Relative Prices and Sectoral Productivity[†]

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Abstract

Lack of comprehensive sectoral productivity data across a large set of countries has turned researchers to structural analysis using detailed international price data to infer cross country productivity at the sector level. Because the relative price of services is higher in rich than in poor countries (and rises with development), a standard interpretation of this observation in the literature is that cross-country productivity differences in the service sector are much smaller than in other sectors of the economy, in particular industry and tradable sectors. Using disaggregate price data from the International Comparison Program we show that the behaviour of the relative price of aggregate services is driven mainly by traditional services such as government, health, and education, but that for richer countries non-traditional services such as communication and transport and insurance and financial services gain in importance. We also show that the price of non-traditional services decreases with income and is much higher than that of traditional services, especially for poor countries. This pattern together with the reallocation across services account for the higher price of services in rich relative to poor countries. We study the importance of disaggregating the service sector for productivity implications at the sector level. Using both a simple development accounting framework and a model of the structural transformation in services, we find that cross-country productivity differences are very large in non-traditional services and at least as large as those in manufacturing. We argue with these results that development requires also an emphasis on solving the productivity problem in non-traditional services in poor countries.

JEL classification: O1, O4, E0.
Keywords: Productivity, services, traditional, non-market, structural transformation.

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1 Introduction

There are large differences in incomes across countries. For instance, measured at international prices, gross domestic product (GDP) per capita in the richest 10 percent of countries in the world is 40 times that of the poorest 10 percent of countries in 2005. Most studies agree that labor productivity (and total factor productivity) differences across countries are the primary factor explaining differences in income across countries. A large literature following Kuznets (1966) has emphasized the importance of the sectoral allocation of factors and productivity in understanding aggregate outcomes.

The cornerstone limitation of a proper quantitative assessment of the sectoral structure is the lack of comprehensive sectoral productivity data for a large number of countries. A standard approach in the literature to circumvent the data limitations is to use sectoral price and expenditure data to back out sectoral productivity. From this literature, a well-known fact is that the relative price of services rises with development and the standard interpretation of this finding is that cross-country differences in productivity are larger in manufacturing than in services, e.g.: Balassa-Samuelson, Kravis, Heston, and Summers (1983), Hsieh and Klenow (2007), Herrendorf and Valentinyi (2011). We argue that heterogeneity in the service sector is important for sectoral productivity implications.

The service sector is very heterogeneous. We disaggregate services between traditional and non-traditional. We find that the relative price of traditional services rises with income while that of non-traditional services falls with income. And, as income grows, there is a structural transformation within the service sector. Keeping the U.S. shares of traditional and non-traditional services constant across countries implies a relative price of services that does not vary with income. These facts suggest that a development strategy based solely in improving productivity primarily in the manufacturing sector may be limited in its effects.

To assess the importance of disaggregating the services sector for productivity implications,

we first use a development accounting framework which imposes very little structure by using all pieces of the data available (expenditures and prices). The analysis reveals that labor productivity differences in non-traditional services are as large as those in manufacturing and much larger than those in traditional services. Development is associated with a reallocation of real expenditures to non-traditional services. To understand more deeply what drives this process, we then develop a model of the structural transformation that includes traditional and non-traditional services. The model reinforces the finding that productivity differences are large in non-traditional services.

The paper is organized as follows. In the next section, we elaborate on a set of facts about sectoral structure and prices from the ICP data. Section 3 performs a simple development accounting as a first pass to assess the productivity implications of disaggregating services. In Section 4, we lay out a standard model of structural transformation to study the reallocation of real expenditures to non-traditional serves and study the sectoral and aggregate implications in the context of that model. Section 5 presents the calibration of the model and results. We conclude in Section 6.

2 Facts

We use disaggregated data from the International Comparisons Program (ICP) for 2005. The data is the basis for the construction of the widely used Penn World Table (PWT) where comparable measures of gross domestic product are available for a large number of countries and years. The ICP data reports information on 129 detailed expenditure categories (on consumption, investment, and government) for 130 countries. The country coverage represents well the world distribution of income. The data contains information on price indices of individual expenditure categories, nominal expenditures (expenditures on individual categories in units of domestic prices), and real expenditures (expenditures on individual categories in

units of an average international price which is common across countries). From the individual expenditure categories, aggregates such as GDP, consumption and investment can be constructed in both domestic and international prices.

We construct an aggregate expenditure category that we call services. In the appendix, we document the list of categories that we include in services. While every expenditure category may contain a service component perhaps as an intermediate input, aggregate expenditure in services is a close approximation to total services in the economy.

We emphasize the following facts:

(1) The price of services relative to that of GDP increases with income per capita. That is, the relative price of services is higher in rich countries compared to poor countries. We report the relative price of services against GDP per capita across countries in Figure 1. In average, the richest 5 percent of countries have a relative price of services which is a factor of 2 of the price in the poorest 5 percent of countries. This is a well known fact that has been emphasized in the related literature (see e.g. Kravis, et al., Summers and Heston, among many others).

(2) The (nominal) share of services in GDP increases with income per capita, that is the share of expenditures in services is larger in rich compared to poor countries. See Figure 2. While rich countries dedicate 60 percent of their GDP to services expenditures, poor countries only 20 percent. This fact is also relatively well know, however, what is less known is whether the expenditure share in services rises because there is more purchases of services in rich countries or because the prices of those services are higher in rich countries. This gets to our next fact.

