【Notes】

Relative Importance of Tradable and Nontradable Prices within Japan

日本国内物価水準における財とサービスの重要性

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ABSTRACT

This paper examines empirically the importance of tradables and nontradables in determining Japanese local price levels. The traditional theory claims the price dichotomy of tradables and nontradables; the relative price level across areas is determined exclusively by nontradables. Tradables and nontradables are represented by goods and services, respectively. First, series of local price indexes of tradables and nontradables are compiled from published disaggregated CPIs for 47 cities in Japan. Then, the extent to which changes in relative price levels across cities are affected by tradable and nontradable facors is examined. Results show that relative price levels across cities are not dominated by the nontradable factor. Both the tradable and nontradable factors are important in determining changes in relative price levels across cities within Japan. The dichotomy of goods and services as final products fails even within a single country.

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1. Aim and background

This paper examines empirically the importance of tradables and nontradables in determining Japanese local price levels. Tradables are represented by goods, and nontradables are represented by services. Results show that changes in relative price levels across Japanese cities are *not* dominated by nontradables. Both tradables and nontradables are important in determining changes in relative price levels across the cities.

In the traditional model of international economics, the relative price level across countries is determined by nontradables, since the price levels of tradables are not regarded as differing between countries provided that trade is free. The traditional theory asserts a price dichotomy between tradables and nontradables because the price of tradables is determined globally and the price of nontradables is locally determined. The relative price level across countries is therefore determined exclusively by nontradables.

Application of the same concept to different areas within a single country indicates that relative price levels across areas should be explained mainly by the prices of nontradables. If local markets within a single country are well integrated with each other, which is a reasonable assumption in countries with an advanced economic system, tradables are subject to the Law of One Price, and changes in relative price levels should be due entirely to changes in the prices of nontradables. This paper investigates these questions empirically.

In the area of international economics, there have been many empirical studies which decompose changes in the real exchange rate into tradable and nontradable components. The real exchange rate here is a synonym for the relative price level across countries.

Engel (1999) measures empirically the importance of the price of nontradables in changes in US real exchange rates, and concludes that changes are dominated by changes in the prices of tradables. He asserts that changes in the prices of nontradables scarcely explain changes in real exchange rates, even in the long run. Because his results are in stark contrast with traditional norm of economics and its significant impact, numerous papers followed his study. The methodology used in his study has been adopted in many studies in the area, including Mendoza (2000), Burstein et al. (2005), Betts and Kehoe (2006 and 2008), Morales-Zumaqueros (2006), Ciplak (2007), Parsley (2007), Basche et al. (2009), and Parsley and Popper (2010).

Parsley (2007) examines the US real exchange rates against East Asian currencies, and concludes that the prices of nontradables explain almost none of the movements in real exchange rates.

Mendoza (2000) concludes that the relation between the real exchange rate and nontradables depends on the exchange rate system, based on examination of the real exchange rate between the US dollar and the Mexican peso. He asserts that the relation is stronger under a managed exchange rate system than under an exchange rate system with no explicit management policy. Betts and Kehoe (2008) claim that a stable real exchange rate leads to a strong relation, based on the real exchange rates among fifty countries. Morales-Zumaqueros (2006) and Ciplak (2007) assert that the importance of nontradables in determining real exchange rates changes over time.

Burstein et al. (2006) conclude that changes in the relative price of tradables and nontradables account for roughly 50% of cyclical movements in the real exchange rates; they look at OECD countries, examining import and export price indexes as well as the consumer price index (CPI). Betts and Kehoe (2006 and 2008) assert that the relation between the real exchange rate and nontradables depends on the choice of price index series and, also, on the choice of trade partners. They also assert that the relation is strong when the trade relationship between the two countries is intensive.

Parsley and Popper (2010) methodologically follow Engel (1999), but they take account of distinction between tradables and nontradables as inputs. Empirically, they take imports as tradable inputs, and conclude that the deviation of the law of one price in inputs contributes little in explaining change in the real exchange rate between the US and Japan.

