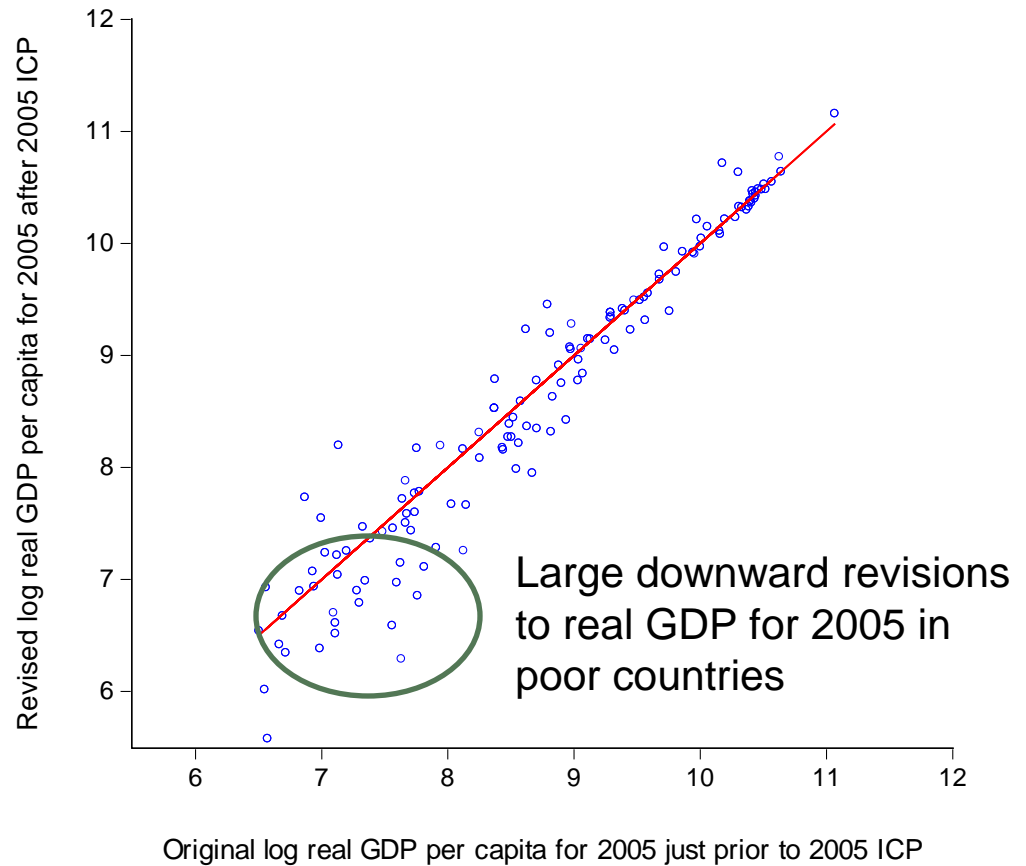# *Price Levels and Economic Growth:*
Making Sense of the Revisions to PPPs

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Dramatic revisions implied by 2005 ICP

- Comparing estimates of real GDP (at PPP) for 2005 from WDI 2007 (just prior to release of 2005 ICP results) to the estimates for same year based on 2005 ICP.

- Asia-Pacific region stands out: real GDP revised downwards by 30%

Large downward revisions to real GDP for 2005 in poor countries

Original log real GDP per capita for 2005 just prior to 2005 ICP

Revised log real GDP per capita for 2005 after 2005 ICP

Methodological changes between ICP rounds cast doubt on their comparability

- Users often avoid mixing PPPs between ICP rounds.

- National price data override the ICP data for inter-temporal comparisons.

- PPP conversion is typically done at the ICP benchmark year.

- Theoretical arguments for and against this practice.

  - Nuxoll (1994): the real growth rates using local deflators better reflect the trade-offs facing decision makers at the country level, and thus have a firmer foundation in the economic theory of index numbers.

  - However, the economic aggregates may lose purchasing power comparability back in time from the ICP benchmark year.

  - Johnson et al. (2009): comparisons should <u>only</u> be made between ICP rounds, since only then can one be sure that the economic aggregates are consistently evaluated at purchasing power parity.

