ESTIMATING PURCHASING POWER PARITIES FROM HOUSEHOLD EXPENDITURE DATA USING COMPLETE DEMAND SYSTEMS WITH APPLICATION TO LIVING STANDARDS COMPARISON: INDIA AND VIETNAM

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This study departs from the previous literature on purchasing power parity (PPP) by proposing a demand system based methodology for calculating the PPP that takes account of consumer preferences and allows for the substitution effect of price changes. The methodology is used to calculate the PPP between the Indian Rupee and the Vietnamese Dong. The study allows for regional variation in preferences and price changes both inside the country and between countries. It proposes and applies a methodology for constructing prices from unit values after adjusting them for quality and demographic effects. The adjusted unit values are used as prices in the demand estimations, and the demand parameter estimates are used to calculate both spatial prices within each country and the PPP between the two countries within a consistent framework. The study illustrates the usefulness of preference consistent methods to calculate the PPP by applying the PPPs to compare living standards between India and Vietnam. The significance of the results follows from the fact that the levels of living comparisons are quite sensitive to the PPP used in converting the Rupee expenditure into Vietnamese Dong. The present results on food PPPs question the relevance of the PPPs from the ICP project in cross-country welfare comparisons especially in a period of high food inflation.

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1. INTRODUCTION

Conversion rates of one currency into another are required for a variety of reasons such as international comparison of living standards, ranking of countries by their per capita GDP, and in cross-country inequality and poverty comparisons.[1] Market exchange rates are inappropriate for such comparisons because they are based on tradable items only. The purchasing power parity (PPP) provides the

[1]Examples include Chotikapanich *et al*. (1997), Milanovic (2002), and Ravallion *et al*. (1991).

adjustments required to market exchange rates such that the price of an item in two countries is identical if expressed in a common currency. The PPP rates are based on a much wider selection of items than market exchange rates including both tradable and non-tradable items. Asian countries such as China and India rank much higher on per capita GDP if PPP rates are used instead of market exchange rates. The United Nations International Comparison Project (ICP) carries out detailed price comparisons across countries to arrive at the PPP values required for a variety of cross-country comparisons such as the ones mentioned above.[2] Given the crucial role that PPPs play in international comparisons, there has been considerable controversy on the PPP values that should be used as deflators.[3] While Clements *et al.* (2006) provide a method of comparison of consumption patterns between countries that is free of currency units, the requirement of PPP is, in general, unavoidable in most cross-country comparisons. Recent examples of international comparisons of real income or real expenditure include Hill (2004), Neary (2004), and Feenstra *et al.* (2009). Oulton (2012a) sets out a preference based algorithm for comparing living standards across countries.

PPP rates are also required in intra-national comparisons since a country's currency unit does not have the same purchasing power in all regions in that country. The issue of intra-national PPP takes the form of spatial prices. The role that PPPs perform in converting an internationally denominated poverty line, for example, US$1 a day, into that of different countries expressed in their own currencies is analogous to the role that spatial prices play inside a country in converting the national poverty line into regional poverty lines, taking into account regional prices and preferences. While considerable resources have been spent by the statistical agencies on calculating PPP rates between countries, as is evident from the scale of the ICP project, the issue of intra-national PPPs has received much less attention. In large heterogeneous countries such as Brazil and India, the requirement of intra-national PPP rates, i.e. spatial prices, is as important as that of the international PPP rates in the cross-country context. This is evident from the recent attempts of Aten and Menezes (2002) on Brazil, and Coondoo *et al.* (2004, 2011) and Majumder *et al.* (2012) on India to calculate spatial prices. The evidence in these studies shows that cross-country PPP rates at the aggregate level that do not take into account the regional diversity in countries such as Brazil and India are likely to be seriously misleading. Setting aside the issue of regional diversity, the idea of a distribution invariant PPP that is supposed to hold for all the expenditure classes, rich and poor alike, is another important issue of interest. This is an assumption that has been criticized in the poverty context by Reddy and Pogge (2007). If untrue, as the present results suggest, this is yet another indictment of the all-purpose, single value, country-wide PPPs that come out of high profile projects such as the ICP.

In view of its importance, the methodologies adopted to calculate the PPP have received considerable critical scrutiny. For example, Hill (2000) and Almas (2012) analyses and quantify the PPP bias in the widely used Penn World Table

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[2]See World Bank (2008).
[3]See, for example, Reddy and Pogge's (2007) critique of the World Bank methodology for fixing national poverty lines denominated in local currencies in cross-country poverty comparisons.

incomes of various countries. One of the most prominent methods adopted in the PPP calculations has been the Country Product Dummy (CPD) method, due to Summers (1973), that is based on the idea of hedonic price regressions, and was originally proposed to deal with the problem of missing observations in international price comparisons. The CPD method has been analyzed and extended by Diewert (2005) and Rao (2005). Coondoo *et al.* (2004) extend the CPD methodology by using it in conjunction with the idea of a "quality or price equation," due to Prais and Houthakker (1971), to calculate spatial prices in the Indian context. The methodology proposed by Coondoo *et al.* (2004) has been used in modified form in the cross-country context by Deaton *et al.* (2004) to calculate PPP rates between India and Indonesia. The latter study is not based on any preference consistent "complete" demand system. In contrast, Oulton (2012a) takes an expenditure function based approach, but does not consider the spatial dimension within each country in the cross-country expenditure comparisons.

A key limitation of the CPD approach is that it does not take into account the preferences of the consumer as revealed by her estimated demand pattern. Notwithstanding the fact that the PPP is analogous to the concept of a True Cost of Living Index (TCLI), and the increasing availability of household survey data that provides the necessary information for a preference consistent, demand systems based approach to PPP calculations, such an approach is conspicuous by its absence. Recent studies that come closest to this spirit are O'Donnell and Rao (2007) who estimate demand systems to calculate PPP between Ethiopia and Uganda, and Coondoo *et al.* (2011) who use Engel curve analysis to estimate spatial prices in India. While O'Donnell and Rao's (2007) study on PPP rates between Uganda and Ethiopia is based on estimated demand parameters, treating each country as a homogeneous entity, and does not concern itself with the spatial dimension inside each country, Coondoo *et al.*'s (2011) study is entirely on spatial prices in India but is restricted to Engel curve analysis that ignores price induced substitution effect between commodities. Majumder *et al.* (2012) propose a demand system based approach to the calculation of spatial prices in India. The present study extends this exercise to the cross-country context of India and Vietnam and to include welfare comparison between the two countries. This paper reports that in a period of high food inflation, not only are the preference consistent food PPPs quite different from those from the ICP project, and those reported elsewhere, but the estimate of relative welfare based on the alternative PPPs varies sharply as well.

The principal motivation of this study is to propose a preference consistent and unified framework for the estimation of PPPs within and between countries. The paper proposes a three-step methodology. In step 1, the study estimates prices from household level unit values after adjusting for quality, demographic, and regional effects. In step 2, the quality adjusted unit values are used to estimate preference parameters from a "complete" demand system. In step 3, the estimated demand parameters are used to calculate spatial prices within a country, and PPP between countries, using the "exact" approach of a "true cost of living index" (TCLI). The usefulness of this three-step methodology is illustrated by applying it to estimate PPPs both within and between India and Vietnam using a recent demand system. The paper contains a systematic comparison of the expenditure

function based PPPs in the spirit of the "exact price indices" with those from using the CPD procedure and the Divisia price indices.

The usefulness of the proposed methodology is illustrated by using the spatial prices and the cross-country PPPs to compare levels of living between India and Vietnam based on food expenditures. The exercise follows the methodology proposed in Oulton (2012a) for calculating prices as true cost of living indices. The comparison of living standards between India and Vietnam extends the cross-country expenditure comparisons in Feenstra *et al.* (2009) and Oulton (2012b) by using PPPs that vary across expenditure percentiles and a welfare measure that, following Sen (1976), is sensitive to inequality changes. The paper reports the sensitivity of the welfare comparisons to the PPPs used, namely, between the welfare rankings obtained using the "demand system" based methodology on food expenditures proposed here with those using PPPs that are currently available. The results underline the policy significance of our results by pointing to a picture of high sensitivity of the welfare comparisons to the PPPs used during a period that overlaps partly with the recent global financial crisis.