Crucini and Landry (2011) use a methodology, which is different from the one initiated by Engel (1999), to study the same issue. They decompose the variance of the relative general price level into a portion attributed to the relative price of tradables and a portion attributed to the relative price of nontradables, assuming the same set of weights of tradables and nontradables in the general price index for all areas. They use goods and services to represent tradables and nontradables, respectively. They assert that the dichotomy of price levels of goods and services as final products fails, i.e., the relative price level is not exclusively attributed to service.[1)]

Previous empirical studies of real exchange rates across countries suggest that changes in relative price levels across areas within a single country should be determined mainly by changes in the prices of nontradables as follows:

(1) The relative price level across different areas within a single country can be interpreted as the real exchange rate between different areas under a fixed exchange rate system which sets the nominal exchange rate always equal to one. Based on the findings of Mendoza (2000) and Betts and Kehoe (2008), it should make the relation between the real exchange rate and nontradables strong.

(2) Trades between different areas within a single country are usually regarded as more intensive than those across an international border. Betts and Kehoe (2006 and 2008) claim that a tight trading relationship causes a strong relation between nontradables and the real exchange rate. The relation between nontradables and relative price levels across areas should therefore be strong within a single country.

However, the results in this paper indicate that changes in relative price levels across citites within Japan are strongly affected not only by changes in the prices of nontradables, which are represented by the price of services, but also by those of tradables, which are represented by those of goods.

The logic of Engel (1999) has only rarely been applied to regional economies within a single country in empirical studies. Chen et al. (2006) is one of the few applications of Engel's methodology to regional economies within a single country, investigating relative price levels across US major regions and also cities. They examine how relative price levels across areas within the US are affected by tradable and nontradable factors. They claim that, if the entire contiguous US is partitioned into four major regions, nontradables play a central role in explaining changes in relative price levels across regions. They claim, however, that tradables are also important in explaining changes in relative price levels across cities. The present paper applies Engel's methodology and examines the relative importance of nontradables in determining Japanese local price levels.

The relative influence of tradables and nontradables on local price levels within a single country hinges on the extent of integration of domestic local markets. The traditional assumption is that markets of tradables are integrated, and markets of nontradables are segmented. In that case, then differences among local price levels are due exclusively to nontradables. Empirical studies show that integration of markets of tradables is not guaranteed even within a single country, however. For example, Ikeno

(2014) shows that inter-city convergence of price indexes, many of which are exclusively based on tradables, is limited within Japan.

2. Data

This paper uses the price index of goods as the price index of tradables, and the price index of services as the price index of nontradables. The Japanese Statistics Bureau (JSB) publishes monthly the national general and disaggregate CPIs, and the general and disaggregate CPIs for all 47 Japanese prefecture capitals. It also publishes the national CPIs of goods and services separately. It does not publish local CPIs of goods and services separately, however. In this paper, local series of price indexes of goods and services are compiled monthly for the period 1985:01-2016:12 from the published local disaggregate CPIs, using the national CPI weights of 2000. The base year of CPI weights 2000 is chosen because it is essentially the mid-point of the sample period.

The JSB classifies all items covered by the general CPI into 47 groups, and publishes their monthly local price indexes. Based on the definition of goods and services used by the JSB, these 47 groups are classified below into goods and services. Details of the classification are given in the appendix.

The local price indexes of tradables and nontradables, denoted as $P_{i,t}^{T}$ and $P_{i,t}^{N}$ are calculated as follows;

$$P_{i,t}^{T} = (\sum_{g=1}^{m} \mathrm{w}_g \times CPI_{i,t}^{g}) / \sum_{g=1}^{m} \mathrm{w}_g \ ,$$

and

$$P_{i,t}^{N} = (\sum_{s=1}^{n} \mathrm{w}_s \times CPI_{i,t}^{s}) / \sum_{s=1}^{n} \mathrm{w}_s$$

where w_g is the national weight of price index g classified as goods, w_s is the national weight of price index s classified as services, and $CPI_{i,t}^{g}$ and $CPIi_{i,t}^{s}$ are their local price index in capital city i. The coefficients w_g and w_s represent weights used for compilation of the national CPI in 2000.

For the general price $P_{i,t}$, the following index is used in place of the original numbers published by the JSB, so as to be consistent with the tradable and nontradable price indexes calculated in this paper:

$$P_{i,t} = (\sum_{g=1}^{m} \mathrm{w}_g \times CPI_{i,t}^{g} + \sum_{s=1}^{n} \mathrm{w}_s \times CPI_{i,t}^{s}) / (\sum_{g=1}^{m} \mathrm{w}_g + \sum_{s=1}^{n} \mathrm{w}_s) \ .$$

In the following analysis, the logarithms of the tradable, nontradable and general price indexes are used, such that

$$p_{i,t}^{T} \equiv \log (P_{i,t}^{T}) \ ,$$
$$p_{i,t}^{N} \equiv \log (P_{i,t}^{N}) \ , \text{ and}$$
$$p_{i,t} \equiv \log (P_{i,t}) \ .$$

3. Methodology

The paper uses two types of measure to estimate the extent of effects of nontradable prices on the general prices. One follows the methodology in Engel (1999), and the other

follows that of Chen et. (2004). Both separate the movement in the general price level into tradable and nontradable parts.