Can we make sense of the changes in PPPs between ICP rounds?

The Balassa-Samuelson model

- Competitive market economy in which all factors are fully employed and are freely mobile between the traded and non-traded-goods sectors.

- Relative price of traded goods = the labor productivity differential between traded and non-traded goods.

- Assume that the more developed the country the higher its labor productivity in traded goods, but that productivity for non-traded goods does not vary.

- A higher marginal product of labor in traded goods production comes with a higher wage rate, which is also binding on the non-traded goods sector (given that labor is freely mobile), implying a higher price of non-traded goods in more developed countries and thus a higher overall price level.

=> Penn effect

- Price level index (P): PPP for GDP divided by the nominal exchange rate (US=100%);

  inverse = "real exchange rate".

- Under the Balassa-Samuelson model, P will be an increasing function of income.

Slope=0.2

Log price level index (US=0)

Log GDP per capita at official exchange rates
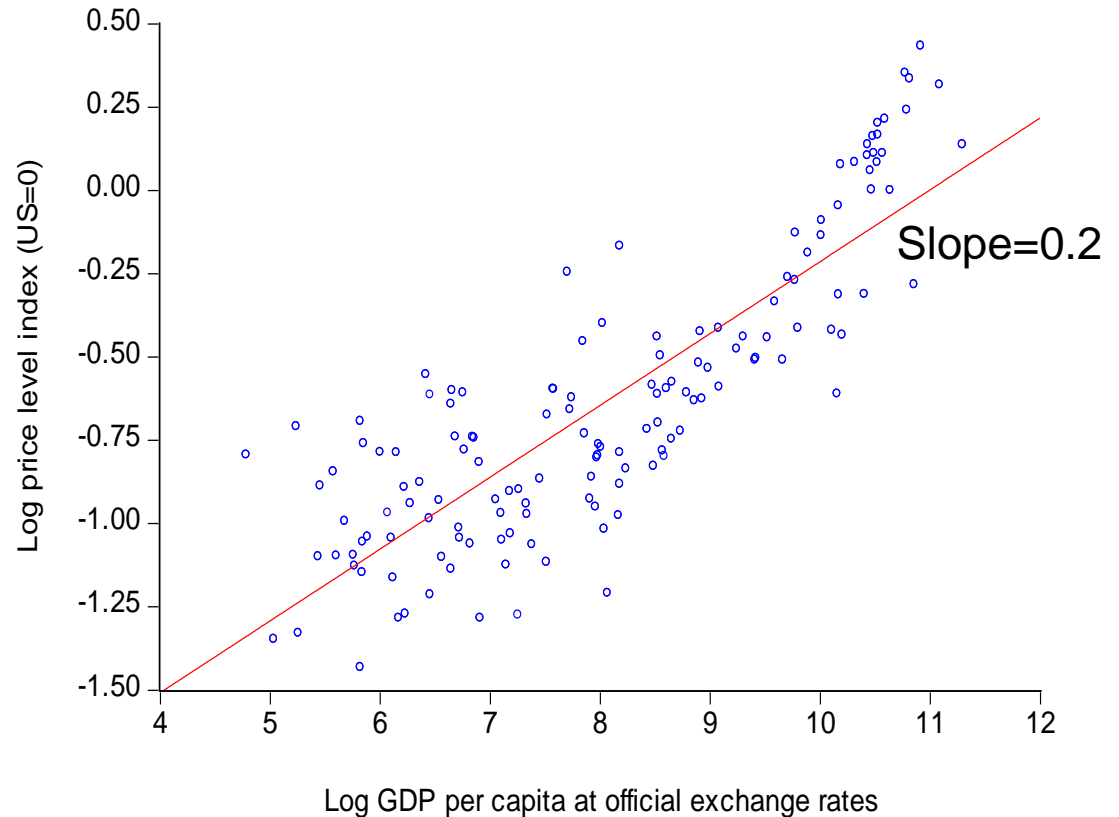
The Dynamic Penn Effect

- For the same reason that one uses PPPs rather than exchange rates for <u>international</u> comparisons, it can be hypothesized that the PPP will tend to rise relative to the market exchange rate in a growing economy.