In view of the absence of studies that estimate inter-country PPPs using a preference consistent framework, this study fills a significant gap in the literature. In the spirit of combining the spatial dimension in each country with the cross-country aspect, the study calculates the PPP rates between the two countries both in aggregate and separately for the rural and the urban areas, and provides evidence on their movement over time. A significant contribution of this study is that it tests for invariance of inter-country PPP across expenditure classes and hence departs from the practice of assuming that the PPPs between countries is the same for all households irrespective of their affluence, an assumption that has been criticized in the poverty context by Reddy and Pogge (2007), as mentioned earlier. To the best of our knowledge, this assumption has not been tested before. Another key distinguishing feature of this study is that it concentrates on food based PPPs and departs from the practice in the ICP and other studies of considering all items, both food and non-food, in the PPP calculations. Consistent with the point made by Reddy and Pogge (2007), PPPs based on food items alone are more relevant in welfare comparisons such as poverty calculations that require price indices that are more relevant for the poor. While the PPPs from the ICP are an improvement from the market exchange rates by considering a wider basket of goods, namely, tradable and non-tradable items, they go overboard by including a host of items which hardly figure in the consumption basket of the ultra-poor. This is a serious limitation of the ICP PPPs, given that one of the main uses of PPPs is to convert poverty lines denominated in US dollars into that in local currencies. As we report later in the levels of living comparisons, the results from using the ICP PPPs are quite different from those using the distribution sensitive and preference consistent PPPs obtained in this study. Moreover, the present results provide significant evidence of rural urban heterogeneity in the PPPs and in the welfare comparisons between India and Vietnam.

Perhaps for the first time, the present study estimates the PPP exchange rates between two countries (India and Vietnam), taking account of their regional heterogeneity in preferences and prices. The heterogeneity in preferences between (and within) India and Vietnam is explicitly taken into account by estimating the

rank three Quadratic Almost Ideal Demand System (QAIDS), due to Banks *et al.* (1997), separately for (i) India and Vietnam, (ii) in each country, separately for its rural and urban areas, and (iii) within each sector, separately for each of the constituent states and regions in India and Vietnam, respectively. QAIDS is estimated in its true, non-linear form rather than its linear approximate version, LQAIDS, that has been used in several recent applications (see, for example, O'Donnell and Rao, 2007).

Other distinguishing features of this study include the modification of the procedure due to Cox and Wohlgenant (1986) and Hoang (2009) to generate the quality adjusted prices of food items based on unit values from the household surveys that are subsequently used in the demand estimation, and the incorporation of demographic effects in the estimated quality equations.[4] The methodological contribution of this study has wider application than the immediate PPP context of this study since the quality adjusted food prices, obtained from the hedonic price regressions using the unit values from the household surveys, will help in constructing food poverty lines in both countries that can validate, or otherwise, the poverty lines currently in use.

The rest of the paper is organized as follows. Section 2, which presents the framework and describes the methodology, is subdivided into three subsections. Section 2.1 introduces the estimating equations, and describes the procedure for calculating the intra-country and the cross-country PPP rates. Section 2.2 describes the procedure for constructing prices, required in the demand estimation and the PPP calculations, from the unit values contained in the Household Expenditure Surveys. Section 2.3 describes the procedure for comparing the levels of living between India and Vietnam using the spatial prices/PPPs obtained earlier. The datasets are briefly described in Section 3, along with the presentation and discussion of the estimates of the quality adjusted prices of the principal food items in each country. The results on the intra-country PPP rates (i.e., spatial prices in each country) and the PPP rates between the two countries, along with the levels of living comparisons between India and Vietnam, have been presented and discussed in Section 4. Section 5 concludes the paper.

2. Framework and Methodology

2.1. *Procedures for Estimating the PPPs*

The methodology views the PPP as a True Cost of Living Index as follows:

$$(1) \qquad \text{PPP}(A, B) = \frac{C^A(u^r, p^A)}{C^B(u^r, p^B)}$$

where u^r denotes reference utility, C^A, C^B denote the expenditure function of the comparison country/region, A, and the base country/region, B, respectively, and p^A, p^B denote the corresponding vector of prices in the two countries/regions.

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[4]See McKelvey (2011) for recent Indonesian evidence on the ability of unit values and market prices to act as satisfactory proxies of one another.

Equation (1) gives us spatial prices when A, B refer to regions inside a country, and PPP when A, B refer to different countries.

The TCLI based approach of estimating PPPs adopted in this study has the following principal advantage over that adopted in the World Bank's ICP exercise. In using a reference utility, rather than a reference commodity bundle, to calculate the PPPs, the present approach sidesteps comparability issues on definition of items or commodities that arise in international comparisons based on reference commodity bundles. The same commodity may have different meanings in different countries. In some cases, an item in one country may not even exist in another. This posed non-trivial problems in the ICP. As noted in Oulton (2012a, p. 449), for example, this resulted in several of the 106 items included under "Basic Headings" in the 2005 ICP to record zero expenditure in some countries and had to be excluded from the common reference basket. In contrast, the mapping from the commodity space to the utility space in the cross-country comparisons, implicit in the use of the TCLI approach, implies that one can consider all the principal items of consumption in one country without having to worry about whether they are consumed or have identical meaning in another. This is not to claim however that comparability issues do not arise in the present context as well, but to note that in working with broad aggregates or composite items such as Cereals and Cereal Substitutes, that have roughly similar meaning in the two countries, the present study minimizes the distortions and problems caused by working with a finer classification of items, and avoids the problem of inconsistent item definitions and zero expenditures noted above. Consequently, the present approach does not require information on prices for a finer classification of items, nor does the present study calculate PPPs for each item, unlike in our earlier study on spatial prices within India (Majumder *et al*., 2012). The disadvantage of the present approach, however, is that it requires estimation of "complete demand systems" which sets a severe constraint on the number of items that can be considered, since the complexities of demand estimation multiply with the number of items included in the demand estimation. Another disadvantage that follows from this is that the assumption of additive separability between the constituent items within a group is unlikely to hold, and is a price we need to pay to keep the demand estimation manageable. Incidentally, we should note that the use of two Asian countries in the present study that have similar, though not identical, food consumption patterns helps to minimize the comparability issues that arise in international comparisons. The issue of consistency in the definition of items is much less severe within a country and does not affect the calculation of spatial prices as in Majumder *et al*. (2012). Hence, while the TCLI approach has been widely used in the intra-country context, this is one of the first studies to extend that to the cross-country context. The contribution of this study is to show that if one works with broad item groupings that have roughly similar meaning in the countries being compared, the rich information contained in the unit values available in the Household Expenditure Surveys can be used to calculate PPPs both within and between countries using a consistent methodology.

Though both spatial prices and cross-country PPPs are estimated as TCLIs in this study, it is important to draw a conceptual distinction between the spatial

prices/PPPs, which involve cross-sectional price comparisons, and the TCLI, which measures temporal price movements. The former, unlike the TCLIs, capture not only the price differences but also other differences such as changes in demographic characteristics and in tastes. The spatial prices/PPPs should not, therefore, be viewed strictly as TCLIs. Hence, while the TCLIs can be estimated on time series data pooled over different time periods, we cannot estimate the spatial prices/PPPs by pooling data over different regions or over different countries. Moreover, one cannot pool the Indian and Vietnamese expenditure datasets since that will require economically relevant exchange rates between the two currencies which are not available. The calculation of such exchange rates is, indeed, one of the principal motivations of this study. Unless preferences are homothetic, a possibility that is rejected by the evidence presented in Oulton (2012b), the spatial prices/PPP are dependent on reference utility, u^r, and hence on reference expenditure. This provides the background to the evidence presented later on the sensitivity of the PPPs between the two countries to reference expenditure.

The general cost function underlying Quadratic Logarithmic (QL) systems (e.g., the QAIDS of Banks *et al*. (1997) and the Generalized Almost Ideal Demand System (GAIDS) of Lancaster and Ray (1998)), is of the form:

$$(2) \qquad C(u, p) = a(p) \cdot exp\left(\frac{b(p)}{(1/lnu) - \lambda(p)}\right),$$

Where p is the price vector, $a(p)$ is a homogeneous function of degree one in prices, $b(p)$ and $\lambda(p)$ are homogeneous functions of degree zero in prices, and u denotes the level of utility. The budget share functions corresponding to the cost function (2) are of the form:

$$(3) \qquad w_i = a_i(p) + b_i(p) ln\left(\frac{x}{a(p)}\right) + \frac{\lambda_i(p)}{b(p)}\left(ln\frac{x}{a(p)}\right)^2,$$

where x denotes nominal per capita expenditure and i denotes item of expenditure.

Using equation (1), the corresponding TCLI in logarithmic form comparing price situation p^A with price situation p^B is given by:

$$(4) \qquad ln P(p^A, p^B, u^r) = [ln a(p^A) - ln a(p^B)] + \left[\frac{b(p^A)}{\frac{1}{lnu^r} - \lambda(p^A)} - \frac{b(p^B)}{\frac{1}{lnu^r} - \lambda(p^B)}\right],$$

where u^r is the reference utility level. The first term of the R.H.S. of (4) is the logarithm of the basic index (measuring the cost of living index at some minimum benchmark utility level) and the second term is the logarithm of the marginal index. Note that for $p^A = \theta p^B$, $\theta > 0$, $a(p^A) = \theta a(p^B)$, so that the basic index takes a value θ and hence, may be interpreted as that component of TCLI that captures the effect of uniform or average inflation on the cost of living. On the other hand, for $p^A = \theta p^B$ the marginal index takes a value of unity. Hence, the marginal index may be interpreted as the other component of TCLI that captures the effect of changes in the relative price structure.