(3) The real share of services in GDP (real=when measured at international prices) does not vary systematically with income per capita, at around 60 percent for all countries. That is, rich and poor countries spend the same fraction of their real expenditures in

services. See Figure 3. What we observe is that while the real share of services is roughly the same, the is a substantial and systematic reallocation of real expenditures across services categories, sort of a structural transformation within services to which we get into in the next few facts.

We divide services into two broad categories: traditional and non-traditional services. Traditional services includes the government and consumption expenditures by households in rents, health services, education, and domestic and household services (mostly non-market services). Non-traditional services is the rest and comprises mainly communication and transport services, insurance and financial services, and recreational and cultural services.[1]

(4) The relative price of traditional services increases with income while the relative price of non-traditional services declines with income. In addition, traditional services are cheap while non-traditional services are expensive (relative to the price of GDP). See Figures 4, 5, and 6.

(5) The real share of traditional services (in total services) declines with income while the real share of traditional services increases with income. The reallocation across the services categories is substantial with poor countries allocating most of the real expenditures in services to traditional whereas rich countries allocate almost 40 percent of the real service expenditure to non-traditional services. See Figure 7

To provide a first pass at the importance of the reallocation within services in explaining the fact that the price of services in higher in rich countries, note that the relative price of services can be decomposed as:

$$\frac{P_S}{P} = \frac{E_S/Q_S}{P} = \frac{P_{S_T}}{P} \cdot sQ_{S_T} + \frac{P_{S_N}}{P} \cdot (1 - sQ_{S_T}),$$

[1]We use the terminology traditional and non-traditional to broadly characterize the main distinction across services categories but the same categories can be broadly characterized as market vs.non-market services, and broadly speaking our facts are robust to other characterizations of the service sector.

where P_S/P is the relative price of services (relative to GDP), P_{S_i}/P is the relative price of i services (traditional or non-traditional) and sQ_{S_T} is the real share of traditional services in total services. We then perform the following counterfactual. We ask what the relative price of aggregate services would be if there was no reallocation across services categories (we fix the real share of traditional services to that observed for the United States). What we find is that without the reallocation across services, the relative price of services would be essentially the same across rich and poor countries. (See Figure 8). For poorer countries, the relative price of traditional services is low, the relative price of non-traditional services is high, and the weight of non-traditional (expensive) services is low. This reallocation in poor countries compared to rich countries accounts for the low relative price of services. As alluded to in the introduction, the relative price of aggregate services has often been viewed as informative of the relative productivity of the service sector in poor countries relative to rich countries. We argue that the reallocation within services is critical in making inferences about the productivity of the service sector. In the rest of the paper we work out the details of how heterogeneity in the service sector is important for the implications of sectoral productivity across countries.

3 Development Accounting

To start investigating the importance of reallocation across services categories for sectoral productivity across countries, we follow a large literature in development accounting assessing the productivity implications of price and expenditure data across sectors and countries. More specifically, we ask the following question: What are the productivity implications of disaggregating the service sector?

We closely follow Herrendorf and Valentinyi (2011) in imposing the minimal structure into our accounting exercise. There are three sectors: manufacturing (m), traditional services

(s_T), and non-traditional services (s_N). Production in each sector is governed by linear technologies requiring labor input:

$$Y_i = A_i L_i, \qquad i \in \{m, s_T, s_N\},$$

where Y_i and L_i are output and labor in sector i and A_i is labor productivity in sector i. Notice that, given our assumption of the production function for each sector, data on labor productivity across sectors and countries can directly pin down the variables of interest, i.e., A_i for all countries and sectors. However, such data does not exist, at least for a comprehensive set of sectors and for a large number of countries. The main difficulty is that what is available is the value of labor productivity across sectors and countries and these values can reflect differences in relative prices across sectors within a country as well as differences in relative prices across countries, potentially confounding true differences in real productivity. In addition, even if we could make a mapping from the real expenditure data and output in a sector, we would generally won't have the corresponding labor input associated with that sector specification. Hence, more structure is needed before we can identify A_i across sectors and countries using data.

We proceed by assuming, in addition to linear technologies in labor, competitive markets for goods and labor, and perfect factor mobility across sectors. With these assumptions, the value of labor productivity (the marginal product of labor in this case) is equalized across sectors. The stand-in firm in each sector maximizes profits by choosing an appropriate amount of labor, which requires $p_i A_i = w$ for all i. Normalizing the amount of labor in each country to 1, we have that $\sum_i L_i = 1$. Then it follows that the value of aggregate output is $\sum_i p_i Y_i = w$ and that the labor input is determined by the share of value output,

$$L_i = \frac{p_i Y_i}{\sum_i p_i Y_i}.$$

Table 1: Development Accounting Results

	Relative	A_i			
	GDPpc	m	s	s_T	s_N
Income elasticity	–	1.12	0.85	0.81	1.16
D_{10}	0.95	0.79	1.06	1.20	0.85
D_5	0.16	0.06	0.36	0.49	0.15
D_1	0.02	0.01	0.05	0.07	0.01
Ratio D_{10}/D_1	40	66.8	21.4	18.2	63.9

Then, productivity in each sector country is given by the ratio of output to labor with the labor inferred from the share value of output,

$$A_i = \frac{Y_i}{sE_i},$$

where $sE_i = L_i = \frac{p_i Y_i}{\sum_i p_i Y_i}$.