- In the Balassa-Samuelson model this happens if economic growth comes with higher labor productivity in the traded-goods sector (relative to non-traded goods).

- This can be thought of as a <u>dynamic Penn effect</u> (DPE).

But will we necessarily see DPE?

- Whether one would see the DPE in a growing developing country is a moot point.

- It can be argued that such economies are characterized by factor-market imperfections and surplus labor, dulling the Balassa-Samuelson mechanism.

- One can also expect that there will be measurement errors confounding the PPP comparisons.

Modeling changes in PPPs

- Let PPP_{ri} denote the PPP rate for country i in year r using ICP round r and let E_{ri} be the corresponding market exchange rate.

- By definition, the price level index is $P_{ri} \equiv PPP_{ri} / E_{ri}$ (which is of course a relative price, interpretable as the inverse real exchange rate).

- Also let Y_{ri} denote GDP per capita in \$US at the market exchange rate, while Y_{ri}^{PPP} is GDP per capita at PPP.

- Thus $Y_{ri} = GDP_{ri} / E_{ri}$ where GDP_{ri} is GDP in local currency units and $Y_{ri}^{PPP} = GDP_{ri} / PPP_{ri}$.

- The basic empirical model for changes in the price level index is as follows:

$$\ln(P_{05i} / P_{93i}) = \alpha + \beta \ln(Y_{05i} / Y_{93i}) + \varepsilon_i \qquad (1)$$

Comments

1. Equation (1) can be interpreted as the time-differenced version of the widely used double-log model for static PE, incorporating a year effect but common slope (though this will be relaxed later).
2. Unlike the cross-sectional specification, the parameter estimates in (1) will be robust to any (time-invariant additive) country effectss that jointly influence the level of prices and GDP.
3. If $\beta > 0$ then there is evidence of a DPE.
4. If $\alpha > 0$ (<0) then the 2005 ICP schedule of price levels is higher (lower) than that for 1993 at given GDP per capita.
5. Equation (1) can be written equivalently in terms of GDP at PPP:

$$\ln(P_{05i} / P_{93i}) = \left(\frac{\alpha}{1-\beta} \right) + \left(\frac{\beta}{1-\beta} \right) \ln(Y_{05i}^{PPP} / Y_{93i}^{PPP}) + \frac{\varepsilon_i}{1-\beta}$$

Augmented specifications 1

1. Testing homogeneity: H$_o$: $\gamma = 1$

$$\ln(PPP_{05i} / PPP_{93i}) = \alpha + \beta \ln(Y_{05i} / Y_{93i}) + \gamma \ln(E_{05i} / E_{93i}) + \varepsilon_i$$

2. Allowing DPE parameter to vary with initial GDP. I expect a negative interaction effect, on the grounds that it is the initially poorer countries where higher growth should come with the type of structural change that would put upward pressure on the price level index.

3. Testing whether the relationship is any different for cases in which the 1993 PPP was derived from actual price surveys—in which case we refer to the country as a 1993 "benchmark country" (following common practice).

Augmented specifications 2

4. Testing a nested model encompassing the above specification and the inflation-adjustment method used by the *World Development Indicators* to update PPPs over time between ICP rounds.

- By this method, the extrapolated PPP for date *t* (>1993), using the 1993 ICP as the benchmark, is given by:

$$P\hat{P}P_{ti} \equiv PPP_{93i} \frac{DEF_{ti} / DEF_{93i}}{DEF_{tUS} / DEF_{93US}}$$

  where DEF_{ti} is the GDP deflator for country *i* at date *t* (where *i=US* denotes the US deflator).

- The encompassing test entails adding a term in $\ln(DEF_{05i} / DEF_{93i})$. If one cannot reject the joint null that the coefficient on this extra variable is unity, while $\beta = \gamma = 0$, then the inflation-adjustment method is supported.

Results

Rising price levels in poor countries

- Price level rose for 74% of countries.

- Rose by 10 percentage points or more in half the countries.

- Bulk of increase was for countries with initially low price levels.

- CDFs are virtually indistinguishable for price levels above 60%.