The specific functional forms of $a(p^r)$, $b(p^r)$ and $\lambda(p^r)$ for QAIDS in (2) are as follows:

$$ln\,a(p^r) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i^r + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i^r \ln p_j^r; \quad b(p^r) = \prod_{i=1}^{n} p_i^{r\beta_i} \quad \text{and}$$

$\lambda(p^r) = \sum_{i=1}^{n} \lambda_i \ln p_i^r$, where p_i^r is the price of item i in region r.

The resulting budget share equations are given by:

$$(5) \qquad w_i^r = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_j^r + \beta_i \log(x/a(p^r)) + \lambda_i \left[\log(x/a(p^r))\right]^2.$$

Given a reference utility level, the regional PPPs can be calculated from equation (4) using the estimated parameters and information on prices.

Based on the level (country/region/sector) of data used, estimation of demand system (equation (5)) yields the estimates of $a(p^r)$, $b(p^r)$ and $\lambda(p^r)$, where superscript r denotes country/region/sector, as the case may be. Substitution in (4) and taking the exponential yields the PPP between countries/regions/sectors, conditional on pre-specified reference utility, u^r, in each situation. A comparison among regions yields spatial prices and that between countries measures the PPP between countries. In the empirical work, we have used the utility level corresponding to median expenditure in the base country, India, as the reference utility level, u^r, to calculate the PPPs and have compared them with those at other percentile points of the expenditure distribution—see Oulton (2012b) for a full description of the 2005 ICP.

2.2. *The Procedure to Generate Quality Adjusted Unit Values as Prices (Food Items)*

The PPPs based on complete demand systems require price information for estimation of the price parameters. Such information is missing in most datasets. We use as proxies for prices[5] the unit values for food items obtained by dividing expenditure values by quantities. However, the raw unit values need to be adjusted for quality and demographic effects. To do so, we adopt the following procedure.

The unit values, v_i, are adjusted for quality and demographic factors following Cox and Wohlgenant (1986) and Hoang (2009), through the following regression equation:

$$(6) \qquad v_i^{hsjd} - (v_i^{sjd})_{median} = \alpha_i D_s + \beta_i D_j + \gamma_i \sum_j \sum_d D_j D_d + \varphi_i x^{hsjd} + \omega_i f_i^{hsjd} +$$

$$\sum_m b_i Z_{im}^{hsjd} + \varepsilon_i^{hsjd},$$

where v_i^{hsjd} is the unit value paid by household h for item i in state/province j, district d and sector s, $(v_i^{sjd})_{median}$ is the median unit value for the district in which the household resides, x is the household food expenditure per capita, f is the proportion of times meals are consumed outside the home by that household, and D_s, D_j and D_d are dummies for sector, state/province, and district, respectively.

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[5]See Atella *et al.* (2004) for an alternative methodology for constructing spatial prices in cross sections using the variability of budget shares that do not require quantity information.

While Hoang (2009) estimates equation (6) using *mean* (in place of *median* being used here) unit prices and then adds the predicted residual $\left(\widehat{\varepsilon}_i\right)$ to the district *mean* to get the quality adjusted price for each good, the present paper uses deviation of household level unit prices from *median* unit prices to represent quality effect. The quality adjusted unit prices are calculated by, first, estimating equation (6) which, for each commodity *i*, regresses the deviation of household's unit price from the median price in the district *d*, of state/province *j*, in each sector *s* (rural or urban), $\left(v_i^{sjd}\right)_{median}$, on household characteristics.

Next, the district-wise quality adjusted price for each item is generated by adding the district median unit value for this item to the estimated residual from equation (6):

$$(7) \qquad \left(p_i^{sjd}\right)_{median} = \left(v_i^{sjd}\right)_{median} + \left(\widehat{\varepsilon_i^{sjd}}\right)_{median}$$

The district-wise median of the prices calculated in equation (7) is used to represent the district-wise quality adjusted price for each food item *i* in state/province *j*. In other words, each household is assumed to face the vector of quality adjusted median value, using equations (6) and (7), of the item in the district where the household resides. The use of district level information on unit values allows us to consider price variation among districts, and hence the present empirical exercise goes beyond previous studies that rarely went beyond state level variation in prices and preferences.

2.3. *Comparing Levels of Living between Countries*

The methodology proposed by Sen (1976) for real income comparisons between countries is used here to compare the levels of living between India and Vietnam as measured by their spending on food items. Following Sen (1976), we consider, as a welfare measure, the inequality corrected mean per capita food spending in the two countries: $W_I = \mu_I(1 - G_I)$, $W_V = \mu_V(1 - G_V)$, where μ, G denote the mean per capita food expenditure (over the principal food items) and Gini food expenditure inequality, respectively. The superscripts *I*, *V* refer to India and Vietnam, respectively. The ratio, W_V/W_I, is a measure of the relative level of living in Vietnam vis-à-vis India. To calculate this ratio, we converted the Indian food expenditures (in Rupees) to Vietnamese Dong using the PPPs obtained in this study. Recognizing the dependence of the calculated PPP on the reference expenditure and spatial differences in preferences and prices, we provide below the welfare ratios calculated separately for rural and urban areas using the corresponding PPPs. Besides the rural–urban differences in the levels of living comparison, the paper also provides evidence on the sensitivity of the welfare comparisons to the PPPs used, namely, between those that allow them to vary across expenditure percentiles, and those which do not. Note that, while the Gini expenditure inequalities are unit free and consequently will be the same after conversion of the food expenditures from one currency into another, this will not be the case if the PPPs are allowed to vary with reference expenditure as is the case here. The temporal comparison of the welfare ratio allows us to incorporate the movements in PPPs over time. As we shall show later, the PPP produced by the ICP understates the

depreciation of the Dong vis-à-vis the Rupee over the period 2004–05 to 2008 and consequently overstates sharply the welfare level of the Vietnamese relative to the Indian consumer during the recent global financial crisis.

3. Data, the Quality Adjusted Unit Values, and the QAIDS Estimates

The Indian data came from the 55th (July 1999–June 2000), 61st (July 2004–June 2005), and 66th (July 2009–June 2010) rounds of India's National Sample Surveys (NSS) on consumer expenditure. All these rounds are "thick" rounds, being based on large samples. The exercise was performed over 15 major states of the Indian union, with each state subdivided into rural and urban sectors. The list of the states covered, along with the number of districts in each state, is provided in Table A1 in the Appendix. The data from the unit records (household level) were used in our analysis.

The Vietnamese data came from the VLSS in 1997/98, and the VHLSS of 2004 and 2008. The 1997/98 VLSS was the second VLSS survey conducted by the General Statistics Office (GSO) of Vietnam, with technical support from the World Bank and financial support from the United Nations Development Program (UNDP) and Swedish International Development Cooperation Agency (SIDA). The VHLSS 2004 and 2008 are parts of the Vietnam household living standard survey conducted every two years between 2002 and 2010. The VHLSS questionnaires are the same as those of the VLSS surveys except that some modules are simplified and some modules are not included. The household expenditure module used in the present analysis remains the same across the VLSS and VHLSS surveys. For the purpose of this study, the eight major regions of Vietnam are grouped into three regions for rural and urban areas separately. North Vietnam consists of Red River Delta, Northeast, and Northwest; Central Vietnam consists of North Central coast, South Central Coast, and Central highlands; and South Vietnam consists of South East and Mekong Delta. The list of the regions, along with the number of communes in each region, is presented in Table A2 in the Appendix.

The empirical exercise was conducted on the following six food items in each country:[6] Cereals & Cereal Substitutes; Pulses; Milk & Milk Products; Edible Oil; Meat, Fish, & Eggs; and Vegetables. These are well defined food items whose meaning does not change much between India and Vietnam. Also, we have household level quantity and expenditure information that goes down to district level in both the countries.