3-1 The Engel measure

The general price index of the i'th area in period t in log, $p_{i,t}$, is given by the following Equation, where α is the share of nontradables in the general price index:

$$p_{i,t} = (1-\alpha)p_{i,t}^{T} + \alpha p_{i,t}^{N}.$$ [2)]

The relative general price level across areas i and j in period t is denoted by $q_{ij,t}$ and is defined as:

$$q_{ij,t} = p_{i,t} - p_{j,t} \ .$$

The relative general price level can therefore be written as

$$q_{ij,t} = x_{ij,t} + y_{ij,t}$$

where

$$x_{ij,t} = p_{i,t}^{T} - p_{j,t}^{T}$$
$$y_{ij,t} = \alpha\left(p_{i,t}^{N} - p_{i,t}^{T}\right) - \alpha\left(p_{j,t}^{N} - p_{j,t}^{T}\right) \ .$$

Here, $x_{ij,t}$ is the relative price of tradables, and $y_{ij,t}$ is the ratio of nontradable-tradable relative prices. If the two local markets of tradables are integrated, then tradables are arbitraged and $x_{ij,t}$ is zero, implying that changes in the general price, $q_{ij,t}$, between two areas come entirely from $y_{ij,t}$.

Engel (1999) formulates the following measure;

$$B_{ij}(k) = MSE\left(x_{ij,t} - x_{ij,t-k}\right)/\left(MSE\left(x_{ij,t} - x_{ij,t-k}\right) + MSE\left(y_{ij,t} - y_{ij,t-k}\right)\right) \ ,$$

where the mean squared error, MSE, is defined as

$$MSE(a_t - a_{t-k}) \equiv \frac{1}{n-k}\sum_{t=k+1}^{n}(a_t - a_{t-k})^2 \quad .$$

Here, $B_{ij}(k)$ is interpreted as the proportion of the contribution of tradables in the change of the general price level over k periods. It is defined by allocating the covariance of the two factors to fluctuations in y_{ij} in proportion to the relative size of its variance. If tradable markets are perfectly integrated, $B(k)$ should be zero for all k. It is reasonable to assume that arbitrage needs some time and cost to occur, due presumably to transportation costs and other transaction costs. Then, $B_{i,j}(k)$ is expected to decrease over k.

3-2 The Chen-Choi-Devereux (CCD) measures

Chen et al. (2004) define the following measure;

$$V_{ij} = \left(var\left(w_{ij}\right) + cov\left(w_{ij}, z_{ij}\right)\right)/var(q_{ij})$$

where $w_{ij} = \alpha(p_i^N - p_j^N)$, and $z_{ij} = (1-\alpha)(p_i^T - p_j^T)$. This measure corresponds to the proportion of the contribution of nontradables in the variance of the relative general price under the assumption that the covariance of these two factors is equally allocated to the factors. If the markets of tradables are perfectly integrated, the variance of the relative general price comes wholly from the variance of the relative price of nontradables,

implying that V_{ij} should be equal to unity.