- Larger upward revisions in poorer countries
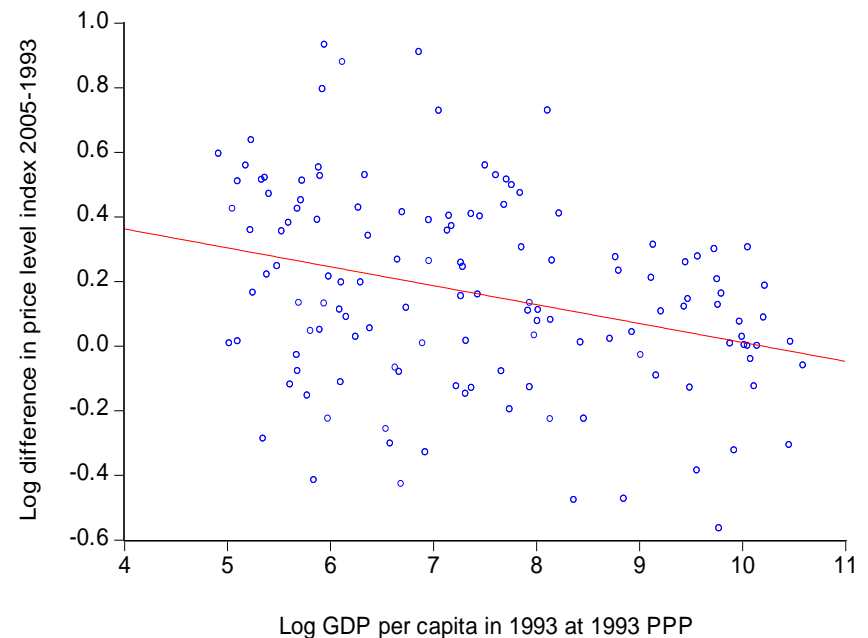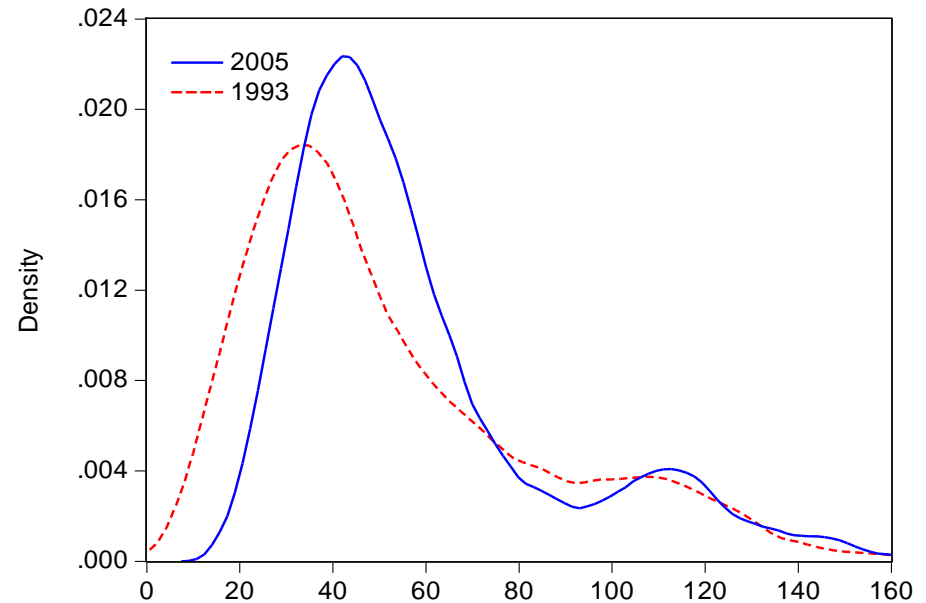
Homogeneity passes

- The estimate of the unrestricted model is (with White standard errors in parentheses):

$$\ln(PPP_{05i}/PPP_{93i}) = \underset{(0.044)}{-0.029} + \underset{(0.053)}{0.290}\ln(Y_{05i}/Y_{93i}) + \underset{(0.014)}{1.011}(E_{05i}/E_{93i}) + \hat{\varepsilon}_i$$

$$R^2 = 0.987; n = 125$$

- The restriction clearly performs well.
- Given that this is a regression for changes rather than levels, it is also notable that almost 99% of the variance is accounted for.

