International Comparisons of Transportation Prices and Output

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The use of different currency converters in international comparisons can significantly affect comparisons of gross output and productivity in two sectors, nonmotorized and motorized transportation. This is illustrated for Indonesia and the Republic of Korea. Further support is provided by a comparison of bus fares in approximately 60 countries and a comparison of aggregate transportation demand in various categories in 1980 and in 1985. These comparisons also illustrate exchange rate distortions, particularly between countries whose price structures are dissimilar. The main results contrast the labor costs and value added in bicycle production in the two countries with production in the motorized sector and show the understatement of Korea's productivity in the transportation sector when exchange rates are used, relative to Indonesia. In the second comparison, transportation prices are systematically lower at exchange rates, particularly for low-income countries, and both price and income elasticities in the aggregate demand analysis are affected by the conversion method.

Transportation demand prices are often compared on the basis of data using a cross section of countries. For example, during the oil crisis in the Middle East, the press commonly compared gasoline prices in different countries. These types of comparisons are useful, but they can also be misleading if done incorrectly.

Transportation costs and expenditures in national currency units are usually compared using exchange rates. This paper discusses an alternative purchasing power–based converter that is preferable in many applications. The derivation of the purchasing power converter is discussed, and illustrative applications in international comparisons in the transportation sector are provided.

The first example is a binary comparison of productivity in the Republic of Korea and in Indonesia. Estimates of the real value added at factor costs for the motorized and nonmotorized sectors are shown, using manufacturing census data on the production of passenger vehicles, motorcycles, and bicycles in 1985. Labor costs and output per employee in each sector are then discussed when real and nominal values are used. The second example uses price data on several transportation categories for 60 countries in 1980 and 30 countries in 1985 to analyze the relationship between transportation use, final demand prices, and income. The differences between exchange rate conversions and relative price comparisons will also be discussed for each of the categories. The final section describes the methodology and its application in the production and in the expenditure approach in international comparisons.

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COMPARISONS

Motorized and Nonmotorized Transportation Equipment Manufacture

The output quantities and unit values for Japan, Korea, and Indonesia are used to calculate the price relatives, or parities, for motorized (passenger cars and motorcycles) and nonmotorized (bicycles and carts) sectors. These are shown in Table 1 with the average annual exchange rates in 1985. Japanese numbers are based on aggregate gross values of output in the manufacturing sector, and Korean and Indonesian prices are based on the values of shipments. Korean value added, however, includes subsidies and taxes.

Since the Japan-Korea price relatives relate to 1985, the results will not reflect declines in relative prices of manufacture in Korea since 1985. As noted, one of the main difficulties with the Korean census data is the treatment of taxes. Although it is possible to reconcile partially the diverse tax treatments in different countries and sectors, this has not been attempted here. For this reason, the parities reflect internal price structure, not necessarily parities relevant to foreign trade. For an extended treatment of Korean taxes in manufacturing using input-output tables and the system of national accounts, see the paper by Szirmai and Pilat (*1*).

The overall parity, or aggregate price relative, for the three sectors between Korea and Japan is twice the exchange rate, indicating that it is relatively more expensive to produce transportation equipment in Korea than it is in Japan. The reverse occurs between Korea and Indonesia, so that if Indonesian output is converted at the rupiah-won exchange rate, it is likely to be overstated relative to Korea, compared to conversions by parities. The interesting fact about Korean manufacture in particular is that bicycle production in Korea is more expensive than it is in Japan or Indonesia relative to the other transportation sectors. Some possible explanations will be given.