To implement this development accounting empirically, we assume that the real expenditure data (Q_i) represents sectoral output in the model (Y_i) and that the share of nominal expenditure (E_i/E) represents the share value of output in each sector in the model. We report the results of the development accounting exercise in Table 1. For each sector and country, we calculate labor productivity (A_i) and calculate statistics to illustrate how sectoral productivity varies with GDP per capita in the cross country data. We compute the income elasticity by regressing the log of A_i on log GDP per capita, and by calculating the average A_i for countries in different deciles of the income distribution.

We emphasize the following results from Table 1. (1) When services aggregated, we find that the variation in manufacturing productivity is larger than in services productivity as reflected in the larger income elasticity in manufacturing than services. For the ratio of the 10 percent richest and poorest countries, differences in manufacturing productivity are close to 67-fold while for services they are 21-fold. These results are consistent with the findings in the broad

accounting literature such as Hsieh and Klenow (2007) and Herrendorf and Valentinyi (2011) and the related literature emphasizing productivity differences between the tradable and non tradable sector (e.g. Kravis, et al.). (2) When the service sector is disaggregated between traditional and non-traditional, the accounting results are different in that the traditional sector features lower differences in productivity than manufacturing which are critical in determining the implications for aggregate services (since traditional services are almost all the services in poor countries and still more than 60 percent in rich countries) whereas the non-traditional services look more like manufacturing in terms of the cross country differences in productivity. In fact, using the income elasticity as a summary indicator of differences in productivity across countries, non-traditional services feature a larger elasticity than manufacturing. The stark implied differences in productivity between traditional and non-traditional services is relevant for development since development involves a reallocation to non-traditional services. Depending on the factors that drive the reallocation across services, the sectoral differences in productivity may constitute an obstacle to development or affect negatively aggregate productivity. We turn next to this issue by considering a model of the structural transformation in services.

4 Model

While the development accounting just discussed provides estimates of the sectoral differences in productivity that are consistent with the price and expenditure data across sectors and countries, development accounting is silent about the forces driving differences in sectoral quantities in the cross-country data. In this section, we investigate the sectoral productivity implications in a standard model of reallocation with three sectors: manufacturing, traditional services, and non-traditional services.

The model is a general equilibrium model of the structural transformation closely following

Duarte and Restuccia (2010). There are three sectors: manufacturing, traditional services, and non-traditional services. We assume homothetic preferences since the real share of services is roughly constant across countries. Reallocation within services driven by differential productivity growth and non unitary elasticity of substitution.

Production In each period, three goods are produced: manufacturing (m), traditional services (s_T), and non-traditional services (s_N) with linear technologies in labor,

$$Y_i = A_i L_i, \qquad i \in \{m, s_T, s_N\},$$

where A_i - labor productivity in sector i, and L_i - total labor hours in sector i. Labor and goods markets are competitive

Preferences There is a stand-in representative household with preferences over consumption:

$$u(c_m, c_{s_T}, c_{s_N}) = b \log(c_m) + (1-b) \log \left[\phi c_{s_T}^{\rho} + (1-\phi) c_{s_N}^{\rho} \right]^{\frac{1}{\rho}},$$

with b and ϕ between 0 and 1 and $\rho < 1$.

Equilibrium A *competitive equilibrium* is a set of prices $\{p_m, p_{s_T}, p_{s_N}\}$ and allocations $\{c_m, c_{s_T}, c_{s_N}\}$ for the household and $\{L_m, L_{s_T}, L_{s_N}\}$ for firms such that:

1. Given prices, firm's allocations $\{L_m, L_{s_T}, L_{s_N}\}$ maximize profits

2. Given prices, household's allocations $\{c_m, c_{s_T}, c_{s_N}\}$ maximize utility subject to the budget and non-negativity constraints

3. Markets clear:

- Labor market: $L_m + L_{s_T} + L_{s_N} = L$

- Goods markets: $c_m = Y_m, \quad c_{s_T} = Y_{s_T}, \quad c_{s_N} = Y_{s_N}$

Characterization

- Prices of goods: $p_i = \frac{w}{A_i}$

- Consumption of traditional and non-traditional services:

$$\frac{A_{s_N}}{A_{s_T}} = \frac{\phi}{1-\phi}\left(\frac{c_{s_T}}{c_{s_N}}\right)^{\rho-1}$$

- Consumption of services and manufacturing:

$$\frac{A_m}{A_{s_T}} = \frac{b}{1-b}\frac{c_m}{c_{s_T} + c_{s_N}\frac{A_{s_T}}{A_{s_N}}}$$

5 Quantitative Analysis

5.1 Calibration

Strategy: Calibrate a benchmark economy to data for the United States. Calibrated parameters reported in Table 2.

Table 2: Calibration

Parameter	Value	Target U.S. Data
A_i	1.0	Normalization
b	0.26	Share of expenditures in manufacturing
ϕ	0.71	Ratio of expenditures c_{s_T}/c_{s_N}
ρ	-0.5	

Table 3: Model Results

Model		A_i		$\frac{P_{s_T}}{P_m}$	$\frac{P_{s_N}}{P_m}$	$\frac{P_{s_N}}{P_{s_T}}$
	m	s_T	s_N			
D_{10}	0.8	1.2	0.8	0.7	1.0	1.5
D_1	0.018	0.098	0.0066	0.18	2.7	14.8
Accounting		A_i		$\frac{P_{s_T}}{P_m}$	$\frac{P_{s_N}}{P_m}$	$\frac{P_{s_N}}{P_{s_T}}$
	m	s_T	s_N			
D_{10}	0.8	1.2	0.8	0.7	0.93	1.42
D_1	0.012	0.066	0.0132	0.18	0.89	5.0

5.2 Results

We use the model to measure sectoral relative labor productivity across countries (A_m, A_{s_T}, A_{s_N}). We impose three targets:

- shares of real expenditures in manufacturing and traditional services
- relative aggregate labor productivity.

