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REPLY TO ROBERT INKLAAR

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In a major statistical effort, the International Comparison Project (ICP) collects the primary price data across countries on which Purchasing Power Parity (PPP) exchange rates are based. The PPPs allow for the fact that some goods and services are not internationally traded, and so do not come into parity; given lower wage rates in poorer countries these goods tend to be cheaper there. Thus the price-level index, given by the ratio of the PPP to the market exchange rate (sometimes also known as the inverse of the real exchange rate), has long been known to have a positive income gradient across countries. The higher the GDP per capita, the closer the PPP comes to the market exchange rate. This has been dubbed the "Penn effect" (because of its historical origins in the work of a number of economists at the University of Pennsylvania). The fact that the price index tends to be lower in poor countries is arguably the international community's main motivation for supporting the ICP in collecting its price data. Otherwise, we will tend to understate living standards in developing countries.

Collecting the ICP price surveys is a costly exercise and so it is not done annually; the last five ICP price surveys were in 2011 (for which results are not available at the time of writing), 2005, 1996, 1993, and 1985. Nonetheless, PPPs are estimated between survey rounds. In doing so, the standard practice is to adjust the PPPs solely for the difference in the inflation rates between the country in question and the reference country, the U.S. This is the method used by the World Bank's *World Development Indicators* (WDI); see, for example, World Bank (2012).

However, we have known for some time that these updating methods in lieu of new ICP data are not very reliable. Relative to the updates between ICP rounds, past ICP results have implied substantial revisions to PPPs for a given year, and especially so for a number of developing countries (see, for example, World Bank, 2008a, 2008b). The revision for China in 2008, based on the 2005 ICP, was especially large and received much attention. The new PPP for China implied that the country's GDP per capita at PPP for 2005 was 40 percent lower than we thought prior to release of the 2005 ICP (World Bank, 2008b). Just before the release of the ICP, China's price level index for 2005 was deemed to be 0.25 (the PPP was 25 percent of the exchange rate), up from 0.19 in 1993. The price surveys from the 2005 ICP implied a price index of 0.42 (World Bank, 2008b). China is arguably a special case, given that it had not participated in the 1993 ICP.

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However, there were large revisions for many other developing countries, as documented in World Bank (2008b) and Ravallion (2013).

The most common explanation for these large data revisions has been methodological changes between the ICP rounds. For example, the 2005 ICP used better defined product standards in collecting prices, which would do a better job of allowing for differences in product quality (World Bank, 2008a). However, in Ravallion (2013) I argued that a large share of these data revisions was in fact an artifact of the poor performance of the WDI's inflation-adjustment method for interpolating PPPs between ICP rounds. I proposed an alternative method that clearly outperforms the WDI practice empirically, and so can go a long way toward avoiding the large PPP revisions. I also provided an economic rationale for my method. For the same reason that one uses PPPs rather than exchange rates for international comparisons, I hypothesized that the PPP will tend to rise relative to the market exchange rate in a growing economy. This can be thought of as the dynamic Penn effect (DPE), corresponding to the well-known cross-county Penn effect. My alternative method exploits the DPE, after showing that the PPP does in fact tend to rise as a proportion of the exchange rate in developing economies. Furthermore, I showed that once one allows for the DPE, the usual inflation-rate adjustment method plays no useful role.

In seemingly stark contrast to my claims, Inklaar (2013) argues that GDP growth rates have no additional explanatory power over inflation rates in updating PPPs between the survey rounds of the ICP. In Inklaar's view, the current inflation-adjustment method cannot be improved upon by allowing for the DPE. How can we come to such different conclusions, including when we use the same data?

The essence of Inklaar's comment is his claim that a "clearer test" is to use PPP changes as the dependent variable rather than changes in the price level index. Regressing the change in log PPP on the inflation rate (change in log of the GDP deflator) and the GDP growth rate, he finds that the coefficient on the latter variable is not significantly different form zero. He provides numerous versions of this regression (for different time periods and datasets) and in all of them the GDP growth variable has no significant impact, ostensibly refuting my claim.