In Table 2 the estimates of value added in national currencies for each sector are shown, as well as productivity in

TABLE 1 Parities and Exchange Rates

	Korea-Japan (Won/Yen)	Korea-Indonesia (Won/Rps)	Japan-Indonesia (Yen/Rps)
PARITIES			
All	7.37	0.28	0.044
Motorized	7.33	0.27	0.044
Non-Motor	11.57	0.44	0.038
EXCHANGE RATE	3.66	0.78	0.215

TABLE 2 Value Added and Productivity

	Korea		Indonesia	
	VA Won (bil)	VA/Emp Won (mil)	VA Rps (bil)	VA/Emp Rps (mil)
Motorized	1,034	12.66	369	17.98
Non-Motor	20	6.20	7	1.46

national currencies, measured as valued added per employee. Cart production was left out of the value-added estimates because carts in the Indonesia census were classified as "motor vehicle body and equipment manufacture" and totaled only 15 units. The Korea-Indonesia ratio of productivity is obtained by converting the Korean won values into Indonesian currency units by the won-rupiah parity and by exchange rate, then dividing each by Indonesia's productivity. The conversions and the Korea-Indonesia ratio are shown in Table 3.

Table 4 shows the ratios of labor costs and value added per employee among the sectors within a country, in local currency units. Labor costs per employee in Indonesia for bicycle production are nearly one-fifth of the costs in the motorized sector. In Korea, by contrast, the costs per employee in bicycle production are four-fifths of the costs per employee in the motorized sector. The labor force is smaller but more expensive in Korea, and it is therefore likely that Korean bicycle manufacture is more capital-intensive than in Indonesia. In addition, Korea's high productivity in bicycle production—more than half of the productivity in its motorized sector—is also a likely indicator of high capital intensity; Indonesia's productivity at national currencies is only about one-twelfth that of its motorized sector.

The final point to emphasize is how the exchange rate understates the productivity ratio for this Korea-Indonesia comparison. In this example, the direction of change was the same for both sectors, that is, exchange rate conversions of Indonesian output are greater than their price ratio conversions for both motorized and nonmotorized transportation equipment manufacture, although less so for bicycles than for passenger cars and motorcycles. The Korean data include establishments with 5 or more workers (a total of 71 for bicycle production); Indonesia includes 54 establishments. The total number of motor vehicle and motorcycle production firms included in Korea was 1,285 and in Indonesia, 87. The next example discusses in more detail these differences from the expenditure side. Instead of unit values derived from output values and quantities, final expenditures and market prices are used. The production approach may use prices instead of unit value estimates (*2,3*). An example of unit value estimation will be given the next section.

TABLE 3 Ratio of Korea and Indonesia Productivities

	Korea		Indonesia	Ratio	
	Rps (Parity)	Rps (Xrate)	Rps	Korea-Indonesia at Parity	Xrate
Motorized	46.20	16.15	17.98	2.57	0.90
Non-Motor	13.96	7.91	1.46	9.58	5.43

TABLE 4 Ratio of Nonmotorized to Motorized Costs and Value Added

	Labor Costs/Employee Non-M : Motor	Value Added/Employee Non-M : Motor
Korea (Won)	2.62 : 3.77 (1 : 1.4)	6.20 : 12.66 (1 : 2)
Indonesia(Rps)	0.65 : 3.11 (1: 5.0)	1.46 : 17.98 (1 : 12)

Transportation Prices and Aggregate Demand Analysis

Two comparisons of prices and aggregate demand are discussed in this section. The first comparison uses 1985 data on bus fares in various cities and countries taken from two independent sets of data. One set is the nominal exchange rate value for fares up to 5 km in 21 selected cities, averaged between public and private suppliers of bus services (*4*). The other set is a national average of short-distance bus rides ranging from 1 to 10 km in approximately 40 other countries (*5*). The second comparison takes 1980 and 1985 average national price levels for several categories in addition to bus services, and includes approximately 60 and 30 countries, respectively (*5*). The categories in this second comparison are

- Passenger vehicles;
- Motorcycles and bicycles;
- Tires, tubes, and accessories;
- Repair charges;
- Gasoline, oils, and greases;
- Local transportation services (up to 10 km); and
- Long-distance rail and bus services.