4. Empirical results of the two measures

4-1 The Engel measures

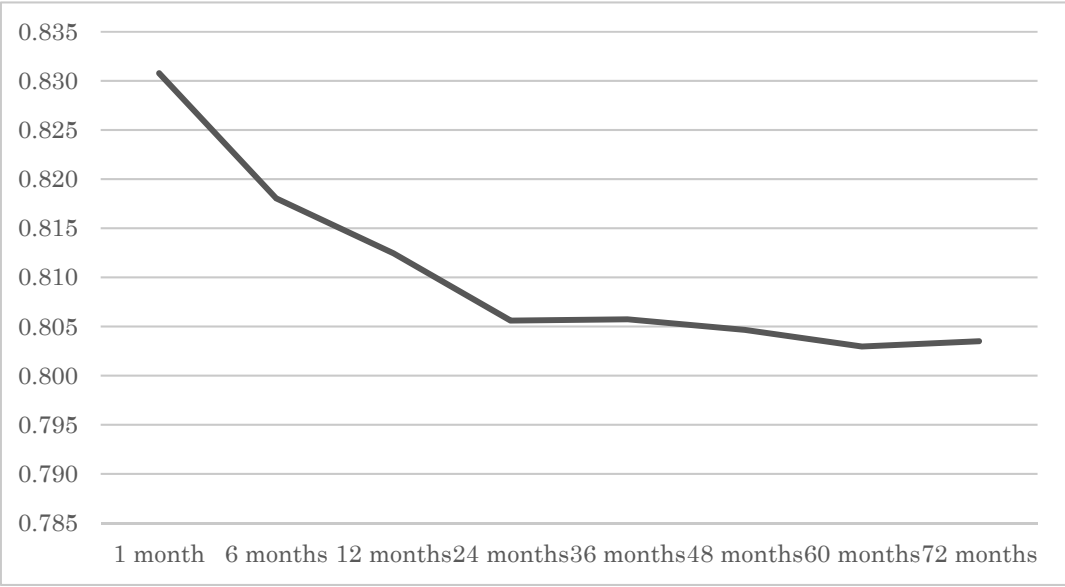
Table 1 reports averages, maximums, minimums, and variances of the Engel measures. The start of the period is k months after 1985:01. The end is in 2016:12. The number of samples is equal to 47×46/2=1081 since there are 47 prefecture capitals in Japan. Figure 1 depicts the same results graphically. The averages indicate that the movements of the relative general price levels between capital cities is due mainly to the tradable factors. The nontradable factors explain a small portion of intercity price differences even over several years. The proportion due to tradables decreases over time as expected, but it still remains dominant even over years. It is remarkable that the measure still exceeds 0.8 even after 72 months. This is contrary to the notion of integrated Japanese local markets of tradables.

The minimum of the Engle measures substantially decreases as k increases. It means as follows: the difference in the regional general price levels is due exclusively to the tradable factors over a short periods, but there are some cases where the difference in the regional general price levels is due dominantly to the nontradable factors over a long periods. This result suggests that arbitrage of tradables is not carried out instantaneously and it needs a substantial time. On the other hand, the maximum does substantially change even when k increases. It suggests that arbitrage of tradables fails to work even in a long run in some cases.

Table 1. The Engel measures

k	1	6	12	24	36	48	60	72
average	0.831	0.818	0.812	0.806	0.806	0.805	0.803	0.804
max	0.887	0.893	0.900	0.921	0.934	0.935	0.937	0.951
min	0.736	0.669	0.615	0.520	0.488	0.427	0.372	0.320
var	0.001	0.001	0.002	0.004	0.005	0.007	0.009	0.010

Figure 1. Averages of the Engel measures



4-2 The CCD measure

Table 2 reports descriptive statistics of the CCD measures over various sample periods. The number of samples is equal to that of the Engel measures, i.e., 1081. The results indicate that the nontradable factors explain a small fraction of the intercity price variances for all periods. Inflation rates changed drastically over the whole sample period 1985:01 to 2016:12. Hence, the measure is calculated over various subsample periods. The averages indicate the measure does not substantially change over different subsample periods. The variance of the intercity general prices derive mostly from the variance of the intercity relative tradable prices. Although this is again contrary to the notion of the integration of local tradable markets in Japan, the results are consistent with those from the Engel measures.

Table 2. CCD measures

periods	start	1985:01	1985:01	2000:01	1985:01	1995:01	2005:01
	end	2016:12	1999:12	2016:12	1994:12	2004:12	2016:12
average		0.200	0.271	0.199	0.261	0.241	0.282
max		3.591	5.120	1.988	4.350	2.393	1.486
min		-0.392	-0.299	-0.616	-0.312	-0.403	-0.714
var		0.150	0.168	0.099	0.160	0.148	0.087

4-3 Effects of intercity distances

Suppose that arbitrage of tradables between local markets is subject to transaction costs, and suppose also that nontradables are not arbitraged between local markets, due to their immobility. If transaction costs are typified by transportation costs and consequently increase with the distance between the two markets, the difference in prices of tradables remains more as the two markets are further from each other. The effects of prices of tradables on the intercity relative general prices increase, and the effects of nontradables decrease, as the distance between two cities increases. This hypothesis is tested using the Engel measures and the CCD measures.