Dynamic Penn Effect is evident

- On imposing $\gamma = 1$, the regression coefficient of $\ln(P_{05i}/P_{93i})$ on $\ln(Y_{05i}/Y_{93i})$ is $\hat{\beta} = 0.283$ (s.e.=0.054; n=132) with $\hat{\alpha} = -0.019$ (s.e.=0.043) and R^2=0.212.

- Close to the static Penn effect, suggesting that latent country characteristics are not an important source of bias in past tests.

Slope=0.3

Difference in log price level index

Difference in log GDP per capita 2005-1993
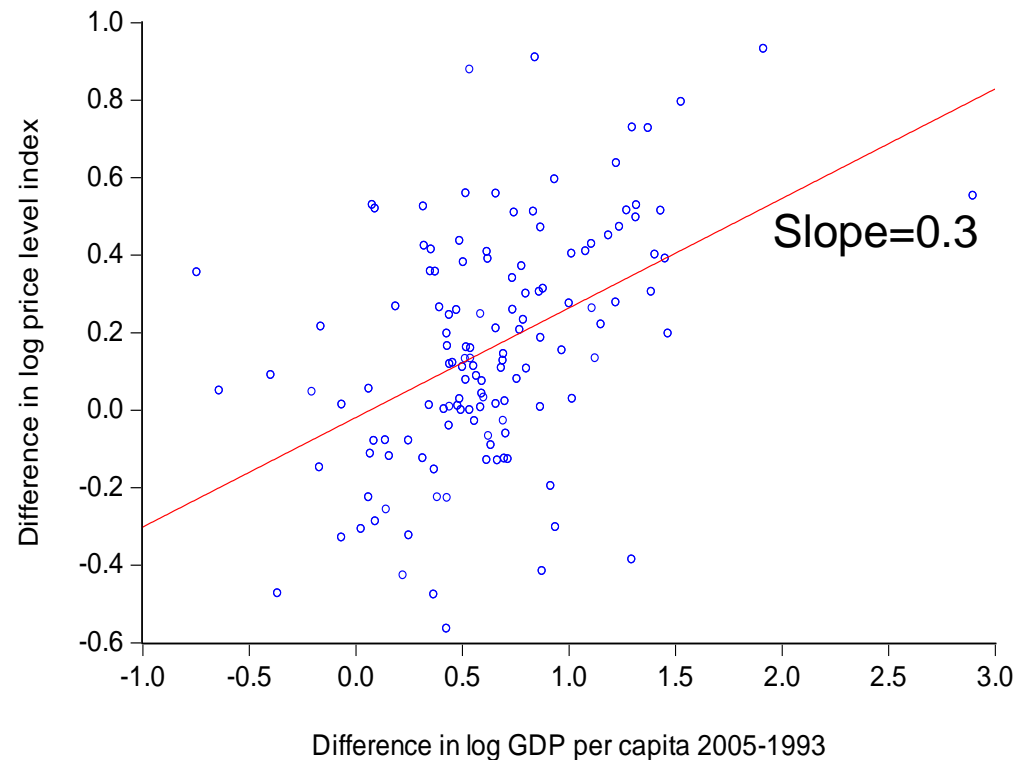
Further tests for DPE

- The DPE is stronger in poorer countries:

$$\ln(P_{05i}/P_{93i}) = \underset{(0.046)}{0.008} + (\underset{(0.143)}{0.604} - \underset{(0.020)}{0.049}\ln Y_{93i})\ln(Y_{05i}/Y_{93i}) + \hat{\varepsilon}_i \quad R^2 = 0.246; n = 132$$

- Not simply a difference between OECD and non-OECD countries. Indeed, the elasticity of the price level to economic growth is higher for the OECD sub-sample; the regression coefficient of $\ln(P_{05i}/P_{93i})$ on $\ln(Y_{05i}/Y_{93i})$ is 0.511 for the OECD countries (s.e.=0.083; R^2=0.661; n=24) while it is 0.272 (s.e.=0.055 (R^2=0.200; n=108) for non-OECD countries.