The VLSS 1997–98, VHLSS 2004, and VHLSS 2008 collect detailed consumption information on market purchase and home production and consumption during the "*tet*" holiday period for 45 food items. The information on household consumption is computed for market purchase, home production, and consumption during the *tet* holiday period. For a 12-month recall period information is collected on number of months (of the 12 months) each food item was purchased, usual frequency of purchase during those months, quantity purchased each time, and value of each purchase. These pieces of information are combined to calculate the total expenditure on each food item over the past 12 months,

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[6]These are the dominant food items that constituted nearly three-quarters of total food spending in each country.

including the consumption during the *tet* holiday period. Besides market purchase, information is also collected for consumption from home production. Separate information is collected for food consumption during the *tet* holiday period. The information on food consumption during the *tet* holiday period and non-*tet* months is combined to get the quantity and value of food consumption during the last 12 months. This information is converted into monthly consumption and expenditure for comparability with NSS data, which consists of monthly figures. The quantity of food items purchased is reported in grams, kilograms, liters, and numbers. For consistency, these quantities were converted to kilograms where possible. For food items reported in numbers such as eggs and bananas, the following conversion has been used: 1 egg (58 g), 10 bananas (1 kg), 1 orange (150 g), and 1 pineapple (1.5 kg). Lemons and ginger were not included.

Appendix Tables A3(a,b) and A4 present the mean per capita quantity and per capita expenditure (in local currencies) of the six principal food items in India and Vietnam, respectively, obtained from the NSS 61st round (India) and VHLSS 2004 (Vietnam). Notwithstanding differences in definition and in their composition, we have tried to ensure that these six food groups are as comparable as possible between the two countries. The Vietnamese consume more Cereals than the Indians, and their consumption of Meat, Eggs, & Fish is a good deal higher. In contrast, the Vietnamese consumption of Milk and Vegetables is considerably lower than that of the Indians. In both countries, Cereals & Cereal Products is, in quantity and expenditure terms, by far the single most important group of food items, with rural households consuming more than the urban ones.

The PPP rates between India and Vietnam were computed, from equation (1), using the QAIDS estimates for Vietnam and adopting the median household in the expenditure distribution of the NSS as the reference household. In other words, the PPP rates presented later in Tables 9 and 10 show the amount of expenditure in Vietnamese currency (Dong) that will yield the same utility to a Vietnamese household as an Indian Rupee spent by the median household in India. To examine the sensitivity of the PPPs to the reference expenditure, the calculations were repeated for NSS 61st round/VHLSS 2004 by using, as reference households, median values of various percentiles in the NSS 61st round expenditure distribution. The coefficient estimates of the quality adjustment regressions of the unit values, item by item (equation (6)) are presented[7] in the Appendix (Table A5 for NSS 61st round, and Table A6 for VHLSS 2004). Several of the quality and demographic effects are highly significant, though much more so in the case of India than in Vietnam. In both countries and for several items, notably for Cereals & Cereal Products, the more affluent households consume superior quality food items, as evident from the positive and significant coefficient estimate of the per capita expenditure variable on unit values. This is also true of the variable measuring the proportion of meals consumed outside the household in India since households that eat outside the home are the more affluent households. The fact that this variable is less significant in Vietnam may reflect the greater tendency to eat outside the home in Vietnam than in India.

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[7]To save space, we have reported the regressions for NSS round 61 and VHLSS 2004 only. Those for NSS 55th round, NSS 66th round and VLSS 1998, VHLSS 2008 are available on request.

The quality and demographically adjusted unit values of the six food items, mentioned above, at the median in the three NSS/VLSS/VHLSS rounds are presented in the Appendix—in Tables A7, A8, and A9 for India, and in Tables A10, A11, and A12 for Vietnam. These tables report the adjusted unit values, treated as proxies for prices, for each state/province, disaggregated by rural and urban, and at the all-country level. The Indian estimates show that over the period between the NSS 55th and 66th rounds, much of the food inflation has been on account of Edible Oil and Meat, Eggs, & Fish. The prices of Cereals & Cereal Substitutes were mostly static or, in some cases, even recorded a slight decline. The period between NSS rounds 61 and 66 saw a much greater increase in the quality adjusted unit values of all the principal food items in India than over the earlier period between NSS rounds 55 and 61. A comparison with the Vietnamese estimates of adjusted unit values presented in Appendix Tables A11 and A12 shows however that the Indian inflation in the second half of our chosen time period pales into insignificance when compared with that in Vietnam over the period 2004–08. For example, there was a doubling in the unit values of Cereals & Cereal Substitutes and a six-fold increase in that of Meat, Fish, & Eggs in Vietnam over this period, 2004–08. The sharp depreciation in the value of the Dong vis-à-vis the Rupee, that we report later, can be largely explained by the much higher food inflation in Vietnam than in India over this period. It also explains the sharp divergence between the PPPs obtained in our study and that from the ICP, since items such as Meat, Fish, & Eggs figure much more prominently in the food basket of the poor in Vietnam than in India.[8] The reader will recall that the PPPs calculated in this study are food PPPs and, unlike the ICP PPPs, they incorporate the varying food preferences and varying price induced substitution between and within the two countries.

The evidence on high food inflation in Vietnam contained in Appendix Tables A11 and A12 is consistent with unpublished reports (available at http://www .vifap.org/wp-content/uploads/2011/09/Food-Crisis_18_December_2010.pdf) on inflation in Vietnamese food prices during this period. As the authors of the report say, "Vietnam, a major agricultural exporter, did not avoid the recent sharp food price increases. Even with export restrictions on rice applied in January 2008, Vietnamese food prices increased dramatically in concert with international food prices. The food price index increased about 70 percent and cereal prices more than doubled from January 2006 to August 2008. This increase in food prices is the major factor that pushed increases in the Consumer Price Index (CPI) to levels that had not been seen since 1990. The sharp price increase generated many concerns about its impacts on different household groups, on social stability, and on food security in Vietnam."

There are two other differences between the two countries that are apparent from the tables. The rural–urban difference in the prices is generally much greater in Vietnam than in India. Also, the all-Vietnam prices are much closer to the rural figures than the urban, which is not necessarily the case in India. This suggests that Vietnam is more rural than India,[9] and this is reflected in the result reported later

[8]See, for example, Mishra and Ray (2009).
[9]Vietnam does not have the equivalent of the large cities and semi-urban metropolitan centers that India has, and consequently the "all Vietnam" figures are closer to those in "rural Vietnam" than in the case of India.

that the intra-country PPP in Vietnam and the Vietnam/India PPP is much closer to their rural counterpart than the urban.

Comparison of the item-wise prices between India and Vietnam shows wide variation in the item specific PPPs, both between items and in their movement over time. It is, therefore, not possible to draw any inference on the overall PPP between the Indian Rupee and the Vietnamese Dong, both on its magnitude and its movement between the two surveys, by simply inspecting the item specific PPPs. Moreover, the sharp variation among the item specific PPPs, and the varying importance of the items in the expenditure pattern of households, both between regions and between varying affluent levels, suggest that the PPPs will vary across different population subgroups. We now turn to the evidence on these issues.

A distinctive feature of this study is that it provides estimates of PPPs, both within country and between countries that are based on the estimated "complete demand systems." The former are presented as "spatial prices" and the latter are referred to by their conventional name, the "purchasing power parity." These take into account both the intra-country and cross-country differences in preferences. The calculation of PPP between countries taking into account the regional heterogeneity in prices and preferences within each country adds to the departure of this study from the previous literature. The paper does so through the consistent use of the QAIDS of Banks et al. (1997), specified in equation (3).

The QAIDS was estimated both at the level of individual regions, i.e., separately for each state/province (for calculating the intra-country spatial prices), and at the rural, urban, and all-country levels (for calculating the PPP between the Indian and Vietnamese currencies). This ensured that the study took account of preference heterogeneity between regions (namely, states in India and provinces in Vietnam) inside each country, between the rural and urban areas, and between the two countries. Also, to take note of temporal changes in preferences, the QAIDS was estimated for each survey and not on data pooled over time. In each case, the estimations were performed on the unit records of household expenditures, taking advantage of the availability of data at the level of individual households. Consequently, the estimations had considerable degrees of freedom. To give the reader an idea of the sample sizes, Table A13 in the Appendix presents the sample sizes for the QAIDS estimations at the state, rural/urban, and all-country levels in NSS round 66 for India, and VHLSS (2008) for Vietnam.

The QAIDS parameter estimates in NSS 66th round for India and VHLSS (2008) for Vietnam are presented in Appendix Tables A14 and A15, respectively. Each of these tables shows the rural/urban heterogeneity in preferences in each country, and a comparison between the two tables shows the preference heterogeneity between the two countries. For example, the a_i's, which are interpreted in the PIGLOG framework as "subsistence budget shares" in the base year, vary sharply between the rural and urban areas in each country and between the two countries. In each country, the subsistence budget share for Cereals is larger in the urban areas than in the rural. Another common feature of both tables is that the quadratic coefficient estimates, namely, of the λ_i's, that denote the extension of QAIDS over AIDS, are mostly highly significant. Due to the use of the unit record data in the QAIDS estimations, nearly all the estimates are well determined and highly significant.