First, the prices of each category—bus fares in the first comparison and passenger vehicles and local transportation services in the second comparison—are plotted against consumption levels in each country, at exchange rates and at purchasing-power parity conversions. Figure 1 is a plot of the nominal bus fares converted at exchange rates against the per-capita consumption of the population, both in 1985 U.S. dollars. Figure 2 is the plot of the real fares, that is, the nominal values corrected by the country's price level. The exchange rate values increase more noticeably with income than the parity conversions, which tend to be scattered for low-income countries and then to even out as income rises. This suggests that, relative to consumption, bus fares are more expensive for low-income countries than their exchange rate values indicate.

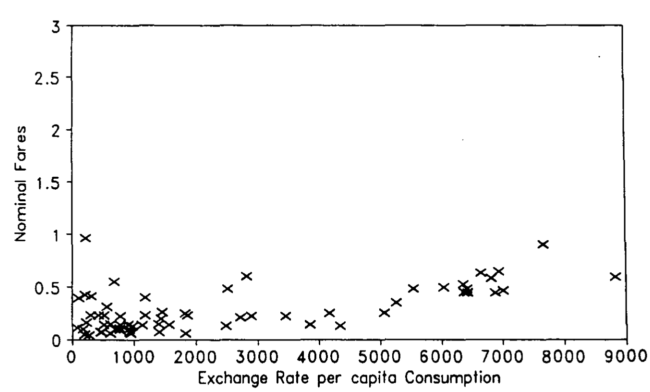

FIGURE 1 Bus fares 1985, nominal prices.

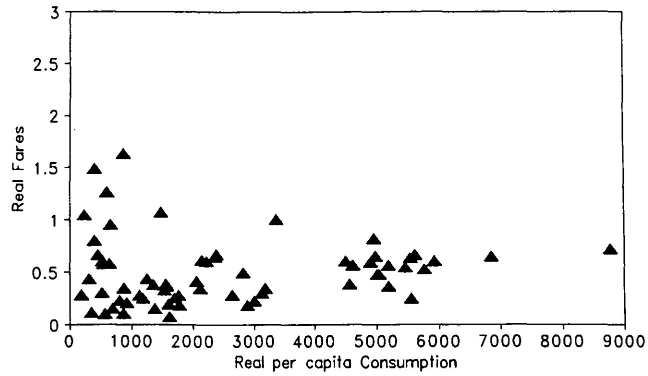

FIGURE 2 Bus fares 1985, real prices.

The exchange rate and parity conversion graphs of prices and consumption in 1980 are shown in Figures 3 and 4 for cars and Figures 5 and 6 for local services. The number that is plotted against consumption at exchange rates is the price relative to the average when all currencies are converted at the U.S. dollar exchange rate. The real prices are converted by the purchasing-power parity of the currency in a manner similar to the bus fare conversions. The difference between the two conversions is more pronounced in the car category, for which the prices are much higher at exchange rates, relative to other consumption goods, in the low-income coun-

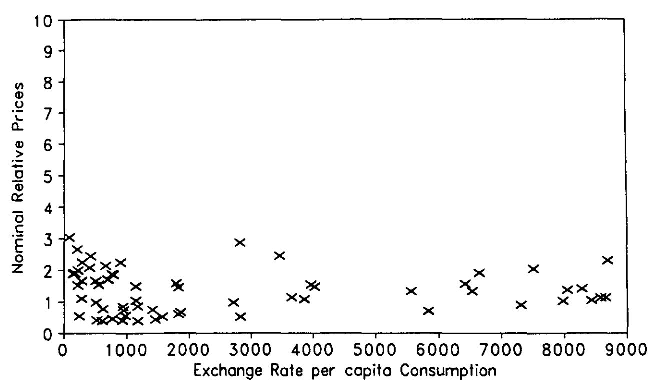

FIGURE 3 Cars 1980, nominal prices.

