent data. But the model rely on the assumption that undernutrition depends solely on caloric intake (relative to dietary energy requirements of such population). This means that other factors, such as access to safe water and sanitation, presence of infectious diseases and vaccination, are being ignored, or consider to play a relative minor role in the prediction. Adding reference from the international literature supporting this strong assumption might be warranted.

Reply from FAO: this is the reason why we refer to “undernourishment” (subalimentacion), rather than “undernutrition” (subnutricion). We do not aim at measuring the actual extent of undernutrition, which may also be conditioned by all other factors mentioned. (a better term in english would be “underfeeding” but it sounds ugly)

In addition, given that you actually have direct measurement of nutrition in the CHNS, such as anthropometric measurements, upper arm circumference, child malnutrition indices, anemia prevalence, as well as other proxies (living conditions, vaccinations, health status), it may be useful to compare the direct estimates of nutrition with the estimated ones obtained using the model.

Reply from FAO: see response to the previous comment.

Given that the demographic composition of China has changed dramatically over the years (aging population, lower reliance on agricultural activities, increased mechanization), how reasonable is to assume that that the minimum requirements and their variability doesn’t change in the past 20 years or hardly does it?

Reply from FAO: we actually compute the MDER based on the current data on population composition by age and sex. It is true that we should try and reflect also secular changes in working habits and median heights, but data availability also constrains such regular updates. In any case, impacts are expected to be limited, given the high value of average dietary energy consumption in china.
Do you found the results reasonable and consistent to the work that the World Bank conducts on poverty in China?

Despite all of the questions and comments above, I do find that the new estimates are more in line with the most recent extreme poverty estimates for China, including both the official estimates for rural areas only, and the World Bank estimate based on NBS ventile information of per capita expenditure and the International Poverty Line of USD 1.90 per person per day (2011 PPP). Given limited access data, WB produces poverty estimates for rural and urban areas, not across provinces. Therefore, it is not possible to compare those statistics with the subnational levels presented.

In addition, the underlying data on expenditure is broadly consistent with the official per capita food expenditure data for 2011 (http://www.stats.gov.cn/tjsj/ndsj/2012/indexeh.htm)

For reference, the latest series of official rural poverty and WB national extreme poverty based on USD $1.90 per person per day are as follows:

<table>
<thead>
<tr>
<th>Official rural poverty</th>
<th>WB USD1.90/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>12.7</td>
</tr>
<tr>
<td>2012</td>
<td>10.2</td>
</tr>
<tr>
<td>2013</td>
<td>8.5</td>
</tr>
<tr>
<td>2014</td>
<td>7.2</td>
</tr>
<tr>
<td>2015</td>
<td>5.7</td>
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<tr>
<td>2016</td>
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<td>2017</td>
<td>3.1</td>
</tr>
<tr>
<td>2018</td>
<td>1.7</td>
</tr>
<tr>
<td>2019</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Therefore, to the extent that undernourishment is expected to present similar levels as extreme poverty, the most recent estimates of PoU in since 2013 (<2.5%) is broadly in line with the poverty levels estimated by WB, and since 2017 with the official numbers.

Yet, for the estimates up to 2011, the previous estimates of PoU (~15% in 2005, 10.9% for 2011) were closer to both poverty rates. Given that the new FAO suggests that China already reached below 2.5% by 2011, it is not able to capture the progress monetary poverty since 2011. This is not to cast doubt to the nutrition estimates at all, but still, it is worth pointing out this discrepancy.

I can see that at this point, any validation of the levels of undernutrition through other survey-based measures (even if outdated and not covering the whole country), could be useful to strengthen the results.

Reply from FAO: official data based on anthropometry from the “nutrition and health status of the Chinese people” national report show that underweight in adults (BMI lower than 18.5) had already fallen to 6% in 2012.

Once again, thank you for the invitation to review the note. I’ll be happy to follow-up on any of these issues, if it useful. And good luck with the final publication and adoption of the methodology.