The results of the model are summarized in Table 3.

Productivity differences in non-traditional services may be even larger than suggested by development accounting. A wedge in the output price of non-traditional services may explain

smaller price differences exacerbating productivity differences in non-traditional services. These results reinforce our emphasis that heterogeneity in the service sector is important for productivity implications.

5.3 Discussion

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6 Conclusion

A non-trivial and growing subset of services categories feature a falling relative price with income (non-traditional services). A standard development accounting exercise uncovers the importance of disaggregating services between traditional and non-traditional for productivity implications. We find that labor productivity differences in non-traditional services are at least as large as those in manufacturing (the model predicts much larger differences than in manufacturing).

The process of development involves a reallocation to non-traditional services which in turn hinges on productivity in that sector. Facilitating development requires solving the productivity problem in non-traditional services in poor countries.

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A Data Sources and Definitions

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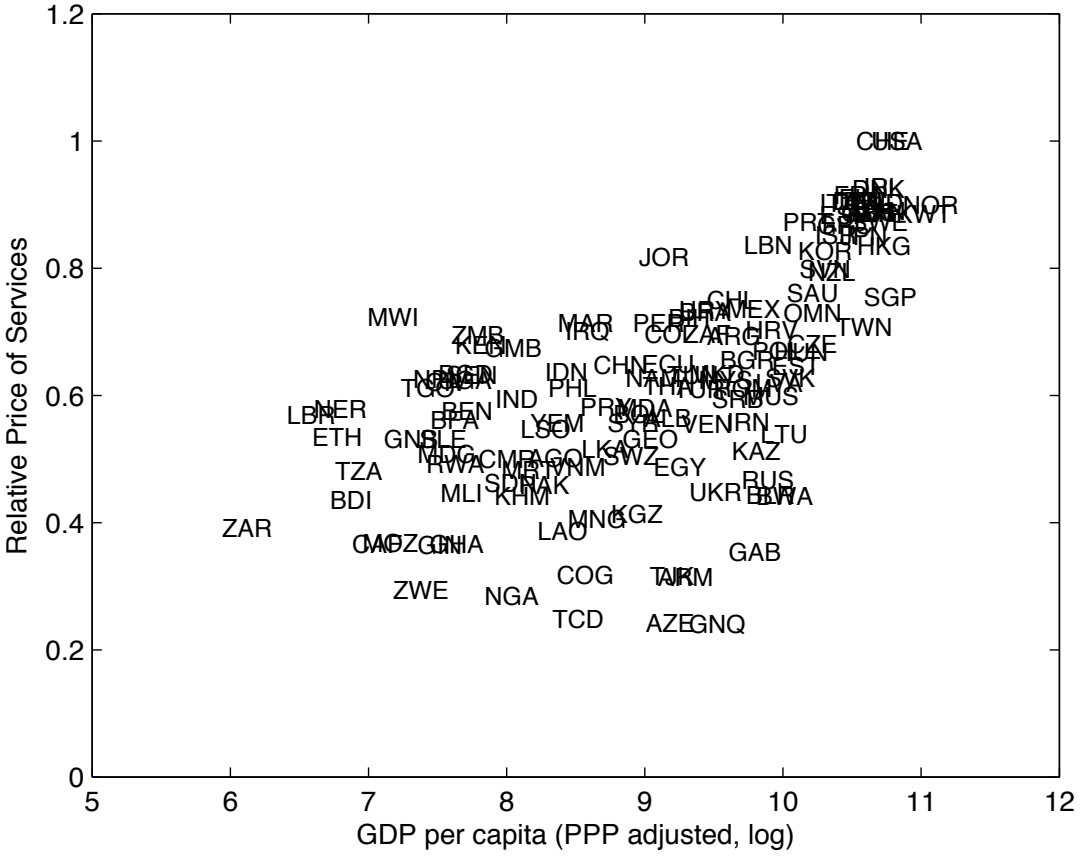
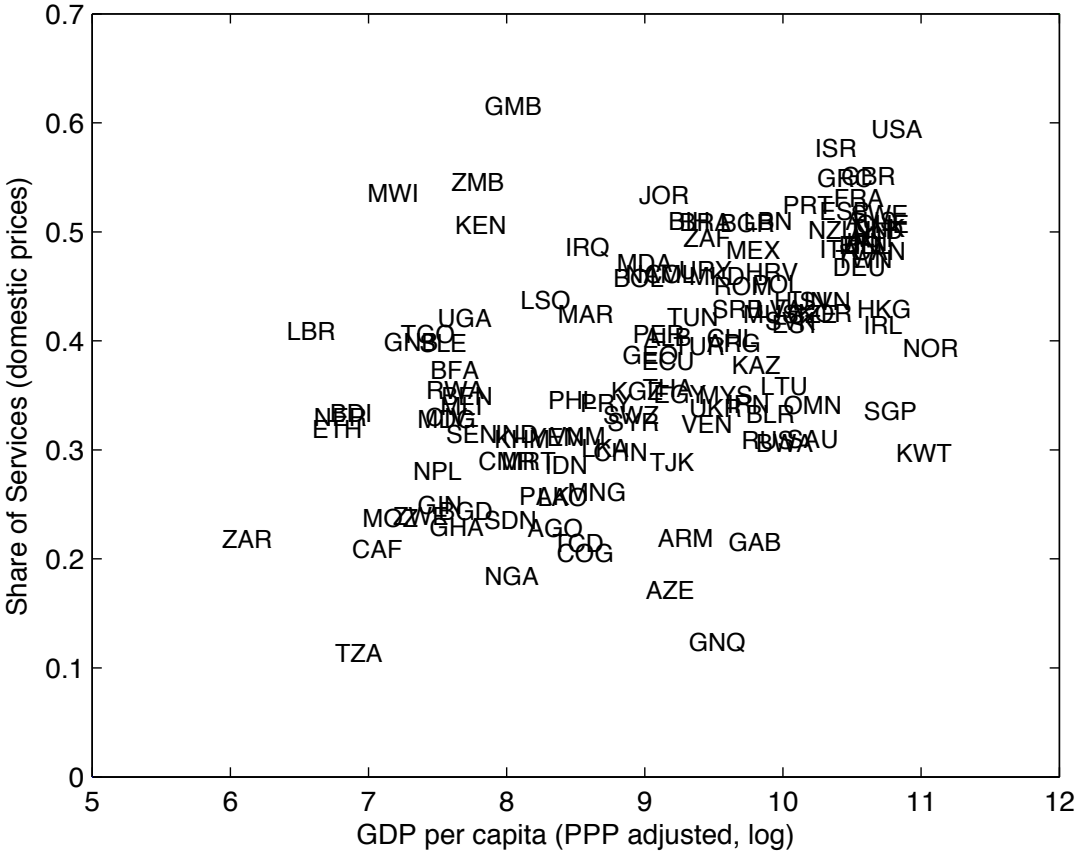
Figure 1: Relative Price of Services across Countries



