the review of income and wealth

Review of Income and Wealth
Series 59, Number 4, December 2013
DOI: 10.1111/roiw.12078

"PRICE LEVELS AND ECONOMIC GROWTH: MAKING SENSE OF REVISIONS TO DATA ON REAL INCOMES": A COMMENT

BY ROBERT INKLAAR*

Groningen Growth and Development Centre, University of Groningen

In his recent paper, Ravallion (2013) proposes a new method to predict changes in purchasing power parities (PPPs), arguing that a model that includes economic growth and exchange rate movements is superior to the standard approach of using inflation differences. In this comment, I argue that his test is wrong and I show that with a correct specification of the test, there is no robust and stable relationship between changes in PPPs and economic growth while the usefulness of the standard approach is confirmed. I also suggest an approach that could be more helpful to understand changes in PPPs.

JEL Codes: E31, O47

Keywords: Balassa-Samuelson, economic growth, purchasing power parity

1. INTRODUCTION

Purchasing power parities (PPPs) play an invaluable role in modern statistics, for example in comparisons of standards of living across countries (Deaton and Heston, 2010) and in tracking global poverty (Chen and Ravallion, 2010). Yet the challenge of comparing the prices of over 1000 products across 100–200 countries means that data are not collected annually and processing the survey results is time-consuming as well.[1] There is thus great demand for more timely estimates of PPPs, to allow for timely estimates of comparative living standards, global poverty, and so on.

The standard approach to forecasting changes in PPPs is the inflation adjustment method: if inflation is 5 percent higher in country A than in country B, the PPP would be forecasted to increase by 5 percent. This is conceptually an appealing approach: PPPs measure the price of a basket of goods in country A relative to country B, so the PPP is expected to increase if prices rise faster in country A than in country B. Yet such forecasts have a poor record. Ravallion (2013) discusses how estimates of real GDP per capita were revised substantially following the release of the 2005 PPP results and developing countries in particular turned out to

Note: The author is grateful for useful discussions, comments, and suggestions on earlier versions by Angus Deaton, Prasada Rao, Martin Ravallion, and Marcel Timmer. Thanks are also due to Martin Ravallion for providing his dataset.

*Correspondence to: Robert Inklaar, University of Groningen, Faculty of Economics and Business, PO Box 800, 9700 AV Groningen, The Netherlands (R.C.Inklaar@rug.nl).

[1]See World Bank (2008a) for a detailed description of the 2005 PPP construction and results. The World Bank coordinates the International Comparison Program (ICP), which is tasked with the compilation of PPPs for as broad a set of countries as possible.

be much poorer according to the new PPPs. These countries had not been included in PPP comparisons since 1993, yet the magnitude of the revisions was still surprisingly large.[2]

Given the poor performance of the standard forecasting approach, Ravallion (2013) aims to improve upon it. His argument starts from the Penn effect and the Balassa (1964)/Samuelson (1964) hypothesis. The Penn effect is the empirical observation that richer countries have a higher relative price level, i.e. a higher PPP relative to their exchange rate.[3] Balassa (1964) and Samuelson (1964) argued that this could be due to differences between the traded and the non-traded sector of the economy. Higher productivity in the traded sector would drive up wages in the entire economy and if the scope for productivity growth in the non-traded sector is limited, prices of non-traded products would increase. Ravallion (2013) hypothesizes that this process can explain not only differences in PPPs in a given year but also changes in PPPs over time. He labels this mechanism the dynamic Penn effect (DPE), whereby countries showing faster economic growth would show an increase in their PPP relative to their exchange rate.

This is a sensible conjecture,[4] yet the test that Ravallion (2013) proposes for the DPE is wrong. Specifically, his measure of economic growth includes not only economic growth (i.e., the increase in the volume of GDP), but also the increase in prices. Correcting for this flaw and employing a broader and more consistent dataset, I show that the DPE is not a robust or stable relationship over time. By contrast, inflation is a much more stable predictor of PPP changes, with PPPs changing, on average, 1-for-1 with changes in inflation.