An alternative strategy that would have simplified the empirical exercise considerably would have been to estimate the QAIDS model on data pooled over the two countries. That strategy was not adopted here for, principally, three reasons: (a) such a strategy assumes that preferences are identical between the two countries, an assumption that can be seen to be rejected by comparing the QAIDS parameter estimates of the two countries presented in Appendix Tables A14 (India) and A15 (Vietnam); (b) pooling implies identical meaning and definition of the various individual items constituting the broad groups of food items in the two countries, that is certainly not the case; and (c) as already noted, pooling will have required knowledge of the PPP rates between the two countries' currencies whose estimation was one of the chief objectives of the exercise. Since these factors do not apply, at least to such a large extent, in the intra-national context, our earlier study (Majumder *et al.*, 2012) estimated the QAIDS on pooled data from the states in India to estimate item specific spatial prices within India. Note, incidentally, that unlike the ICP exercise, the present study does not estimate the PPP between the two countries' currencies for each group of food items separately, precisely because that will have raised the issues such as identical meaning of each individual item between the two countries, discussed above. It is important to recognize that while the individual food items at a disaggregated level, or what the ICP calls "basic headings," may not be comparable between countries, the broad groups that we have considered here have similar meaning, and food (as a whole) has the same meaning in the two countries; consequently, the overall food PPP that we have calculated here has an operational significance that we have subsequently used to compare living standards between India and Vietnam.

4. Results

4.1. *Intra-Country PPPs in India and Vietnam*

Spatial Food Prices in India

Table 1 presents the food PPPs (along with their standard errors) based on the QAIDS parameter estimates for each of the 15 major states in India (rural and urban), with all-India (for the respective sectors) as base, for the three NSS rounds: 55th, 61st, and 66th. The QAIDS was estimated for each state separately and for each of the three rounds, along with that for all-India which pooled the data over these 15 major states.

Several features are worth noting. First, the regional or spatial food PPPs are generally well determined. Second, in several cases, though not always, the state PPPs are considerably different from the all-India PPP normalized value of 1; prominent examples are the poorer states of Bihar, Orissa, and Uttar Pradesh where 1 Rupee buys much more than it buys elsewhere. Third, there is rural–urban agreement on the PPPs in all three rounds with a reasonable degree of stability in the PPP values over this period. And fourth, the idea that a Rupee buys the same everywhere in India, underlying the conventional between-country PPP calculations in ICP, is inconsistent with the picture portrayed in Table 1 which rejects, in case of several states, the hypothesis that the spatial price is one.

TABLE 1

SPATIAL FOOD PRICES IN INDIA (QAIDS BASED)

State	Rural			Urban		
	NSS 55th Round	NSS 61st Round	NSS 66th Round	NSS 55th Round	NSS 61st Round	NSS 66th Round
Andhra Pradesh	0.960* (−4.09)	0.994 (1.078)	0.994 (−0.52)	0.936* (−4.84)	0.812* (12.97)	1.079* (5.95)
Assam	1.183* (7.98)	1.060 (1.25)	0.880* (−4.91)	0.884* (−3.17)	0.867* (2.59)	0.976 (0.55)
Bihar	0.879* (−18.81)	0.578* (−30.69)	0.751* (−17.03)	0.862* (−11.67)	0.719* (14.99)	0.797* (8.94)
Gujarat	1.092* (2.16)	0.961* (−2.52)	0.940* (−4.15)	0.950* (−2.54)	0.887* (5.35)	0.926* (4.44)
Haryana	0.902* (−2.02)	1.060 (1.46)	0.860* (−10.30)	0.858* (3.17)	0.801* (8.93)	0.917* (5.01)
Karnataka	1.001 (0.06)	0.997 (−0.11)	0.843* (−12.11)	0.917* (−5.83)	0.693* (21.91)	0.882* (8.06)
Kerala	1.243* (8.66)	1.246* (7.02)	1.303* (15.88)	1.003 (0.07)	1.091 (1.11)	1.115* (5.47)
Madhya Pradesh	0.745* (−22.46)	0.914* (−6.64)	0.985 (−0.98)	0.748* (−20.48)	0.924* (6.14)	1.049* (3.21)
Maharashtra	1.027** (1.97)	0.641* (−50.94)	0.774* (−17.58)	1.057* (4.68)	0.657* (25.73)	0.790 (16.11)
Orissa	0.760* (−14.68)	0.546* (−36.73)	0.762* (−19.56)	0.814* (−5.11)	0.599* (15.48)	0.760* (11.58)
Punjab	0.971 (−0.45)	0.713* (−17.02)	0.874* (−11.80)	0.928 (−1.28)	0.941* (2.20)	0.815* (20.92)
Rajasthan	1.057 (0.86)	0.499* (−30.25)	0.712* (−26.10)	0.830* (−3.68)	0.596* (9.61)	0.763* (19.50)
Tamil Nadu	1.273* (8.79)	1.131* (5.29)	0.988 (−0.68)	1.020 (1.32)	1.009 (0.50)	0.930* (5.13)
Uttar Pradesh	0.845* (−16.34)	0.777* (18.93)	0.712* (−37.93)	0.760* (−27.52)	0.677* (29.04)	0.765* (31.51)
West Bengal	1.003 (0.013)	0.938* (−2.27)	1.322* (8.88)	0.983 (0.52)	0.920 (1.50)	1.136* (2.58)
All-India	1.000	1.000	1.000	1.000	1.000	1.000

Notes: The State's median household is the comparison household and the All-India median household is the reference household.

Figures in parentheses are the t-statistic given by $\dfrac{S^{State}-1}{se\left(S^{State}\right)}$.

*p < 0.01, **p < 0.05, ***p < 0.10 are levels of significance for testing PPP = 1.

Spatial Food Prices in Vietnam

Table 2 presents the corresponding QAIDS food PPPs for the three regions of Vietnam (rural and urban), with all-Vietnam (for the respective sectors) as base, for 1997–98, 2004, and 2008 along with their standard errors. The PPPs are less well determined than in India, which largely reflects the much smaller sample size in VLSS/VHLSS compared to the NSS. The affluent Southern region[10] is the most expensive region, with the Dong buying less there than in the rest of the country. A comparison with the spatial prices in India in Table 1 shows that the spread in food prices between the most expensive (Southern) region and the least expensive (Central) region is much smaller than in India. However, as in India, the qualitative picture is robust between the rural and urban sectors and is stable over the period covered by the three Vietnamese surveys.

4.2. *Purchasing Power Parity between India and Vietnam*

Table 3 compares the QAIDS food based PPP rates between the Indian Rupee and the Vietnamese Dong with those from using the CPD method (Rao, 2005), and the conventional Divisia (DIV), Paasche (PA), Laspeyres (LA), and Fisher (FI) price indices. The QAIDS based food PPP rates are obtained by inserting the QAIDS parameter estimates in the two countries in the cost functions in equation (1) and then evaluating both of them at a (common) reference utility level. The latter is expressed in terms of observable variables by inverting the QAIDS expenditure function to obtain an observable expression for indirect utility, u. The reference utility level, u^r, chosen for the PPP calculations in Table 3 is that for the household with median per capita food expenditure in India. Hence, while the denominator in equation (1) is simply the median per capita household expenditure on food in India, the numerator is obtained by using the Vietnamese coefficient estimates along with the reference utility level of the median Indian household which is calculated by inverting the estimated QAIDS expenditure function, equation (2), for India.

The CPD index is obtained from the following regression equation:

$$(8) \qquad \sqrt{w_i^r} \, log \, p_i^r = \pi \sqrt{w_i^r} D_r + \sqrt{w_i^r} \sum_j \eta_j D_j^* + \varepsilon_i,$$

where w_i^r is the budget share of the i-th item in the r-th country, Dr, $r = I$ (India) and V (Vietnam) are the country dummies, and D_j^*, $j = 1, 2, \ldots, n$ are the product (item) dummies. If $\hat{\pi}$ is the ordinary least square squares estimator of π, then $exp(\hat{\pi})$ yields the CPD index. The DIV, PA, LA, and FI indices are given, respectively, by the following formulae:

$$\text{DIV} = exp\left[0.5 \sum_{i=1}^{k} \left(w_i^V + w_i^I \right) log\left(\frac{p_i^V}{p_i^I} \right) \right]; \text{PA} = \frac{\sum_i p_i^V q_i^V}{\sum_i p_i^I q_i^V}; \text{LA} = \frac{\sum_i p_i^V q_i^I}{\sum_i p_i^I q_i^I}; \text{and}$$

$$\text{FI} = \sqrt{LA.PA}.$$

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[10]See Mishra and Ray (2009) for evidence of disparity in affluence between the various regions in Vietnam.