The following equations are estimated by the OLS across the pairs of cities:

$$B(k)_{ij} = \alpha_0 + \alpha_1 DIST_{ij} \quad \text{, and}$$

$$V_{ij} = \beta_0 + \beta_1 DIST_{ij} \quad ,$$

where $B(k)_{ij}$ is the Engel measure for the pair of cities i and j, V_{ij} is the CCD measure for the pair of cities i and j, and $DIST_{ij}$ is the logarithm of the distance between cities i and j in kilometers. Of the coefficients, if arbitrage of tradables works, α_1 is expected to be negative, and β_1 is expected to be positive. The number of samples is equal to 1081.

Table 3 reports the results from the Engel measures. Since arbitrage of tradables is found to take a substantial time, the results are shown for $k \geq 24$. The results indicate that, although the sign of the distance is always negative as expected, the distance is significant for $k \geq 60$ at the conventional significance level. This is interpreted to mean that arbitrage of tradables takes a long time to work in the way expected. In a short-run, arbitrage of tradables works only a little.

Table 4 reports the results from the CCD measures. The distance is either significantly positive or insignificantly negative, in accordance with expectation. The distance is insignificant for periods starting after the mid-1990s, when the Japanese economy has been marked by continuous weak deflation. Inflation rates fell within a very limited range. A possible reason for these results is that most of the explanatory variables, namely the intercity differences in prices, are distributed within a very narrow range around zero, and it does not lead to the expected results.

Table 3. The Engel measures and distances

k	24	36	48	60	72
constant	0.807	0.817	0.834	0.845	0.861
	(54.191)	(49.023)	(43.496)	(39.708)	(37.154)
$DIST_{ij}$	0.000	-0.002	-0.005	-0.007	-0.010
	(-0.061)	(-0.654)	(-1.563)	(-1.980)	(-2.492)
R^2	-0.001	-0.001	0.001	0.003	0.005

Note: t-values in parentheses.

Table 4. CCD measures and distances

periods	start	1985:01	1985:01	2000:01	1985:01	1995:01	2005:01
	end	2016:12	1999:12	2016:12	1994:12	2004:12	2016:12
constant		0.008	0.019	0.306	0.011	0.262	0.347
		(0.088)	(0.199)	(4.263)	(0.121)	(2.973)	(5.155)
$DIST_{ij}$		0.032	0.042	-0.018	0.042	-0.003	-0.011
		(2.193)	(2.721)	(-1.497)	(2.772)	(-0.240)	(-0.980)
R^2		0.004	0.006	0.001	0.006	0.000	0.000

Note: t-values in parentheses.

5. Conclusion

The Engel measures and the CCD measures both indicate that the intercity price difference comes from tradables rather than nontradables. This result is consistent with those from empirics of international price differences, such as Engle (1999) and most subsequent studies. Chen et al. (2006) claim that a long time is necessary for the effects of tradables on the inter-regional difference in the general price level in the US to become substantial. The results from the empirics in the present paper are also in accordance with these results. These results are not consistent with the traditional ideas expressed as follows, even after allowing substantial adjustment time: “Japanese local markets are well connected with each other, and hence integrated. Transportation of tradables is spontaneous and the prices of tradables rarely differ from each other, while local markets of nontradables are segmented due to their immobility”.

These observations undermine the traditional idea that nontradables dominate change in the relative price level across areas. They are in contrast to what are suggested by the results in Mendoza (2000) and Betts and Kehoe (2006 and 2008), and are consistent with the results about US cities in Chen et al. (2004).

Given the idea that local markets of goods are well integrated within Japan, the results are surprising. The results suggest failure of the price dichotomy of goods and services as final products within Japan. This paper show that failure of the price dichotomy, which Crucini and Landry (2011) show using cities located across international borders, holds even within a single country. Note that analyses in this paper depend on the CPI and, hence, the price indexes compiled in this paper are based on prices of final products.

The results in this paper have two possible interpretations. One is that arbitrage between local markets of goods is not perfect within Japan, because of economic factors such as transportation costs and local monopolies. The other is that goods are not sufficiently tradable. The latter casts doubt on the usefulness of distinguishing goods and services from the point of view of the price index.

Atkeson and Burstein (2008) theoretically analyze economic factors causing violation

of the PPP for tradable goods in the framework of a two-country model. They conclude that transaction costs of international trade and imperfect competition, which leads to pricing-to-market, are essential for the deviation from the PPP. Their results suggest that transportation costs between areas and local monopoly in each area should be responsible for differing prices of tradable goods between areas within a single country. Basche et al. (2009) stress the importance of costs which are attributed to the distribution process, which are understood to affect retail prices of final goods.[3)]

On the other hand, the results from the within-region analysis in this paper indicate that an introduction of simple transportation costs, such as those which are assumed to be simply correlated with geographical distances, cannot be an answer to the issue.