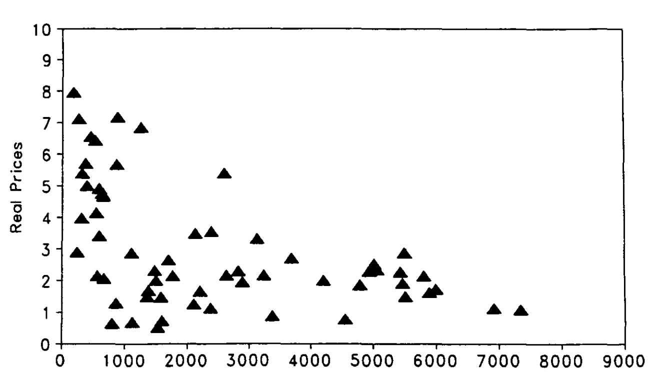

FIGURE 4 Cars 1980, real prices.

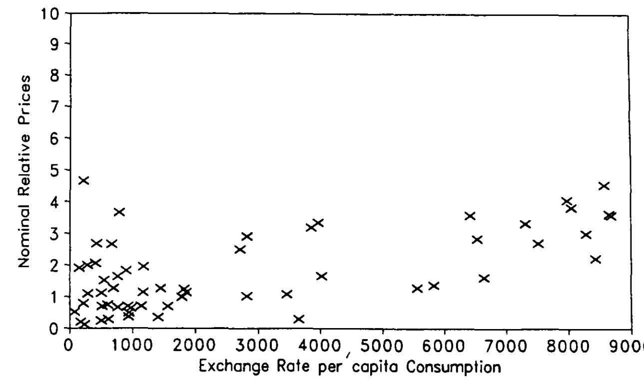

FIGURE 5 Local services 1980, nominal prices.

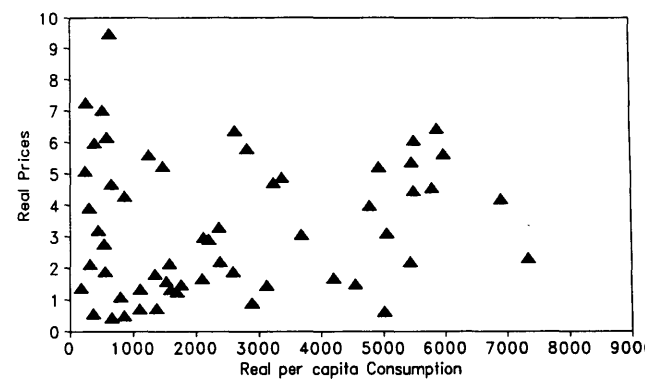

FIGURE 6 Local services 1980, real prices.

tries. The local services category shows a similar but more dispersed trend in relation to the bus-fares-only example. Prices at parities continue to be higher than prices at exchange rates, particularly for low-income countries.

Besides prices and incomes, the per-capita quantity purchases of each category, in both 1980 and 1985, are obtained from the national expenditure data described, and a crude estimating equation is specified for the comparisons. A discussion of the merits and disadvantages of this demand analysis is given elsewhere (*6*). A simple log-linear demand equation is used in this section, for each conversion method (exchange rates and at parities), and is defined as

$$\ln q_{ij} = b_{i0} + b_{i1} \ln p_{ij} + b_{ij} \ln c_j + u_{ij} \quad (1)$$

where

i = 1 category in first comparison (bus fares);
i = 1, . . . , 7 categories in second comparison;
j = 1, . . . , 64 countries in first comparison;
j = 1, . . . , 60 countries in 1980 in second comparison;
j = 1, . . . , 30 countries in 1985 in second comparison;
q_{ij} = per-capita quantity of item i consumed in country j;
p_{ij} = unit price of i in country j; and
c_j = per-capita consumption in country j.