However, rather oddly, Inklaar does not provide the obvious nested test, combining his model with mine. He does not actually let the two competing models compete. At one point he does write down an encompassing specification (his equation 2) but he does not provide an estimate of it. His justification for not providing the obvious nested test is that two of the explanatory variables in the encompassing model are highly correlated, namely the change in the exchange rate and the inflation rate. For this reason, Inklaar enters the two variables one at a time, never together. So he does not control for the change in the exchange rate when he regresses the change in the PPP on the inflation rate and the growth rate. This is unsatisfactory. As a general comment, correlations amongst regressors are not a good reason for specification choices to over-ride the theoretically preferred specification—in this case the encompassing model that will resolve whether Inklaar has in fact refuted my result. By imposing arbitrary restrictions on the encompassing model, he does not in fact establish that the inflation-adjustment method outperforms my proposed alternative.

So for the purpose of this reply I am providing the encompassing model—to let the data decide by forcing the two specifications to "fight it out" empirically. I use my dataset of PPPs from the 2005 and 1993 ICP rounds, but the choice of datasets is not the issue; I comment on data further below. In Tables 1–4, DEF05/DEF93 is the ratio of the GDP deflators for 2005 and 1993; EXRATE05/EXRATE93 is the corresponding ratio of the exchange rates; YUSD05/YUSD93 is the corresponding ratio of GDP per capita in US dollars; and PI05/PI93 is the ratio of the price-level index (PPP normalized by the market exchange rate).

My estimate of the encompassing test is provided in Table 1, regressing the change in the log of the PPP on the growth rate, the inflation rate, and the change in the (log) exchange rate. All three regressors have significant coefficients. And I find that, despite the high correlation between the inflation rate and the change in the exchange rate, one can still separate out their effects with precision. We also see that the estimated elasticity of the PPP to the exchange rate is not significantly different from unity at given values of the inflation rate and GDP growth rate. On imposing this restriction one obtains the result in Table 2.

Next I impose a further restriction that is consistent with the data, namely that the two slope coefficients are not significantly different from each other. This

TABLE 1

Encompassing Regression Combining Inklaar's Preferred Specification and Mine

Variable	coefficient	t-ratio	prob.
Constant	–0.056	–1.257	0.211
Change in log GDP at constant national prices: log(YUSD05/YUSD93) – log(DEF05/DEF93)	0.275	3.158	0.002
Change in log GDP deflator: log(DEF05/DEF93)	0.368	6.362	0.000
Change in exchange rate: log(EXRATE05/EXRATE93)	0.930	8.700	0.000
N	123		
R^2	0.982		
S.E.	0.260		
F	2194.244		
Prob.	0.000		

Note: The dependent variable is log(PPP05/PPP93); t-ratios based on White standard errors.

TABLE 2

On Imposing the Data-Consistent Restriction That the Coefficient on the Change in the Exchange Rate is Unity

Variable	coefficient	t-ratio	prob.
Constant	–0.047	–1.084	0.280
Change in log GDP at constant national prices: log(YUSD05/YUSD93) – log(DEF05/DEF93)	0.307	6.019	0.000
Change in log GDP deflator: log(DEF05/DEF93)	0.321	6.241	0.000
N	130		
R^2	0.252		
S.E.	0.261		
F	21.427		
Prob.	0.000		

Note: The dependent variable is the log of the price index (inverse real exchage rate) as given by log(PI05/PI93) = log(PPP05/PPP93) – log(EXRATE05/EXRATE93); White standard errors.

TABLE 3

My Preferred Specification Now Reemerges as a Data-Consistent Restricted Form of the Encompassing Model

Variable	coefficient	t-ratio	prob.
Constant	–0.019	–0.441	0.660
log(YUSD05/YUSD93)	0.283	5.226	0.000
N	132		
R^2	0.212		
S.E.	0.268		
F	34.888		
Prob.	0.000		

Note: The dependent variable is log(PI05/PI93); White standard errors.