That still leaves the challenge of more accurately predicting changes in PPPs over time. Summers and Heston (1991, 1993) already confronted the problem that changes in PPPs from one survey year to another are not accurately predicted by inflation differentials. McCarthy (2013) discusses a broad range of reasons for why PPP changes and inflation differentials do not match. Those reasons include differences in measurement practices and data quality, but there are also conceptual reasons, related to the weighting of detailed prices in PPPs and national inflation rates, an issue explored in more detail by Deaton (2012). Section 3 provides further discussion and suggests a way forward on this issue.

2. PPP Changes and the Dynamic Penn Effect

According to the static Penn effect, a country's relative price level—its PPP divided by the exchange rate—increases with income. Ravallion (2013) then defines the DPE as the change over time of the dependent and independent variable:

[2]See World Bank (2008b). At the time, the most recent PPP comparison for (non-EU) OECD countries was in 2002 and there were 2004 estimates for EU countries.

[3]Following Samuelson (1994), the Penn effect means that the income difference between a rich and a poor country is larger according to exchange-rate-converted GDP per capita than to PPP-converted GDP per capita. This is equivalent to finding that the PPP over the exchange increases with GDP per capita (converted using either exchange rates or PPPs).

[4]And indeed, also discussed by Balassa (1964).

$$(1) \qquad \ln\left(\frac{PPP_{it}}{E_{it}} \Big/ \frac{PPP_{it-1}}{E_{it-1}}\right) = \alpha + \beta \ln\left(\frac{P_{it}Y_{it}}{E_{it}} \Big/ \frac{P_{it-1}Y_{it-1}}{E_{it-1}}\right) + \varepsilon.$$

Equation (1) is equivalent to equation (1) of Ravallion (2013), with as the dependent variable the change, for country i from $t-1$ to t, of the PPP over the exchange rate, E, and as the explanatory variable the change in real GDP per capita. This variable consists of three terms, namely the GDP deflator, P, GDP per capita at constant national prices, Y, and the nominal exchange rate. It is important to note that "real" here refers to "comparable across countries," as GDP per capita at current prices in local currency, $P_{it}Y_{it}$, is divided by the nominal exchange rate. Comparing the 1993 and 2005 benchmarks, Ravallion (2013) found that β was positive and significant and presented this as evidence in favor of the DPE.

However, from equation (1) it should be clear that Ravallion's (2013) regression is not a good test of the DPE as he conceptualizes it. Instead, it nests the inflation adjustment method and the DPE. This can be best illustrated by "unpacking" the dependent and independent variable of equation (1) and allowing each variable to have a separate effect on the change in PPPs, the new dependent variable:

$$(2) \qquad \ln(PPP_{it}/PPP_{it-1}) = \alpha + \underbrace{\beta_1 \ln(P_{it}/P_{it-1})}_{\text{Inflation adjustment}} + \underbrace{\beta_2 \ln(Y_{it}/Y_{it-1}) + \beta_3 \ln(E_{it}/E_{it-1})}_{\text{Dynamic Penn effect}} + \varepsilon.$$

The first term on the right-hand side captures the effect of inflation on the change in PPPs, and if the inflation adjustment method is a valid procedure, β_1 would be equal to one.[5] The second two terms represent the DPE, the joint effect of economic growth and exchange rates on the change in PPPs. If there is a DPE, the coefficient on exchange rate changes, β_3, should be equal to one, and β_2 should be positive and significant, as the DPE predicts that prices rise more quickly if economic growth is faster. Ravallion (2013) does not explicitly include the requirement that β_3 is equal to one in his discussion, though he states that it "would clearly be worrying" if it were not. Implementing the DPE as a forecasting tool would at least require coefficients for β_2 and β_3 that are stable and significant over time. In parallel with $\beta_1 = 1$ of the inflation adjustment method, I will also require $\beta_3 = 1$, but I will show below that this is not important for my conclusions.

To determine which of the methods is supported by the data, it is most straightforward to first estimate a model explaining PPP changes using inflation—the first right-hand term of equation (2)—and then a model explaining PPP changes using exchange rate changes and economic growth—the last two right-hand terms of equation (2). It is of course also possible to include all three terms simultaneously, but the very high correlation between exchange rate changes and inflation makes it impossible to reliably test whether β_1 and β_3 are equal to one. In such a joint estimation, it is thus only possible to test whether economic growth has a significant effect on PPP changes.