The regression coefficients b_{i1} and b_{i2} are the price and income elasticities for each item or category heading. They are estimated by ordinary least squares regression, one equa-

TABLE 5 1985 Bus Fares

Obs=64	Intercept	Price	Consumption
EXCHANGE RATES			
coefficient	-5.167	-0.217	0.993
standard error	(1.035)	(0.184)	(0.118)
prob > |t|	0.0001	0.2446	0.0001
PARITIES			
coefficient	-4.003	-0.753	0.777
standard error	(1.159)	(0.217)	0.149
prob > |t|	0.0001	0.0010	0.0001

tion at a time, for 1980 and 1985. The first comparison is only for the bus category, and the second uses all the transportation categories in the two years. The exchange rate and parity conversions are shown in separate lines. The derivation of all the parities are described in more detail in the next section.

Table 5 shows the results for the bus fare demand analysis, with the standard errors of the coefficients in parentheses and the associated *t*-statistics below. The nominal price variable is not significant in the former, though it is of the right sign. It is mainly the income variable, consumption, that "explains" demand, and the elasticity is unity, which is high. If we look at the prices expressed relative to a country's consumption price levels, bus fares and income both significantly affect demand. The sign of the price coefficient is negative and the income elasticity is lower, suggesting that an increase in prices decreases the quantities of bus rides demanded but that higher incomes or consumption levels lead to less-than-proportional increases in bus demand.

The second demand analysis for the various categories in 1980 and in 1985 exhibit similar differences. The coefficients of each log-linear demand equation are shown in Tables 6 and 7. There are 60 observations in 1980 and 30 in 1985. The dependent variable is the per-capita quantity of each category and the independent variables (price and consumption) for each category are defined in Equation 1. Table 8 shows the adjusted R-squares for each equation, as well as the root mean square errors.

At exchange rates, the coefficients on the price variable are usually positive; when they are of the right sign, as for repair charges, they are not significant. In contrast, at parities, the coefficients on the price variable are always negative, except for passenger cars in 1980, and always smaller (have larger negative values) than at exchange rates. Income elasticities for local and long-distance rail and bus services generally follow a pattern similar to the bus fare results in Table 5—that is, they are lower at parities. They are also less than unity, suggesting that increases in income lead to less than proportional increases in the demand for purchased transportation services. On the other hand, the income elasticities for individual transport vehicles and for parts and accessories

TABLE 6 1980 Aggregate Demand Estimates

	Dep:Quantities		
(Std.Errors)	*Int.*	*Price*	*Consump.*
PASSENGER CARS			
Exchange Rates	-9.59 (1.10)	0.66 (0.33)	1.64 (0.15)
Price Relatives	-13.33 (1.80)	0.04 (0.33)	2.10 (0.22)
MOTORCYCLES & BICYCLES			
Exchange Rates	-7.11 (0.86)	0.08 (0.27)	1.15 (0.12)
Price Relatives	-9.03 (1.54)	-0.03 (0.29)	1.39 (0.18)
TIRES, TUBES & ACCESSORIES			
Exchange Rates	-7.74 (1.05)	0.52 (0.48)	1.28 (0.15)
Price Relatives	-9.39 (1.45)	-0.22 (0.43)	1.49 (0.18)
REPAIR CHARGES			
Exchange Rates	-8.79 (1.09)	-0.15 (0.26)	1.40 (0.15)
Price Relatives	-7.71 (1.35)	-1.06 (0.31)	1.33 (0.18)
GASOLINE, FUEL & OILS			
Exchange Rates	-10.10 (1.15)	0.23 (0.32)	1.67 (0.16)
Price Relative	-11.34 (2.02)	-0.57 (0.34)	1.85 (0.25)
LOCAL SERVICES (up to 10kms)			
Exchange Rates	-4.68 (0.92)	0.09 (0.18)	0.97 (0.13)
Price Relatives	-4.18 (1.10)	-0.62 (0.19)	0.94 (0.15)
RAIL & BUS SERVICES			
Exchange Rates	-2.20 (0.86)	0.33 (0.17)	0.60 (0.12)
Price Relatives	-1.50 (0.96)	-0.49 (0.18)	0.54 (0.13)