TABLE 4

The Inflation Variable has no Additional Explanatory Power Bas Claimed in Ravallion (2013)

Variable	coefficient	t-ratio	prob.
Constant	–0.047	–1.084	0.280
log(YUSD05/YUSD93)	0.307	6.019	0.000
log(DEF05/DEF93)	0.014	0.984	0.327
N	130		
R^2	0.252		
S.E.	0.261		
F	21.427		
Prob.	0.000		

Note: The dependent variable is log(PI05/PI93); White standard errors.

brings us back to my original test for the DPE in Table 3. This is nothing more than the differenced version of the usual Penn effect in which the log price level index rises with log GDP per capita in US dollars evaluated at market exchange rates. This specification makes sense; on the left-hand side we have the log of the PPP (in local currency units) deflated by the market exchange rate, while on the right-hand side we have GDP in local currency units deflated by the same exchange rate. Finally, on testing for any additional explanatory power of the inflation variable, one obtains Table 4. The inflation rate has no extra explanatory power for the price level index (a real variable) once one controls for the GDP growth rate.

So starting with the encompassing model and only imposing data-consistent restrictions (instead of Inklaar's arbitrary ones) I am lead back to the conclusion of Ravallion (2013) that the DPE does have explanatory power for the price index, and that the inflation rate brings no extra power for the PPPs once one controls for the growth rate and the exchange rate.

Notice that my specification predicts the price level index not the PPP, which Inklaar prefers. This is an unimportant difference. As Ravallion (2013) also showed, and is plain from one of Inklaar's reported regressions (Table 1, column

2), whether one puts the change in the exchange rate on the left-hand side or the right is immaterial, given that its coefficient is so close to unity. Ravallion (2013) directly addresses this issue, though Inklaar ignores my argument on this point, and prefers to arbitrarily exclude the exchange rate as a predictor.

It is important to note that the exchange rate is data when updating PPPs between ICP rounds. Indeed, as a practical matter, the exchange rate is available well ahead of the inflation rate. So it makes perfect sense to use this information when updating PPPs and it is surely rather odd to ignore it. My method predicts the price index and then backs out the PPP using the exchange rate. At one point Inklaar says, "no-one uses the exchange rate to forecast PPP changes." But the fact that people do not do this is hardly a good reason for persisting with the practice when (as I show) using the exchange rate this way can greatly improve our ability to forecast PPPs between ICP rounds. Essentially I am saying: by all means, use the exchange rate *if* it helps. And it does!

As I show in Ravallion (2013), my method outperforms the WDI method preferred by Inklaar. See Figure 8 in Ravallion (2013). This could hardly be more convincing; it can be seen that the density function of the errors implied by the WDI's inflation-adjustment method has thicker tails (large errors in both directions, but more so in the upper tail) and is not centered on zero, with underestimation at the mean; the mean error is 0.071, or roughly a 7 percent underestimation of the PPP (or 7 percent overestimation of GDP at PPP). Inklaar in his comment ignores my results on the relative performance of the methods.

This does not depend crucially on which dataset one uses. However, Inklaar criticizes Ravallion (2013) for using the 1993 ICP, which (like all ICP rounds) had its problems. Inklaar does not, however, point out (except rather tangentially in a footnote) that Ravallion (2013) also used the 1985 ICP. I obtained essentially the same results. Contrary to Inklaar's claim, the DPE is quite stable over time.

Inklaar also criticizes my paper for using both the ICP-based estimates and the extrapolations (using a regression model when the country did not participate in the ICP). However, he ignores the quite lengthy discussion in Ravallion (2013) about the differences between the two sets of PPP estimates. Ravallion (2013) provides results with controls for ICP participation, and shows that this does change the results, but still comes to essentially the same conclusion on the DPE.

In conclusion, starting from a regression specification that encompasses Inklaar's preferred model and my own, I confirm my claims in Ravallion (2013). Not only does the growth rate variable have explanatory power consistent with the DPE, the inflation rate brings no useful extra information once one controls for the growth rate in a regression for the log of the price level index. The reason why Inklaar does not find this is that he arbitrarily drops the change in the log exchange rate from his regressions for the change in log PPP. As I demonstrated in Ravallion (2013), the exchange rate has considerable predictive power for the PPP at a given growth rate, though one cannot reject the null of a unitary elasticity, implying that the relevant dependent variable is the log price level index rather than the log PPP. With this amendment to Inklaar's tests, one finds again that the method used by the WDI and others for updating PPPs between ICP rounds can be improved upon considerably without collecting more ICP price data. Ironically, obtaining much

better PPP estimates between ICP rounds entails nothing more than exploiting the same real income effect on the price level index that originally motivated the estimation of PPPs.

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