TABLE 2
SPATIAL FOOD PRICES IN VIETNAM (QAIDS BASED)

Region	1998		2004		2008	
	Rural	Urban	Rural	Urban	Rural	Urban
North Vietnam	0.886*** (−9.39)	1.076 (1.31)	0.872*** (−21.79)	1.083*** (5.66)	1.095* (9.24)	0.986 (−0.66)
Central Vietnam	1.011 (0.81)	0.922* (−1.84)	0.979*** (−2.69)	0.976 (−1.26)	0.960* (−3.53)	0.850* (−5.82)
Southern Vietnam	1.112*** (7.51)	1.135*** (3.46)	1.128*** (14.19)	1.023* (1.92)	0.911* (−4.99)	0.995* (−0.15)
All-Vietnam	1.000	1.000	1.000	1.000	1.000	1.000

Notes: The Region's median household is the comparison household and the All-Vietnam median household is the reference household.

Figures in parentheses are the t-statistic given by $\dfrac{S^{State} - 1}{se\left(S^{State}\right)}$.

*p < 0.01, **p < 0.05, ***p < 0.10 are levels of significance for testing PPP = 1.

TABLE 3

FOOD PPP OF VIETNAM WITH RESPECT TO INDIA (INDIA=1) USING ALTERNATIVE PROCEDURES

Year	Sector	QAIDS based Estimates	CPD Index (Rao, 2005)	Divisia Index	Paasche Index	Laspeyres Index	Fisher Index
1999–2000	Rural	387.67 (152.53)	333.36 (20.33)	361.153	274.779	608.632	408.949
	Urban	418.86 (338.80)	360.94 (19.13)	405.367	335.625	629.104	459.503
	All	414.43 (124.09)	346.74 (15.26)	382.56	278.633	640.348	422.4
2004–05	Rural	385.65 (167.37)	322.58 (26.77)	343.723	192.32	558.731	327.803
	Urban	379.13 (402.44)	407.05 (27.68)	400.957	280.289	584.229	404.664
	All	344.23 (122.35)	388.89 (22.55)	318.353	191.794	521.634	316.3
2008	Rural	838.35 (232.90)	1025.47 (53.32)	587.390	539.688	680.643	606.081
	Urban	889.92 (395.24)	1079.17 (57.20)	614.310	559.601	746.356	646.268
	All	811.37 (193.42)	1054.62 (42.18)	587.457	544.917	680.812	609.086

Note: Figures in parentheses are the asymptotic standard errors.

The following results are worth noting from Table 3:
(a) The QAIDS based PPP estimates vary between rural and urban areas and reconfirm the picture of rural–urban heterogeneity in each country that was evident from the spatial prices reported earlier.
(b) There has been reasonable stability in the PPPs both between methods and over time in the first two periods. The picture changed dramatically in the third period, 2004/05–2008/09, with the Dong slipping sharply against the Rupee. This is explained by the large increases in the prices of Cereals & Cereal Substitutes, and Meat, Fish, & Eggs in Vietnam, reported earlier, which dwarfed that in India over this period, along with the fact that the latter item features much more prominently in the Vietnamese diet than in the Indian diet. Large parts of India consist of vegetarians who do not consume this item at all.
(c) There is reasonable agreement in the first two periods between the PPP rates from QAIDS and that from the CPD, Divisia, and Fisher Index. However, the Paasche and Laspeyres PPPs vary considerably from one another and the rest, as one expects from the use of these fixed-basket based price indices. The Fisher Index that averages out the large and reverse biases in Paasche and Laspeyres is much closer to the Divisia, CPD, and QAIDS PPP rates, though differences still remain across the alternative procedures.
(d) The picture of rough stability in the PPPs across procedures changes drastically in 2008–09 with the PPP rates varying widely. The Fisher and Divisia PPP rates are in line with one another, but the CPD PPP rates move to values that are much higher than the rest. The QAIDS based PPP rates are also much higher than the Fisher's and Divisia PPP rates but are intermediate, almost halfway, between them and the CPD rates. The explanation, once again, lies in the large inflation in food prices in Vietnam during this period dwarfing that in India.
(e) To see how the food PPP rates presented in Table 3 compare with PPP rates reported elsewhere, we calculated the Re/Dong PPP rates for these years from the PPP rates of these currencies reported in

http://www.economywatch.com/economic-statistics/economic-indicators/ Implied_PPP_Conversion_Rate/. The Re/Dong PPP rates are 304.02, 321.27, and 383.34. The corresponding Re/Dong PPP rates from figures reported in the website https://uqicd.economics.uq.edu.au/[11] are 261.42 in 1998 and 292.83 in 2005. No PPP rates are available from the latter for the years beyond 2005. These are PPP rates based on all items, food and non-food, while the PPP rates of Table 3 are based on food items only. The 2005 QAIDS based PPP rates are much closer to the former than the latter which seems to be biased downwards in relation to both the other sets of PPPs. However, the QAIDS based PPPs, and also the other food PPPs, move far ahead of the PPPs from the former website during the last period, 2008–09. Once again, the explanation lies in the sharp rise in Vietnamese food prices that puts the food PPPs out of line with the PPPs based on all items. As we report below, this has dramatic implications for the estimates of the relative welfare level of the Vietnamese and the Indian household vis-à-vis one another.

Table 4 presents the QAIDS based food PPPs between India and Vietnam calculated at five different reference utility levels, namely at 30 percent ("ultra-poor"), at 50 percent ("poor"), at 200 percent ("rich"), and at 300 percent ("ultra-rich") of median household expenditure of the NSS 61st round data, besides at the median expenditure itself, for rural, urban, and rural–urban combined sectors. Table 4 also presents the pair-wise differences in the PPP values along with the associated t-statistics. Both the sectors agree that the PPP increases with household affluence. In the rural sector and at the all-country level all the t-statistics are highly significant. In the urban sector the PPPs differ significantly in the middle section of the population. Thus, Table 4 provides evidence of the sensitivity of the PPP estimates to the reference household, an issue that received hardly any attention in the literature. The evidence also confirms large variation across the PPPs corresponding to the reference households, especially in the rural areas, but less in the urban areas. At the all-country level, for example, the PPP of 260.37 Dong per Rupee for an "ultra-poor" household at 30 percent of median expenditure is considerably lower than the PPP figure of 344.23 Dong per Rupee for a median household. It is clear that the provision of a single PPP that is intended for use at all levels of affluence severely restricts its usefulness, especially in cross-country welfare comparisons. This has the policy implication that in poverty calculations using the US$1 a day poverty line,[12] one needs to use different PPPs in calculating the number of "ultra-poor" and "poor" in a given country. This adds to the evidence, presented above, on the need to use regionally varying cross-country PPPs (in cross-country inequality and poverty comparisons) and regional poverty lines (in intra-national poverty comparisons).

A comparison of the food PPP estimates of Tables 3 and 4 shows wide variation between them. The reason for the large difference between the estimates in Tables 3 and 4 is twofold: (a) while the former reports expenditure invariant

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[11]See Rao *et al.* (2010) for the methodology for the PPP rates reported on the website.
[12]This is separate from the argument of Reddy and Pogge (2007) on whether the $1 a day (or $1.25 a day as has been used lately) is an appropriate figure to use as the international poverty line.

TABLE 4

PAIR-WISE COMPARISON OF QAIDS BASED FOOD PPPs EVALUATED AT DIFFERENT REFERENCE UTILITY LEVELS: VIETNAM AND INDIA FOR 2004–05

Expenditure Points		Per Capita Expenditure (Rs)	PPP[a] (India = 1)	Difference with PPP of[b]			
				30% of Median	50% of Median	Median	200% of Median
Rural	30% of median	83.29	294.50 (132.50)				
	50% of median	124.94	328.53 (146.51)	34.03* (14.35)			
	Median	249.88	385.65 (167.37)	91.95* (34.13)	57.12* (21.39)		
	200% of median	499.76	438.48 (340.51)	143.98* (31.61)	109.95* (24.14)	52.83* (11.60)	
	300% of median	749.65	466.05 (243.08)	171.55* (34.16)	137.52* (27.38)	80.40* (16.01)	27.57* (5.49)
Urban	30% of median	97.78	333.73 (372.94)				
	50% of median	146.67	350.78 (388.61)	17.05 (1.50)			
	Median	293.33	379.13 (402.44)	45.40* (3.85)	28.35** (2.40)		
	200% of median	586.67	405.98 (850.97)	72.25* (3.64)	55.20* (2.78)	26.85 (1.35)	
	300% of median	880.00	420.78 (530.05)	87.05* (4.12)	70.00* (3.31)	41.65** (1.97)	14.80 (0.70)
All	30% of median	87.88	260.37 (98.70)				
	50% of median	131.82	290.73 (108.99)	30.36* (9.79)			
	Median	263.64	344.23 (122.35)	83.86* (24.28)	53.50* (15.49)		
	200% of median	527.28	397.94 (363.39)	137.57* (17.02)	107.21* (13.26)	53.71* (6.64)	
	300% of median	790.92	428.56 (192.14)	168.19* (19.41)	137.83* (15.90)	84.33* (9.73)	30.62* (3.53)

Notes: [a]Standard errors in parentheses.
[b]t-statistics in parentheses.
*p < 0.01, **p < 0.05, ***p < 0.10.
All estimates are based on LQAIDS estimates for six food items.