- Not simply an "Asia-Pacific effect." The DPE is still evident if one adds a control for those countries for those countries for which the 2005 ICP was implemented by the Asian Development Bank.

Stronger DPE for benchmark countries

- Only when the growth rate exceeds 3.7% do we find upward pressure on the price level.

- Amongst the 1993 ICP participants one finds that the 2005 price levels are actually <u>lower</u> at given GDP per capita than those of 1993.

- These results suggest that it is economic growth in developing countries that explains the upward shift in price levels implied by the 2005 ICP, rather than statistical factors such as the stricter quality standards in the 2005 ICP's price surveys.

- The statistical-comparability problem appears to stem largely from the subset of 2005 ICP countries that had not participated in the 1993 ICP round.

Why is Penn effect weaker for non-benchmark countries?

- Still true if one employs <u>all</u> the variables originally used to predict the 1993 PPP for the non-benchmark countries.

- Nor does it reflect non-linearities in the Penn effect, given that the non-benchmark countries tended to be poorer.

- Selection: Possibly non-participants lacked the public-institutional capacity for implementing the ICP's surveys.

- Weak statistical capacity is probably correlated with weak institutions more generally, including weak states.

- If institutional capacity is cooperant with labor in the production of traded goods—such that the marginal product of that labor is lower when institutions are weaker—then non-participation could signify a weaker relationship between GDP and the relative productivity of labor in the traded-goods sector, and (hence) a weaker Penn effect.

China's controversial PPP revisited

- New PPP for China implies that the country's GDP per capita at PPP for 2005 is 40% lower than we thought; $4,091 rather than the prior estimate for 2005 of $6,760.

- Just before the release of the 2005 ICP's results, China's price level index for 2005 was deemed to be 25%, up from 19% in 1993. The price surveys from the 2005 ICP implied a price index of 42%.

- Some observers have questioned whether China's new PPP is credible.
    - Bhalla (2008) argues that, when combined with the official growth rates, the new PPP implies that China was too poor to be believed in (say) 1950; in Bhalla's words, the World Bank's numbers imply that "most Asians (were) dead in 1950."
    - Maddison and Wu (2008) and Deaton and Heston (2010) raise similar objections, leading Maddison and Wu to claim that the new PPP for China is "weird" and "implausible."

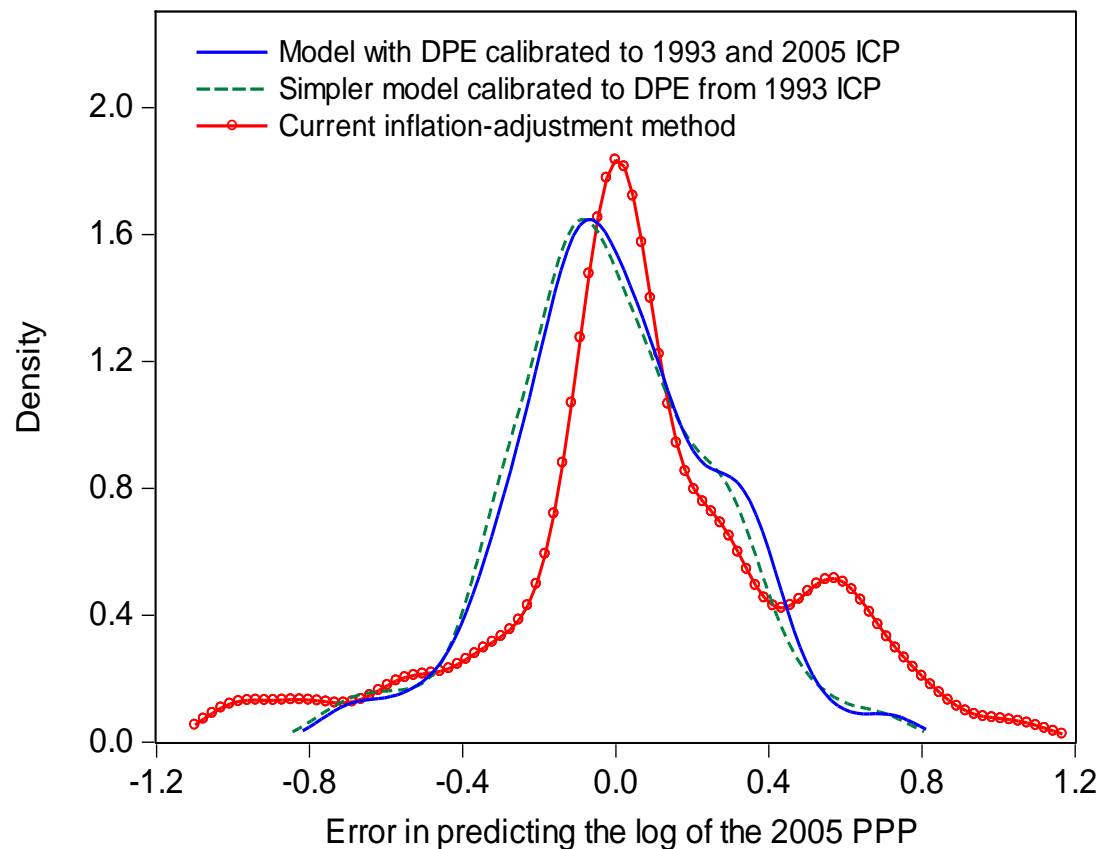# The bulk of the revision to China's PPP is accountable to the DPE