The difficulty in distinguishing between tradability and non-tradability is troublesome. As pointed out in the literature, retail prices of final goods involve not only tradable components but also nontradable components such as marketing service.[4)] Of course, the Japanese CPIs reflect such nontradable components in the prices of goods. Crucini and Landry (2011) recently combine price analysis and input-output analysis to investigate effects of nontradable inputs in goods. Parsley and Popper (2010) stress importance of distinction between tradables and nontradables as inputs, rather than as final products. An extension of the current study towards such direction will be useful.[5)]

Appendix: Classification of goods and services

The Japanese Statistical Bureau classifies all items covered by the general CPI as goods or services. This classification matches fairly closely, but not completely, the classification of all items into the 47 groups whose each local price index are published monthly.

A total of 34 groups are classified as goods in this paper, as follows; (1) cereals, (2) fish and shellfish, (3) meat, (4) dairy products and eggs, (5) vegetables and seaweeds, (6) fruits, (7) oils, fats and seasonings, (8) cakes and candies, (9) cooked foods, (10) beverages, (11) alcoholic beverages, (12) electricity, (13) gas, (14) other fuel and light, (15) water and sewage charges, (16) household durables, (17) interior furnishings, (18) bedding, (19) domestic utensils, (20) domestic non-durables, (21) clothes, (22) shirts, sweaters, and underwear, (23) footwear, (24) other clothing, (25) medicines and health fortifications, (26) medical supplies and appliances, (27) private transportation, (28) textbooks and reference books for study, (29) recreational durables, (30) recreational goods, (31) books and other reading materials, (32) toilet articles, (33) personal effects, and (34) cigarettes.

A total of 13 groups are classified as services, as follows: (1) eating out, (2) rent, (3) repairs and maintenance, (4) domestic services, (5) services related to clothing, (6) medical services, (7) public transportation, (8) communication, (9) school fees, (10) tutorial fees, (11) recreational services, (12) personal care services, and (13) others.

All but four groups contain items of either only goods or only services, based on the

Japan Statistical Bureau's definition. These four groups are: water and sewage charges; private transportation; recreational durables; and personal effects. These four groups are classified as either goods or services in compiling the data in this paper, depending on which of goods and services share more in compilation of the national CPI. The effects of the mixture of goods and services in these groups are not considered to be critical in the data compilation. The weights of these groups in the general CPI are not large, and either goods or services overwhelm the other in these groups on the basis of the national CPI. The detailed weights of each item are not published for all local CPIs, although detailed weights of each item *are* published for the national CPI. Based on weights in the national CPI, the weights of services in the price index of goods that is defined in this paper is 7.3%, and the weights of goods in the price index of services defined in this paper is 1.8%.

Notes

1) They, further, assert that the dichotomy holds when tradability of intermediate inputs are taken into account.
2) The general price levels used for empirics in this paper are compiled as the arithmetic means as indicated above. However, the numerical differences between arithmetic and geometric means are small with the data used in this paper.
3) Their results indicate that the difference between final retail prices and prices at-the-dock explain most fluctuations in the US real exchange rate.
4) For example, see Crucini et al. (2005).
5) The methodology in Crucini and Landry(2011) cannot be directly applied to the study in this paper because of some restrictive assumptions used in their paper.

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（要旨）
この論文は、日本の地域物価水準の決定において、地域間取引可能な財と地域間取引不可能なサービスの相対的重要性を実証的に検証する。 伝統的な経済理論は、取引可能な財と取引不可能なサービスの価格に関する二分法を主張している。地域間の相対物価水準は、地域間取引不可能なサービスによって決定されると考えられている。まず、47都道府県所在地について公表されている日本のCPIから、財とサービスの物価水準のデータを作成する。 次に、都市間での相対物価水準の変化が、財とサービスによってどの程度影響を受けているかを調べる。結果は、都市間の相対物価水準は、取引不可能なサービスの要因によって決まっているわけではないことを示している。地域間取引可能な財と取引不可能なサービスの両方が、日本国内の都市間の相対的な物価水準の変化において大きな比重を占めている。物価水準の決定における財とサービスの二分法は日本国内で成り立たないことを結果は示している。