TABLE 7 1985 Aggregate Demand Estimates

	Dep:Quantities		
(Std.Errors)	*Int.*	*Price*	*Consump.*
PASSENGER CARS			
Exchange Rates	-10.08 (1.42)	0.40 (0.44)	1.75 (0.17)
Price Relatives	-17.31 (3.63)	-0.18 (0.49)	2.62 (0.41)
MOTORCYCLES & BICYCLES			
Exchange Rates	-5.85 (1.40)	0.53 (0.90)	0.98 (0.18)
Price Relatives	-5.99 (2.67)	-1.09 (0.81)	1.05 (0.29)
TIRES, TUBES & ACCESSORIES			
Exchange Rates	-8.43 (1.35)	0.93 (0.56)	1.35 (0.17)
Price Relatives	-12.41 (2.48)	-0.30 (0.60)	1.84 (0.29)
REPAIR CHARGES			
Exchange Rates	-10.61 (2.10)	-0.57 (0.47)	1.72 (0.26)
Price Relatives	-11.20 (1.76)	-1.97 (0.61)	1.88 (0.23)
GASOLINE, FUEL & OILS			
Exchange Rates	-6.71 (0.83)	0.57 (0.58)	1.34 (0.10)
Price Relative	-8.18 (2.49)	-0.87 (0.53)	1.57 (0.27)
LOCAL SERVICES (up to 10kms)			
Exchange Rates	-3.73 (2.17)	-0.45 (0.37)	0.90 (0.28)
Price Relatives	-2.00 (2.01)	-1.60 (0.38)	0.77 (0.27)
RAIL & BUS SERVICES			
Exchange Rates	0.54 (2.02)	0.14 (0.37)	0.29 (0.26)
Price Relatives	2.37 (1.83)	-1.10 (0.40)	0.13 (0.25)

TABLE 8 Adjusted *R*-Squares and Root Mean Square Errors

	1980		1985	
	RBAR²	RMSE	*RBAR²*	RMSE
PASSENGER CARS				
EXRates	0.670	1.437	0.670	1.451
Parities	0.670	1.450	0.814	0.936
MOTORCYCLES & BICYCLES				
EXRates	0.620	1.121	0.658	0.883
Parities	0.616	1.179	0.586	0.893
TIRES, TUBES & ACCESSORIES				
EXRates	0.626	1.296	0.752	0.981
Parities	0.553	1.340	0.686	1.028
REPAIR CHARGES				
EXRates	0.654	1.237	0.831	0.763
Parities	0.495	1.394	0.706	0.771
GASOLINE, FUEL & OILS				
EXRates	0.662	1.489	0.857	0.643
Parities	0.598	1.678	0.841	0.674
LOCAL SERVICES				
EXRates	0.584	1.050	0.408	0.819
Parities	0.448	1.110	0.363	0.793
RAIL & BUS SERVICES				
EXRates	0.492	0.949	0.194	0.777
Parities	0.235	0.989	0.243	0.750

and for gasoline and fuels are larger than unity and higher at parities than at exchange rates. Although elasticities from these demand equations should be interpreted with caution, the significant differences between the conversion methods suggest how projections based on cross-section demand analyses at exchange rates can be misleading to transportation planners.

METHODOLOGY

Production Parities

In general, manufacturing census data are aggregate values and quantities of output, and one way to obtain the individual prices is to calculate the unit value of the product. Unit values are derived from gross values of shipments or of output and from quantity data—that is, for each country j,

$$\text{unit value}_j = \text{output}_j/\text{quantity}_j$$

The other way is to match products and use their market or sale prices. The advantages of both methods have been discussed elsewhere, and in particular for production parities (*2,6*). One of the disadvantages of unit value estimates is that rather than price changes, differences may be due to changes in the composition of goods produced in the sector. For example, China's unit values for 1980 and 1985 in motorcycle production differ by a factor of 10. The gross-net output ratio remained approximately the same, but the quantities of motorcycles increased 22-fold. Unit values of passenger vehicles, motorcycles, and bicycles are derived from the 1987 industrial census.