PPPs, the latter shows their variation over the expenditure percentiles; and (b) while the former compares the PPPs between alternative procedures, the latter reports only the QAIDS based PPPs. Note that the QAIDS based PPP figure of 344.23 Dong per Rupee at the all-country level in 2004–05, and evaluated at the median, is the common point of reference for both tables. The central message from a comparison of Tables 3 and 4 is that not only does the PPP vary sharply between alternative procedures, it varies sharply between the expenditure percentiles as well. The policy significance of the sensitivity of PPP to regions, expenditure percentiles, and procedures is underlined by the discussion in the following section which shows the sensitivity of the levels of living comparisons in India and Vietnam to the PPP used in converting the expenditure figures to a common currency.

4.3. *Comparing the Levels of Living between India and Vietnam*

Table 5 reports the values of the 2004–05 Sen (1976) welfare index, namely, the inequality adjusted mean expenditure on the six food items in the two countries. The last column reports the ratio of the Sen (1976) welfare values in the two countries. The table compares the relative welfare of the Vietnamese vis-à-vis the Indian, under alternative PPP rates used in converting the Indian expenditures from Rupees to Dong. The table shows the impact of allowing the PPPs to vary across different expenditure percentiles on the relative levels of living. This table also allows rural urban comparison. The following points are worth noting:

(a) All the PPPs agree that, in 2004–05, the Vietnamese enjoyed a higher standard of living than the Indian. This is confirmed by Table A16 in the Appendix, which reports the summary budget share of food in the two countries. Consistent with Engel's law, the higher budget share of food in India than in Vietnam indicates a lower level of living in the former vis-à-vis the latter. Note, however, that a comparison of the food shares at the mean or median, rather than by each expenditure percentile, may exaggerate differences in the expenditure pattern between India and Vietnam just as the use of a utility invariant PPP exaggerates the differences in their living standards, as reported below.

(b) All the PPPs agree that the welfare disparity between India and Vietnam is higher in case of the urban residents than the rural ones.

(c) The similarity ends there. The use of expenditure percentile specific PPPs sharply reduces the welfare disparity between India and Vietnam in relation to the others.

(d) The use of the ICP PPP leads to a magnitude of welfare disparity that lies between that from the use of expenditure specific and expenditure invariant food PPPs considered in this paper. The key point from Table 5 is that the use of a fixed, utility invariant PPP exaggerates differences in the levels of living between India and Vietnam.

Table 6 shows how the relative welfare levels between the two countries have moved over the period spanned by the three NSS rounds/VLSS-VHLSS surveys. This table brings out the divergence between the magnitudes of the welfare ratios corresponding to the QAIDS based PPP rates and those from the PPP rates obtained from the

TABLE 5

Comparison of Food Expenditure based Welfare between India and Vietnam (2004–05)

Year	Sector	India			Vietnam			$\frac{W_V}{W_I}$
		Expenditure on 6 Food Items (μ_I) (1000 Dongs)	Gini (G_I)	Sen's Welfare $W_I = \mu_I(1 - G_I)$	Expenditure on 6 Food Items (μ_V) (1000 Dongs)	Gini (G_V)	Sen's Welfare $W_V = \mu_V(1 - G_V)$	
2004–05 Varying PPP between expenditure percentiles	Rural	119.31	0.2878	84.97	118.77	0.2778	85.77	1.01
	Urban	132.97	0.2840	95.21	170.04	0.3209	115.48	1.21
	All	116.81	0.3041	81.29	131.33	0.2884	93.46	1.15
Median PPP	Rural	68.74	0.2517	51.44	118.77	0.2778	85.77	1.67
	Urban	95.22	0.2663	69.87	170.04	0.3209	115.48	1.65
	All	77.28	0.2628	56.97	131.33	0.2884	93.46	1.64
ICP[a] PPP	Rural	88.38	0.2517	66.13	118.77	0.2778	85.77	1.30
	Urban	104.29	0.2663	76.52	170.04	0.3209	115.48	1.51
	All	94.17	0.2628	69.42	131.33	0.2884	93.46	1.35

Note: [a]ICP PPP rates against US$1 in 2005: India (14.669), Vietnam (4712.75), Dong/INR = 321.27.

TABLE 6

TEMPORAL MOVEMENT IN THE RELATIVE WELFARE VALUES AND SENSITIVITY TO THE PPP USED

Year		Sector	India			Vietnam			$\frac{W_V}{W_I}$
			Expenditure on 6 Food Items (μ_I) (1000 Dongs)	Gini (G_I)	Sen's Welfare $W_I = \mu_I(1 - G_I)$ (1000 Dongs)	Expenditure on 6 Food Items (μ_V) (1000 Dongs)	Gini (G_V)	Sen's Welfare $W_V = \mu_V(1 - G_V)$ (1000 Dongs)	
1999[a]	Median PPP	Rural	99.98	0.2493	75.05	56.52	0.3604	36.15	0.48
		Urban	140.54	0.2616	103.78	115.19	0.2592	85.33	0.82
		All	119.75	0.2650	88.02	73.41	0.3313	49.09	0.56
	ICP PPP	Rural	78.40	0.2493	58.86	56.52	0.3604	36.15	0.61
		Urban	102.01	0.2616	75.32	115.19	0.2592	85.33	1.13
		All	87.85	0.2650	64.57	73.41	0.3313	49.09	0.76
2004–05[b]	Median PPP	Rural	68.74	0.2517	51.44	118.77	0.2778	85.77	1.67
		Urban	95.22	0.2663	69.87	170.04	0.3209	115.48	1.65
		All	77.28	0.2628	56.97	131.33	0.2884	93.46	1.64
	ICP PPP	Rural	88.38	0.2517	66.13	118.77	0.2778	85.77	1.30
		Urban	104.29	0.2663	76.52	170.04	0.3209	115.48	1.51
		All	94.17	0.2628	69.42	131.33	0.2884	93.46	1.35
2008[c]	Median PPP	Rural	424.84	0.2475	319.71	148.39	0.3444	97.28	0.30
		Urban	555.96	0.2730	404.21	309.84	0.2636	228.16	0.56
		All	450.14	0.2657	330.53	186.60	0.3253	125.90	0.38
	ICP PPP	Rural	194.26	0.2475	146.19	148.39	0.3444	97.28	0.67
		Urban	239.49	0.2730	174.12	309.84	0.2636	228.16	1.31
		All	212.68	0.2657	156.16	186.60	0.3253	125.90	0.81

Notes: [a]ICP PPP rates against US$1 in 1998: India (12.46), Vietnam (3789.65), INR/Dong = 304.02.
[b]ICP PPP rates against US$1 in 2005: India (14.669), Vietnam (4712.75), INR/Dong = 321.27.
[c]ICP PPP rates against US$1 in 2008: India (16.863), Vietnam (6464.29), INR/Dong = 383.34.

website mentioned earlier. The 2004–05 snapshot is not quite the complete picture. There is a wide divergence between the two in the earlier and later years. If we focus on the period between 2004/05 and 2008/09, we see that both the PPPs agree that, due to the much higher food inflation in Vietnam than in India, there has been a large decline in the relative welfare of the Vietnamese over this period. There is general agreement that over the period, 2004–08, the picture of relative affluence of the Vietnamese household gave way to one of relative deprivation in relation to the Indian household. However, the use of the non-demand systems and all item based PPPs greatly understates the extent of this decline in relation to the preference consistent food PPPs proposed in this study. Consequently, by the end of the period considered in this study, the former exaggerates greatly the relative welfare of the Vietnamese in relation to the latter. This is dramatized by the result that in 2008–09, while the food PPPs show that urban Vietnam experienced a welfare level that is half that in urban India, the all-item PPPs record the exact reverse, with urban Vietnam ahead of urban India by around 30 percent. This is an indictment of the all-item PPPs that underplay the role of high food inflation in increasing deprivation both within and between countries.

5. Summary and Conclusion

This study marks a departure from the previous literature on PPP by proposing a demand system based methodology for calculating the PPP that takes account of consumer preferences and allows for the substitution effect of price changes. The study is conducted within a framework that allows for regional variation in preferences and price changes both inside the country and between countries. The framework is used to calculate PPP between the Indian Rupee and the Vietnamese Dong. These Asian countries were chosen for principally three reasons: (a) both of them registered impressive economic growth following significant economic reforms; (b) they have comparable household expenditure surveys with quantity and expenditure information of food items at unit record levels covering contemporaneous time periods, and (c) though not identical, these two countries have comparable item classifications. This is the first study in the published literature that calculates the PPP between countries not only at the aggregate country to country level, but also between sectors (namely, rural to rural and urban to urban) and by expenditure classes. This paper also provides evidence on how the spatial prices and the PPP have moved over the period, 1998/99 to 2008/09, that suggests that the Rupee has strengthened against the Dong over this period. On the way to calculating the spatial prices and PPP, the study extends the methodology due to Cox and Wohlgenant (1986) to construct prices from unit values that incorporate quality and demographic effects.