- The model can account for 65-70% of the change in China's price level between 1993 and 2005.

- This assessment is affected little by allowing for over-estimation of China's growth rate.

- The rest of the change in China's price level could well stem from the sampling bias in the 2005 ICP's price surveys for China.

- China's new PPP is <u>not</u> as "weird" or "implausible" as some observers have claimed, given China's high growth rate.

- **The mystery is not why China's PPP rose so much but why this was not already factored into the data.**

Implications for estimating PPPs for non-benchmark years

- The most widely-used method for extrapolating and updating PPPs relies solely on the inflation rate in the country in question, relative to the US.

- While the inflation rate is a strong predictor of the proportionate changes in PPPs, in a nested test, the inflation-adjustment method is clearly outperformed by a model incorporating the DPE.

- One cannot reject the null hypothesis that the inflation rate has no effect, once one controls for the DPE and the change in market exchange rates.

Allowing for the DPE greatly improves PPP predictions

The density function of the errors implied by the 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.

Legend:
— Model with DPE calibrated to 1993 and 2005 ICP
--- Simpler model calibrated to DPE from 1993 ICP
—○— Current inflation-adjustment method

Error in predicting the log of the 2005 PPP

Conclusions

The Dynamic Penn Effect is crucial to making sense of PPP changes

- The paper reports new evidence consistent with the existence of a Balassa-Samuelson effect over time such that the PPP rises relative to the exchange rate in a growing economy.

- There are signs that this only starts to happen with a sufficiently high growth rate.

- The paper finds that this "dynamic Penn effect" is even stronger in initially poorer countries.

- Thus the widely-observed static Penn effect (whereby the price level index is lower in poorer countries) has been attenuated over time.

Though comparability concerns remain

- This degree of explanatory power certainly does not eliminate concerns about the comparability of PPPs between ICP rounds.

- The dynamic Penn effect alone still leaves almost 80% of the variance in the proportionate changes in the price level index between 1993 and 2005 unexplained, although this drops to 60% or less once one allows for the measurement errors associated with the need to estimate PPPs econometrically for the countries that did not participate in the 1993 ICP.

- However, the results of this paper do cast doubt on the extreme view of "PPP non-comparability" in which past ICP rounds are essentially ignored at each update.

We could do much better in predicting PPPs between ICP rounds…

- The DPE should be brought explicitly into the inter-temporal extrapolations for the price-level index, using market exchange rates to back out the implied PPPs for non-benchmark years.

- This method yields more reliable estimates than the widely-used inflation-adjustment method for updating PPPs between ICP rounds.

- Neglected insights from the original Balassa-Samuelson model— ironically, the same model that had helped motivate the considerable international statistical effort since the 1960s to collect price data for measuring PPPs—help us better understand how price levels evolve over time in developing countries.

…avoiding some dramatic data revisions