For the examples in this paper, only unit values were estimated in the production comparisons. The basic approach is to match products in the industry, such as passenger vehicles, motorcycles, and bicycles, and to calculate the price relatives in each sector. The sectors may then be aggregated to obtain an industry price relative or parity. The parity between two countries for a one-product, one-sector industry will simply be the price relative of the product, that is Pa/Pb where a and b are countries. The parity for a multiproduct sector will be the price relatives for each product i weighted by the quantity or output of the product—that is,

$$PPPa = \text{sum}_i\ (Pa_i * Qa_i)/\text{sum}_i\ (Pb_i * Qa_i)$$

(at quantity weights of country a)

and

$$PPPb = \text{sum}_i\ (Pa_i * Qb_i)/\text{sum}_i\ (Pb_i * Qb_i)$$

(at quantity weights of country b)

where i is the products in the sector.

The overall *PPP* or parity for a multisector industry can be obtained in a similar fashion, by summing over the sectoral parities weighted by output in the sector—for example, summing over motorized and nonmotorized sectors to obtain the overall transportation *PPP*, as in the preceding example. The parities are used to convert the value added in one country's currency to another country's currency units, that is,

$$VA.ab = VA.aa/PPPa$$

$$VA.ba = VA.bb * PPPb$$

where

$VA.ab$ = value added of country a in country b prices,
$VA.ba$ = value added of country b in country a prices, and
$PPPa$, $PPPb$ = parity at quantity weights of countries a and b, respectively.

For simplicity, the geometric or Fisher average of *PPPa* and *PPPb* was used in the Korea-Indonesia example, and the separate country parities are not shown. This value added is then divided by the number of employees in each sector to obtain productivity per employee. Alternative denominators, such as working hours, were not available on a comparable basis for this paper.

Price Relatives

In the expenditure approach, it is generally easier to obtain price data than quantity data. Thus, instead of calculating unit values from quantity and output data as in the production example, the parities for a category such as household expenditures on transportation are obtained from price and expenditure data. The same *PPP* formulas are used in both the production and expenditure approaches. The weights are the expenditures divided by the prices, or their "notional quantities." If we had all price and quantity data for all items or categories, unit values or notional quantities would not be used. However, if only one or the other is available, together with expenditure and output values, the relation between prices, quantities, and output or expenditures must be used.

Each category or heading consists of a set of items. For example, gasoline prices include premium, regular, and diesel, and local transportation includes bus and cab rides up to 10 km. The estimating steps at each aggregation level are described more fully elsewhere (*6*). If there are detailed disaggregate prices for items such as wheelbarrows, chee-kees, and other transport and travel aids in national currencies, or the prices of purchased services such as pedal-rickshaws, the multilateral comparisons would be at the level of nonmotorized transportation categories. The matching of such products, and the price collection process for transportation services that operate largely in the informal market, are the main obstacles to a more detailed international comparison.

CONCLUSIONS

Although the data used in the examples are not strictly comparable in the case of the production approach, and not at a highly disaggregate level within nonmotorized transportation in the expenditure approach, the main goal of this paper is to illustrate the effects of currency conversions on comparisons of transportation prices and output. Exchange rates may understate the prices of low-cost transportation modes such as buses and bicycles, especially for low-income countries. In other words, although prices may seem cheap at exchange rates, they are in fact, relative to the prices of other goods within each country, more expensive. The conversions of gross output and productivity also suffer from similar distortions, that is, the exchange rate conversions will not adequately reflect the differences in costs between two countries whose price structures are dissimilar. In the Korea and Indonesia example, the exchange rate understates the productivity of Korean transportation equipment manufacture relative to Indonesian transportation manufacture. In addition, the productivity and labor costs in the bicycle manufacture sector are distinct from those in the motorized transportation sector, and the relative costs within these sectors should also be taken into account.

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