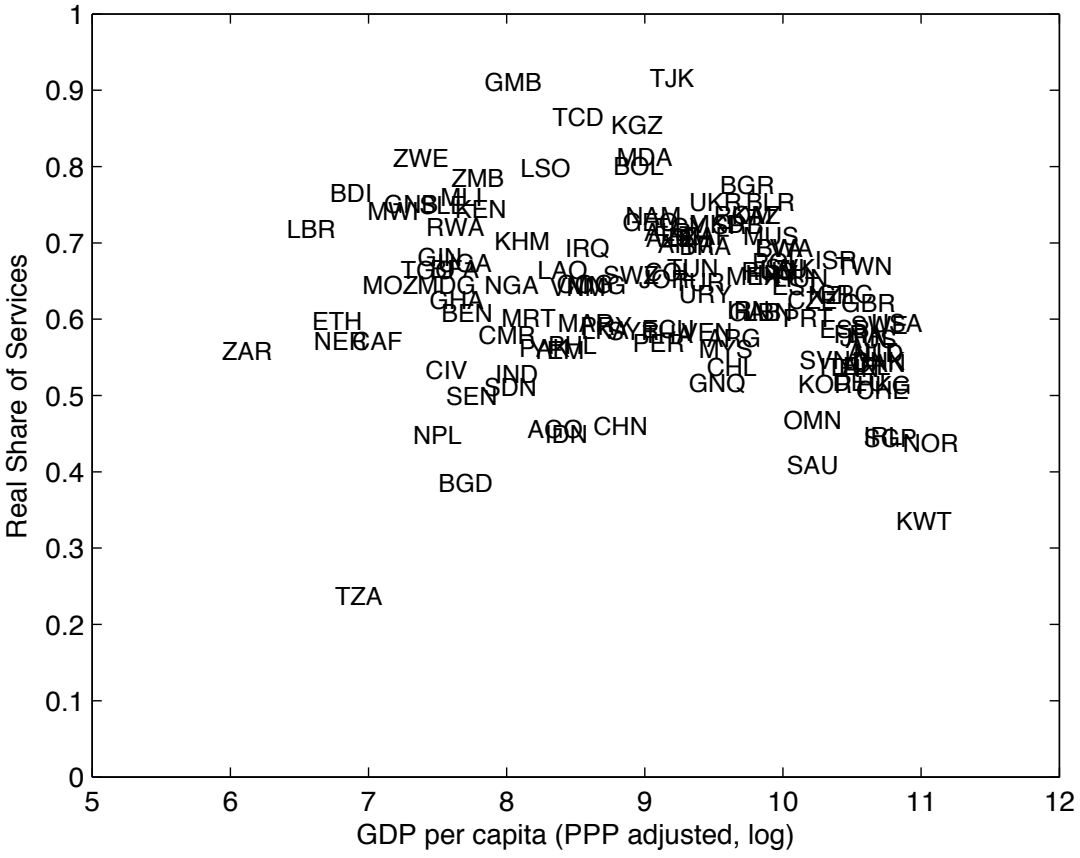
Note: Data for 2005 from ICP. The relative price of service refers to the PPP price of total services relative to the PPP price of GDP.