[5]Equation (2) only includes inflation for country i rather than the difference in inflation between country i and the United States, the base country. As a result, U.S. inflation ends up in the constant term.

It might be the case that there is empirical support for a stable and significant DPE as well as for the inflation adjustment method, and this outcome would raise the question of which method delivers superior forecasts. Ravallion (2013) argues that his DPE is the superior method, but the analysis leading up to this argument falls short of a formal forecast evaluation analysis, such as discussed in West (2006). In particular, Ravallion does not conduct an out-of-sample forecast and presents no formal comparison of the forecast errors of the two methods. There is no need to go into a formal evaluation analysis, though, if either method falls short as a useful description of the data.

To empirically test for the DPE and inflation adjustment method, I use two datasets. The first dataset is from Ravallion (2013), extended by including the growth in GDP per capita at constant local currency units from the World Development Indicators. His dataset draws relative price levels from World Bank (2008b) and adds further data from the World Development Indicators. There are three drawbacks to this dataset, though. First, this "1993 benchmark" is partly based on the 1993–96 price surveys, but the PPPs for OECD and EU countries are actually based on price surveys for 2002 and 2004, as noted in World Bank (2008b). So referring to it as a 1993 benchmark is at best an imprecise characterization and at worst misleading. Second, the index number methods used to construct the set of global PPPs differ between the 1993 and 2005 benchmarks (see also World Bank, 2008b). Third, data are available for a total of six global surveys since 1970 and it would be preferable not to ignore these. Though Ravallion (2013) also uses data from the 1985 benchmark, he still ignores the three earlier ones.

I have therefore constructed a second dataset, which uses the detailed price and expenditure data for each of the six global surveys.[6] For each survey year, the GEKS index number formula is used to weight the detailed prices and construct a GDP PPP. This approach has desirable theoretical features (Balk, 2008) and is used in much of the 2005 PPP results (World Bank, 2008a). Unlike the Ravallion dataset, this dataset only includes observations that are based on survey results, rather than also including econometrically estimated PPPs. The main advantage of this second dataset is that multiple PPP changes are included and the inflation adjustment method and DPE can be tested in a much broader setting.

The results using the Ravallion dataset are shown in Table 1. Column (1) reports the results of estimating equation (1), replicating Ravallion (2013). This shows that countries where real GDP per capita increased faster, had a faster increase in their relative price level. As argued above, this is not a test of the DPE, as changes in real GDP per capita also include changes in prices. The remaining specifications are based on equation (2). Columns (2) and (3) report the results for my preferred approach to testing the inflation adjustment method (column (2)) and the DPE (column (3)). Column (2) shows that the estimated coefficient on the change in GDP deflator is not significantly different from one, providing support for the inflation adjustment method. Column (3) shows that the estimated

[6]The detailed price and expenditure data from the 2005 survey are directly from the World Bank. The earlier five surveys are from the PWT website, www.ggdc.net/pwt. Note that the PWT website includes a 1996 benchmark, rather than a 1993 benchmark. This combines the results from regional price surveys in 1993 and the 1996 OECD/Eurostat survey, see World Bank (2008b). This survey has the least detailed set of results, covering ±30 categories versus the 100+ categories for the other surveys.

TABLE 1

Explaining Changes in PPPs between 1993 and 2005: Ravallion Dataset

	(1)	(2)	(3)	(4)
Change in real GDP per capita at market exchange rates	0.283***			
	(0.0541)			
Change in GDP deflator		0.993***		0.264***
		(0.0258)		(0.0688)
Change in exchange rate			1.011***	0.746***
			(0.00916)	(0.0689)
Change in GDP per capita at constant national prices			0.334***	0.199*
			(0.101)	(0.101)
Constant	–0.0187	–0.162***	0.0629	0.0132
	(0.0425)	(0.0422)	(0.0413)	(0.0410)
Observations	132	125	123	123
R-squared	0.212	0.973	0.986	0.988