A particular advantage of the PPP procedure proposed here, that it shares with the "weighted CPD" procedure (Rao, 2005), is that it allows the calculation of standard errors of the PPP. The usefulness of this is illustrated by the tests of PPP between expenditure classes which question the conventional practice of using a single economy-wide PPP in inequality and poverty comparisons. The policy significance of the PPP estimates is further underlined by their application in the comparison of levels of living between India and Vietnam, and the observation

that the magnitude of relative welfare is quite sensitive to the procedure used to calculate the PPP used in the welfare comparisons. Another advantage of the TCLI based PPP procedure over that used by the ICP is that in using a reference utility rather than a fixed basket of commodities, the former sidesteps the problem of data comparability faced by the latter due to the differing meaning of the same item of consumption between countries that is exemplified by the recording of zero expenditures on some items in several countries. The drawback of the TCLI based procedure used here is that the need to estimate demand systems to move from commodity space to utility space sets a restriction on the number of items that can be considered in the PPP calculations. It also requires a host of expenditure, price, and demographic information at the level of unit records of households that is currently available for only a handful of countries.

The evidence of this study points to the potential for future such investigations that combine calculation of spatial prices with PPPs in a uniform analytical framework. However, for such studies to proceed there needs to be greater and improved information than is currently available. For example, cross-country studies such as the present study require more countries to conduct household expenditure surveys and provide unit record information on quantity and expenditures at the household level. Even for countries such as India and Vietnam that provide data on household consumption in quantity and expenditure terms, such information is restricted to food items only—information needs to be provided for the non-food items as well. There needs to be greater synchronization between countries on the time periods for their surveys and on the definition of the items used. Collection of prices is another area where the need for more information cannot be overstated.

One limitation of this study is the use of unit values from the expenditure records in the household budget surveys as prices. Adjusted or not, unit values of the various items are unsatisfactory proxies for prices. While the corrections minimize the distortions in the unit values, they do not eliminate them completely. However, reliance on them is unavoidable as there is hardly any information on regional market prices. One of the messages of this study is the need to embark on a project to make available regional prices using methods such as "price opinion" suggested by Gibson and Rozelle (2005). However, as McKelvey (2011) has found recently, such price information is not free of bias either.

References

Almas, I., "International Income Inequality: Measuring PPP Bias by Estimating Engel Curves for Food," *American Economic Review*, 102, 1093–117, 2012.

Atella, V., M. Menon, and F. Perali, "Estimation of Unit Values in Cross Sections Without Quantity Information and Implications for Demand and Welfare Analysis," in C. Dagum and G. Ferrari (eds), *Household Behaviour, Equivalence Scales, Welfare and Poverty*, Physica-Verlag, New York, 2004.

Aten, B. and T. Menezes, "Poverty Price Levels: An Application to Brazilian Metropolitan Areas," World Bank ICP Conference, Washington DC, March 11–15, 2002.

Banks, J., R. Blundell, and A. Lewbel, "Quadratic Engel Curves and Consumer Demand," *Review of Economics and Statistics*, 79, 527–39, 1997.

Chotikapanich, D., R. Valenzuela, and D. S. P. Rao, "Global and Regional Inequality in the Distribution of Income: Estimation with Limited and Incomplete Data," *Empirical Economics*, 22, 533–46, 1997.

Clements, K., Y. Wu, and J. Zhang, "Comparing International Consumption Patterns," *Empirical Economics*, 31, 1–30, 2006.

Coondoo, D., A. Majumder, and R. Ray, "A Method of Calculating Regional Consumer Price Differentials with Illustrative Evidence from India," *Review of Income and Wealth*, 50, 51–68, 2004.

Coondoo, D., A. Majumder, and S. Chattopadhyay, "Estimating Spatial Consumer Price Indices Through Engel Curve Analysis," *Review of Income and Wealth*, 57, 138–55, 2011.

Cox, T. L. and M. K. Wohlgenant, "Prices and Quality Effects in Cross-Sectional Demand Analysis," *American Journal of Agricultural Economics*, 68, 908–19, 1986.

Deaton, A. S., J. Friedman, and V. Alatas, "Purchasing Power Parity Exchange Rates from Household Survey Data: India and Indonesia," Working Paper No. 173, Research Program in Development Studies, Woodrow Wilson School, Princeton University, 2004.

Diewert, W. E., "Weighted Country Product Dummy Variable Regressions and Index Number Formulae," *Review of Income and Wealth*, 51, 561–70, 2005.

Feenstra, R. C., H. Ma, and D. S. P. Rao, "Consistent Comparisons of Real Incomes Across Time and Space," *Macroeconomic Dynamics*, 13 (Supplement), 169–93, 2009.

Gibson, J. and S. Rozelle, "Prices and Unit Values in Poverty Measurement and Tax Reform Analysis," *World Bank Economic Review*, 19, 69–97, 2005.

Hill, R. J., "Measuring Substitution Bias in International Comparisons based on Additive Purchasing Power Parity Methods," *European Economic Review*, 44, 145–62, 2000.

———, "Constructing Price Indexes Across Space and Time: The Case of the European Union," *American Economic Review*, 94, 1379–410, 2004.

Hoang, L. V., "Estimation of Food Demand from Household Survey Data in Vietnam," DEPOCEN Working Paper No. 2009/12 (http://www.depocenwp.org), 2009.

Lancaster, G. and R. Ray, "Comparison of Alternative Models of Household Equivalence Scales: The Australian Evidence on Unit Record Data," *Economic Record*, 74, 1–14, 1998.

Majumder, A., R. Ray, and K. Sinha, "The Calculation of Rural Urban Food Price Differentials from Unit Values in Household Expenditure Surveys: A New Procedure and Comparison with Existing Methods," *American Journal of Agricultural Economics*, 94, 1218–35, 2012.

McKelvey, C., "Price, Unit Value and Quantity Demanded," *Journal of Development Economics*, 95, 157–69, 2011.

Milanovic, B., "True World Income Distribution, 1988 and 1993: First Calculation based on Household Surveys Alone," *Economic Journal*, 112, 51–92, 2002.

Mishra, V. and R. Ray, "Dietary Diversity, Food Security and Undernourishment: The Vietnamese Evidence," *Asian Economic Journal*, 23, 225–47, 2009.

Neary, J. P., "Rationalizing the Penn World Table: True Multilateral Indices for International Comparisons of Real Income," *American Economic Review*, 94, 1411–28, 2004.

Oulton, N., "How to Measure Living Standards and Productivity," *Review of Income and Wealth*, 58, 424–56, 2012a.

———, "The Wealth and Poverty of Nations: True PPPs for 141 Countries," CEP Discussion Paper No. 1080, London School of Economics, 2012b.

O'Donnell, C. J. and D. S. P. Rao, "Predicting Expenditure Shares for Computing PPP Exchange Rates," Mimeo, University of Queensland, Brisbane, 2007.

Prais, S. J. and H. S. Houthakker, *The Analysis of Family Budgets*, 2nd edition, Cambridge University Press, Cambridge, 1971.

Rao, D. S. P., "On the Equivalence of Weighted Country-Product-Dummy (CPD) Method and the Rao-System for Multilateral Price Comparisons," *Review of Income and Wealth*, 51, 571–80, 2005.

Rao, D. S. P., A. Rambaldi, and H. Doran, "Extrapolation of Purchasing Power Parities Using Multiple Benchmarks and Auxiliary Information: A New Approach," *Review of Income and Wealth*, 56, Special Issue, S59–98, 2010.

Ravallion, M., G. Datt, and D. van de Walle, "Quantifying Absolute Poverty in the Developing World," *Review of Income and Wealth*, 37, 345–61, 1991.

Reddy, S. and T. Pogge, "How Not to Count the Poor," in S. Anand and J. Stiglitz (eds), *Measuring Global Poverty*, Oxford University Press, Oxford, 2007.

Sen, A., "Real National Income," *Review of Economic Studies*, 43, 19–39, 1976.

Summers, R., "International Price Comparisons Based Upon Incomplete Data," *Review of Income and Wealth*, 19, 1–16, 1973.

World Bank, "Global Purchasing Power Parities and Real Expenditures: 2005 International Comparison Program" (http://siteresources.worldbank.org/ICPINT/Resources/icp-final.pdf), 2008.

SUPPORTING INFORMATION

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