Figure 2: Share of Services across Countries



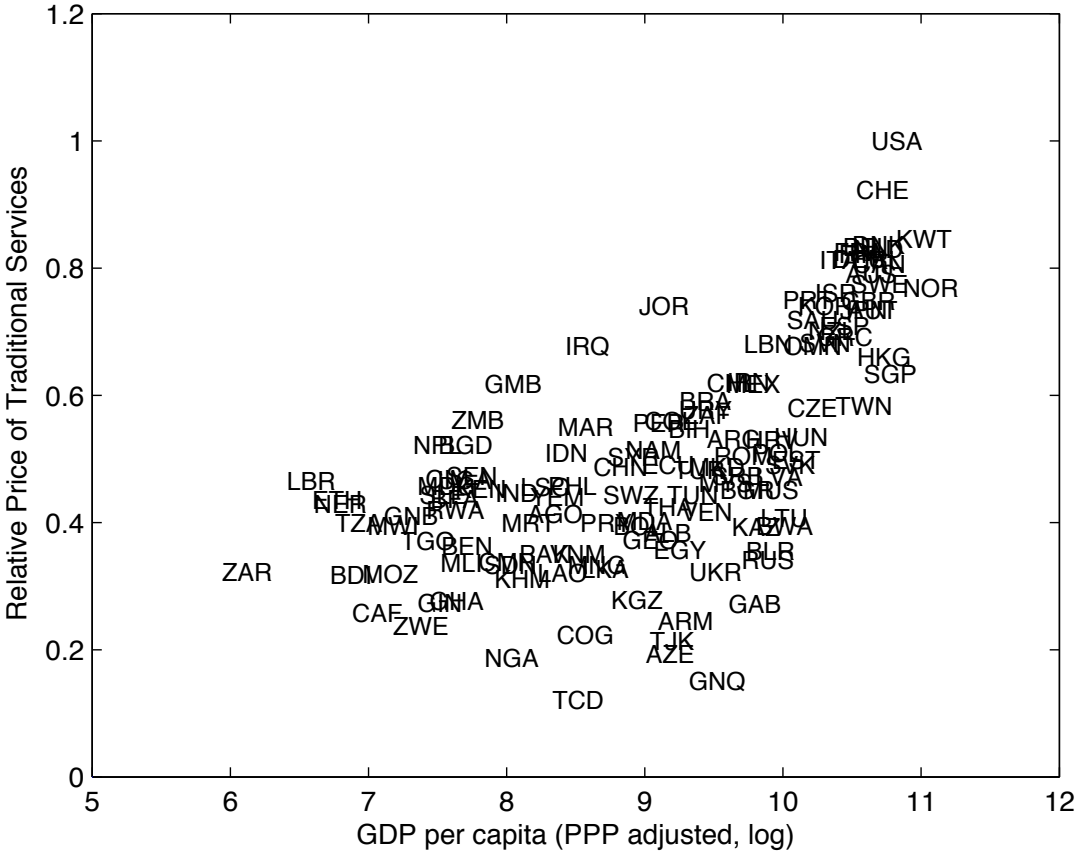
Note: Data for 2005 from ICP. The share of service refers to nominal expenditures in total services relative to nominal GDP.

Figure 3: Real Share of Services across Countries



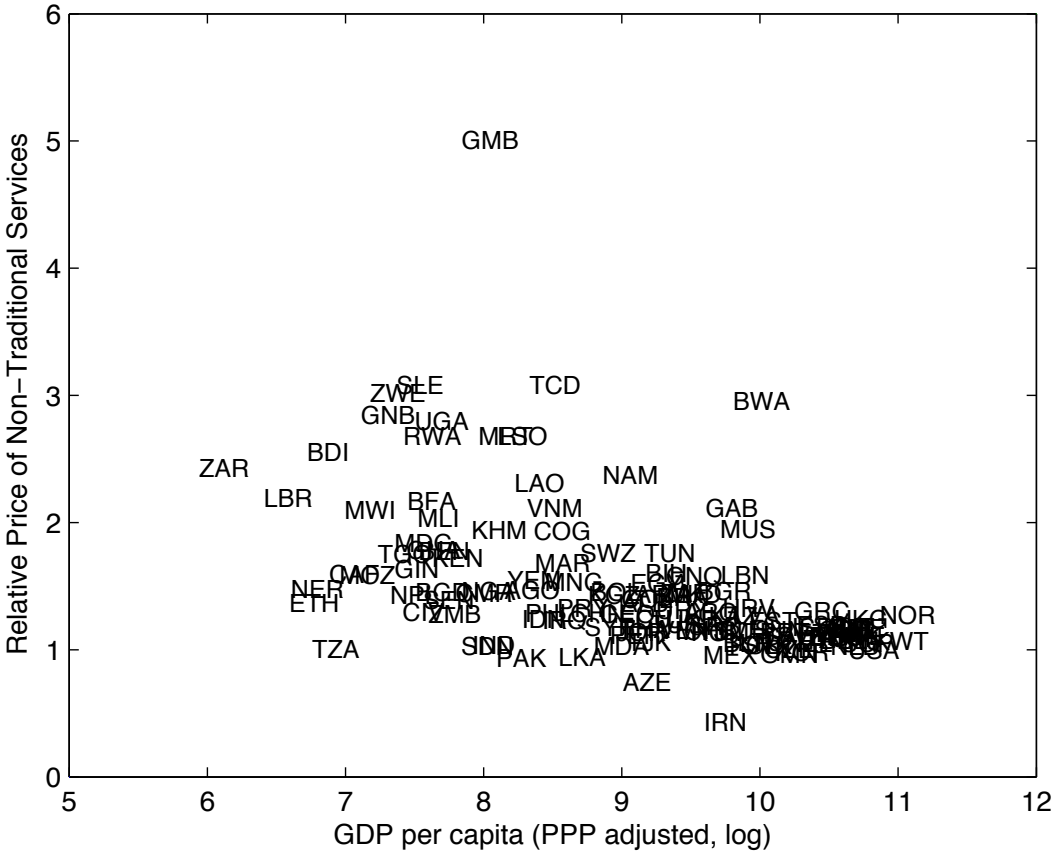
Note: Data for 2005 from ICP. The real share of service refers to real expenditures in total services relative to real GDP. Real refers to expenditures or GDP at international prices.