Notes: ***p < 0.01, **p < 0.05, *p < 0.1. Robust standard errors in parentheses. Column (1) shows the results from estimating equation (1), with the change in relative price level between 1993 and 2005 as the dependent variable; columns (2)–(4) are based on equation (2) and use the change in the PPP between 1993 and 2005 as the dependent variable.

coefficient on the change in exchange rate is not significantly different from one and that economic growth is a significant explanatory variable, providing support for the DPE. Column (4) includes all three terms together. This substantially affects the estimates on the GDP deflator and exchange rates, with much higher standard errors and much lower coefficient estimates. This effect is unsurprising given the 0.98 correlation between the two variables. Both parameters are now significantly smaller than one and the sum of the parameters is not significantly different from one. The coefficient on economic growth is smaller in column (4) than in column (3), though still significant at the 10% level. So in short, the dataset of Ravallion (2013) provides support for both the inflation adjustment method in column (2) and the DPE in column (3).

I now turn to the results based on my broader and more consistent dataset, with Table 2 showing the results for the DPE test. The first column includes the full sample of PPP changes and the other columns analyze the change in PPPs between two subsequent benchmarks, with the period covered shown in the column header. As the table shows, there is support for the DPE in only one of the periods, 1985–96. The parameter on economic growth is not significantly different from zero in any of the other periods, including the full 1970–2005 period. Furthermore, the coefficient on the change in exchange rates is often significantly different from one.[7] There is thus no robust and stable DPE relationship.

In contrast, Table 3 shows much more supportive results for the inflation adjustment method. For the period as a whole and in all but one of the periods, the coefficient on the change in GDP deflator is indistinguishable from one. There is thus clear evidence in favor of the inflation adjustment method while such evidence

[7]Or, more in general, it is not constant over time. As remarked above, to be useful as a forecasting tool, the coefficient should at least be stable over time, rather than equal to one, but even this weaker requirement is not met.

TABLE 2

Testing for the Dynamic Penn Effect (DPE) between 1970 and 2005

	1970–2005	1996–2005	1985–1996	1980–1985	1975–1980	1970–1975
Change in GDP per capita at constant national prices	0.154	0.0544	0.368**	0.00301	–0.491	–0.249
	(0.166)	(0.325)	(0.140)	(0.287)	(0.615)	(0.290)
Change in exchange rates	0.921***	0.991***	0.930***	0.610***	1.048***	0.453***
	(0.0290)	(0.0410)	(0.0358)	(0.133)	(0.0728)	(0.0750)
Constant	0.0253**	0.00667	0.00554	–0.0395**	0.0430***	0.0345***
	(0.00983)	(0.0120)	(0.00476)	(0.0193)	(0.0152)	(0.0112)
DPE test						
Change in GDP per capita >0	NO	NO	YES	NO	NO	NO
Change in exchange rates = 1	NO	YES	YES	NO	YES	NO
Observations	243	100	59	41	27	16
R-squared	0.854	0.817	0.956	0.464	0.910	0.600

Notes: ***p < 0.01, **p < 0.05, *p < 0.1. Robust standard errors in parentheses. The change in the PPP is the dependent variable. The period covered is shown in the column header. The specification in column 1970–2005 includes all periods separately and year dummies to account for differences in U.S. economic growth across the periods. The DPE test indicates whether the coefficient on the change in GDP per capita at constant national prices is significantly greater than zero at the 5% level and whether the change in exchange rates is significantly different from one at the 5% level.

TABLE 3

Testing for the Inflation Adjustment Method between 1970 and 2005

	1970–2005	1996–2005	1985–1996	1980–1985	1975–1980	1970–1975
Change in GDP deflator	0.977***	0.973***	0.995***	0.861***	1.038***	0.580***
	(0.0243)	(0.0469)	(0.0338)	(0.0811)	(0.0478)	(0.128)
Constant	–0.0794***	–0.00818	–0.0388***	–0.0438***	–0.0690***	–0.0382***
	(0.00655)	(0.00652)	(0.00348)	(0.00945)	(0.0102)	(0.0108)
Inflation adjustment method test						
Change in GDP deflator = 1	YES	YES	YES	YES	YES	NO
Observations	243	100	59	41	27	16
R-squared	0.881	0.797	0.974	0.765	0.889	0.735

Notes: ***p < 0.01, **p < 0.05, *p < 0.1. Robust standard errors in parentheses. The change in the PPP is the dependent variable. The period covered is shown in the column header. The specification in column 1970–2005 includes all periods separately and year dummies to account for differences in U.S. inflation across the periods. The inflation adjustment method test indicates whether the coefficient on the change in GDP deflator is significantly different from one at the 5% level.

is lacking for the DPE. This is not to argue that the inflation adjustment method is perfect, but rather that it is well-supported on average and would thus be a useful starting point for any improvement.