Figure 4: Relative Price of Traditional Services across Countries



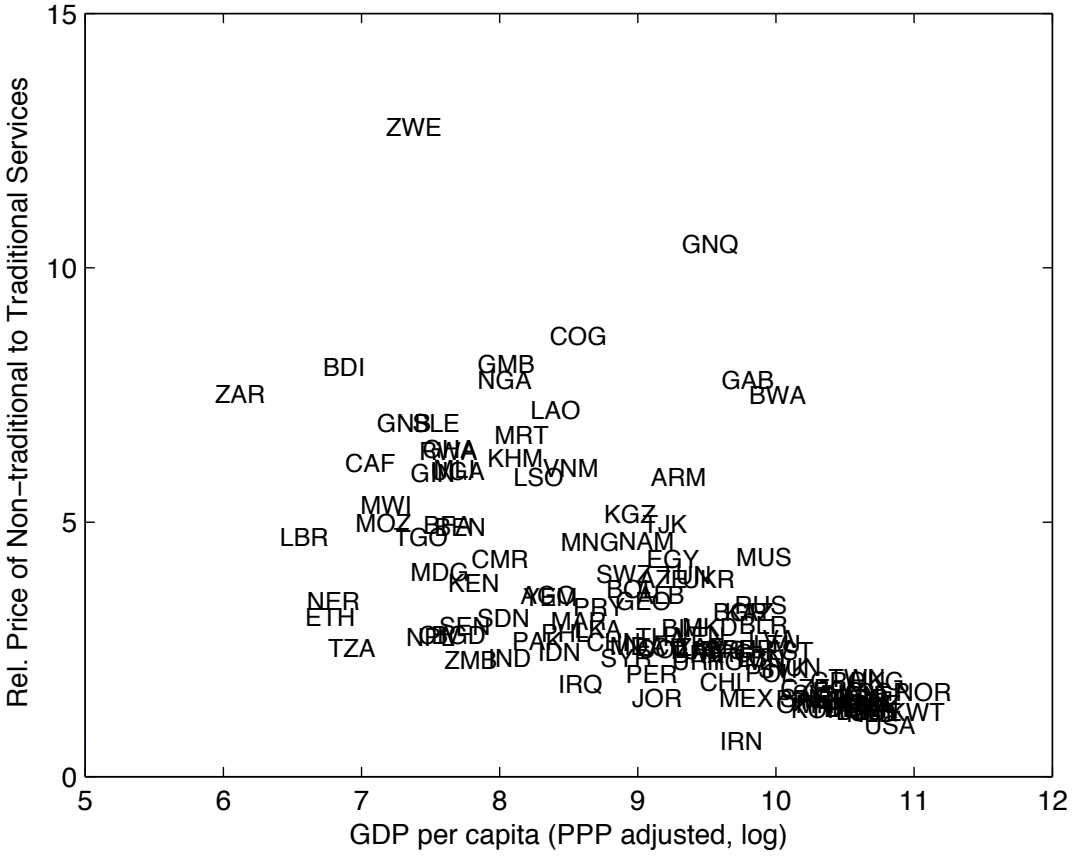
Note: Data for 2005 from ICP. Price of traditional services relative to the price of GDP. Traditional services include ...

Figure 5: Relative Price of Non-traditional Services across Countries



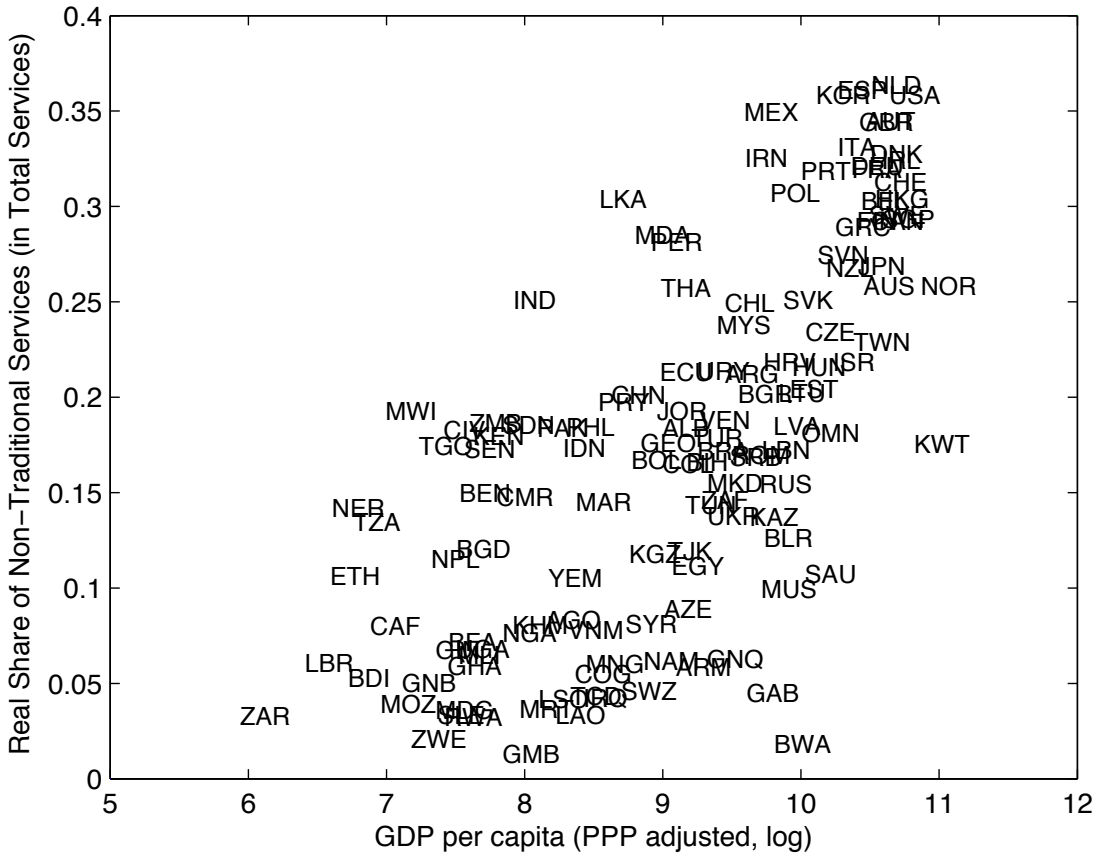
Note: Data for 2005 from ICP. Price of non-traditional services relative to the price of GDP. Non-traditional services include ...

Figure 6: Relative Price of Non-traditional to Traditional Services across Countries



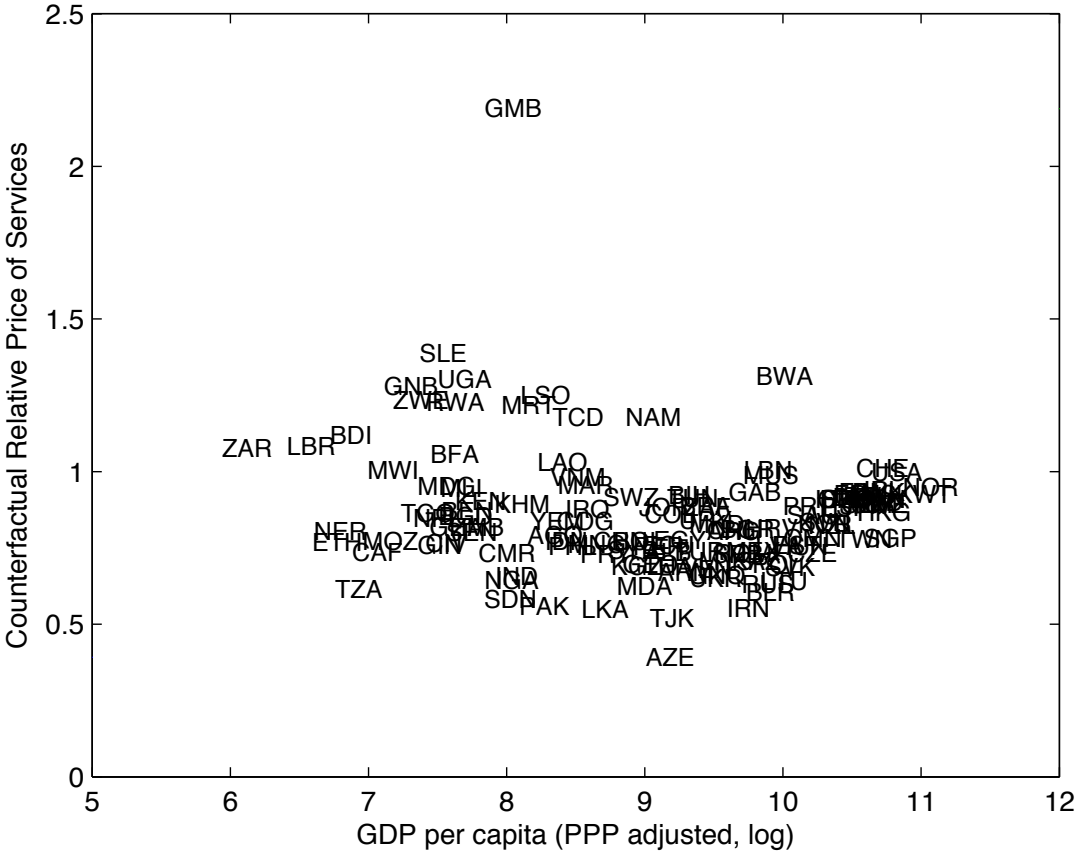
Note: Data for 2005 from ICP.

Figure 7: Real Share of Non-traditional Services across Countries



Note: Data for 2005 from ICP. The real share of non-traditional services refers to real expenditures in non-traditional services relative to real expenditures in total services. Real refers to expenditures at international prices.

Figure 8: Counterfactual Relative Price of Services



Note: The relative price of service is a weighted average of the relative prices of traditional and non-traditional services with the weight being the real share of each time of services. In the counterfactual, we compute the relative price of services for each country using the country relative prices but assuming the real share of traditional and non-traditional services to be the one of the United States.