3. Predicting Changes in PPPs: A Way Forward?

So is it possible to do better than using the inflation adjustment method to predict changes in PPPs? This has been a longstanding challenge, with researchers

trying to reconcile or integrate subsequent PPP surveys and inflation differentials. Those studies include Krijnse Locker and Faerber (1984), Summers and Heston (1991, 1993), Dalgaard and Sørensen (2002), Hill (2004), Rao *et al*. (2010), McCarthy (2013), and Deaton (2012).

These studies have identified many reasons for why PPP changes would be inconsistent with inflation differentials. McCarthy (2013) provides a comprehensive discussion of the many reasons, which include differences in product sampling; differences in the quality of the cross-country price surveys over time; differences in price measurement across countries vs. price measurement over time;[8] differences across countries in price measurement practices, such as the degree to which quality change is accounted for; and revisions to National Accounts that are not reflected in revised PPPs. All these can play a major role, but they are not typically amenable to the type of straightforward adjustment that the DPE would have provided.

What could be a more promising approach is to correct for differences in weighting between national inflation and PPPs. In computing national inflation, a country's statistical agency will only use the expenditure shares of that country. In computing PPPs, though, expenditure shares from multiple countries have to be used to get an economically sensible index.[9] Whenever expenditure shares differ across countries, the changes in PPPs will no longer be well approximated by the difference in inflation. This issue has been raised by many authors, including McCarthy (2013). In a particularly relevant analysis, Deaton (2012) shows that adjusting for the differences in expenditure shares can indeed help explain why the PPPs for poorer countries had to be revised to a greater degree, though this could not explain the full magnitude of the revisions.[10]

This is a useful avenue for further work, given that weighting is a systematic reason for why the overall inflation differential does not match the change in PPPs. The most straightforward method of accounting for differences in weights would be to use detailed inflation series to extrapolate product category PPPs[11] and then use up-to-date expenditure shares to compute overall PPPs. This method is already used (in part) by Eurostat for EU PPPs (Eurostat–OECD, 2006) and there it helps to reduce the forecast error from using the overall inflation differential (Inklaar and Timmer, 2013).

4. Concluding Remarks

Every release of a global set of PPPs has led to (sometimes unpleasant) surprises as estimates based on inflation differentials had to be substantially revised. Chen and Ravallion (2010, p. 577) state that "the developing world is poorer than we thought" following the release of the 2005 PPPs, while Deaton (2010) emphasizes that the 2005 PPPs implied higher international inequality.

[8]This includes differences in the measuring prices of public services, exports and imports.

[9]See, e.g., Caves *et al*. (1982).

[10]Whether this was due to the shortcomings of the 1993/96 price survey or whether other factors are at work is an open question.

[11]Commonly referred to as "basic headings" in ICP. "Prepared fish and seafood" is an example of a basic heading. See World Bank (2008a) for more details.

Ravallion (2013) argued that countries with faster economic growth also show faster increases in the PPP relative to the exchange rate and that this "dynamic Penn effect" (DPE) relationship could be used to improve the current practice of using the inflation differential to forecast PPP changes. I have shown that his conclusion was based on an incorrect test of the DPE. Using an appropriate test and a broader, more consistent dataset, I show that the DPE is not a stable and robust relationship. In contrast, the data do support the method using the inflation differential. There is thus no reason to prefer the DPE as an improvement over using the inflation differential when forecasting PPP changes.

A potentially more fruitful approach forward would be to use detailed inflation series, to account for differences in expenditure shares across countries. Similar research efforts could also prove useful for a more reliable picture of past trends in living standards and poverty. The upcoming results of ICP 2011, which uses methods that are comparable to ICP 2005, should provide an excellent opportunity to undertake such an analysis.

References

Balassa, Bela, "The Purchasing Power Parity Doctrine: A Reappraisal," *Journal of Political Economy*, 72, 584–96, 1964.

Balk, Bert, *Price and Quantity Index Numbers: Models for Measuring Aggregate Change and Difference*, Cambridge University Press, Cambridge, UK, 2008.

Caves, Douglas, Laurits R. Christensen, and W. Erwin Diewert, "Multilateral Comparisons of Output, Input, and Productivity using Superlative Index Numbers," *Economic Journal*, 92, 73–86, 1982.

Chen, Shaohua and Martin Ravallion, "The Developing World Is Poorer Than We Thought, but No Less Successful in the Fight Against Poverty," *Quarterly Journal of Economics*, 125(4), 1577–625, 2010.

Dalgaard, Esben and Henrik Sørensen, "Consistency between PPP Benchmarks and National Price and Volume Indices," Paper presented at the 27th General Conference of the International Association for Research on Income and Wealth, Sweden, 2002.

Deaton, Angus, "Price Indexes, Inequality, and the Measurement of World Poverty," *American Economic Review*, 100(1), 5–34, 2010.

———, "Consumer Price Indexes, Purchasing Power Parity Exchange Rates, and Updating," Paper presented at the Penn World Table Workshop, May 2012.

Deaton, Angus and Alan Heston, "Understanding PPPs and PPP-Based National Accounts," *American Economic Journal: Macroeconomics*, 2(4), 1–35, 2010.

Eurostat–OECD, *Methodological Manual on Purchasing Power Parities*, OECD, Paris, 2006.

Hill, Robert J., "Constructing Price Indexes across Space and Time: The Case of the European Union," *American Economic Review*, 94(5), 1379–410, 2004.

Inklaar, Robert and Marcel P. Timmer, "A Note on Extrapolating PPPs," in World Bank (ed.), *Measuring the Real Size of the World Economy*, Annex D to Chapter 18, World Bank, Washington DC, 2013.

Krijnse Locker, H. and H. D. Faerber, "Space and Time Comparisons of Purchasing Power Parities and Real Values," *Review of Income and Wealth*, 30(2), 53–83, 1984.

McCarthy, Paul, "Extrapolating PPPs and Comparing ICP Benchmark Results," in World Bank (ed.), *Measuring the Real Size of the World Economy*, Chapter 18, World Bank, Washington DC, 2013.

Rao, D. S. Prasada, Alicia Rambaldi, and Howard Doran, "Extrapolation of Purchasing Power Parities using Multiple Benchmarks and Auxiliary Information: A New Approach," *Review of Income and Wealth*, 56(1), S59–98, 2010.

Ravallion, Martin, "Price Levels and Economic Growth: Making Sense of Revisions to Data on Real Incomes," *Review of Income and Wealth*, doi: 10.1111/j.1475-4991.2012.00510.x, 2013.

Samuelson, Paul, "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, 46, 145–54, 1964.

———, "Facets of Balassa-Samuelson Thirty Years Later," *Review of International Economics*, 2(3), 201–26, 1994.

Summers, Robert and Alan Heston, "The Penn World Table (Mark 5): An Extended Set of International Comparisons, 1950–1988," *Quarterly Journal of Economics*, 106, 327–68, 1991.
———, "What Can Be Learned from Successive ICP Benchmark Estimates?" in Adam Szirmai and Dirk Pilat (eds), *Explaining Economic Growth; Essays in Honour of Angus Maddison*, North Holland, Amsterdam, 1993.
West, Kenneth D., "Forecast Evaluation," in Graham Elliot, Clive W. J. Granger, and Allan Timmermann (eds), *Handbook of Economic Forecasting, Volume 1*, 99–134, 2006.
World Bank, *Global Purchasing Power Parities and Real Expenditures. 2005 International Comparison Program*, World Bank, Washington DC, 2008a.
———, *Comparison of New 2005 PPPs with Previous Estimates* (revised Appendix G to World Bank 2008a), World Bank, Washington DC, 2008b.