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Abstract

This study reconsiders the well-known cross-country positive association between prices and income by focusing on heterogeneity between the inter-developed-country and inter-developing-country relationships. Empirical results reveal not only that developed and developing countries differ in magnitude of the income effect on prices, but also that they exhibit the positive price-income association for different reasons. Specifically, we find only for the inter-developed-country case that the positive price-income association is attributable, at least partly, to the Balassa-Samuelson productivity differential effect. The idiosyncrasy of the inter-developing-country relationship is not dissolved by controlling for the effects of a variety of real and financial variables.

JEL-Code: F410, F310, E010.

Keywords: Balassa-Samuelson effect, non-traded goods, purchasing power parity, Penn effect, price-income relationship, productivity differential, real exchange rate.

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1. Introduction

It is well known that national price levels exhibit significant positive association with levels of real *per capita* income. The positive effect of income on price is known as the Penn effect (Samuelson, 1994), coined after a series of pioneering studies by the Penn scholars to document the effect by constructing internationally comparable data (Kravis, Heston and Summers, 1978; Kravis and Lipsey, 1983, 1987, 1988; and Summers and Heston, 1991). Corroborated by a plethora of subsequent studies (Bergin, Glick and Taylor, 2006; Deaton and Heston, 2010; Ravallion, 2010; Rogoff, 1996), the Penn effect has become conventional wisdom in international economics (Bergin 2009). According to Samuelson (1994), it is “a fundamental economics fact”. The implication of the effect is profound for understanding how prices relate to each other across countries. By revealing that absolute purchasing power parity (PPP) fails systematically in association with real income levels, the Penn effect provides an important clue regarding how the PPP theory needs to be modified in order to bear empirical relevance.

The current study, however, argues that the price-income relationship across countries is more complex than commonly portrayed. We show that the positive price-income relationship estimated with cross-sectional data lumping developed and developing countries together can be misleading. Our empirical results reveal not only that developed and developing countries differ in terms of magnitude and significance of the Penn effect, but also that they exhibit positive price-income relationship for different reasons. The conventional cross-country estimates mix these heterogeneous effects, failing to inform us on the essential aspects of the relationship between price and income levels across diverse countries.

The essence of the problem is succinctly put by Rogoff (1996) in examining how prices and income are related to each other across 100 countries in the 1990 data:

> "… whereas the relationship between income and prices is quite striking over the full data set, it is far less impressive when one looks either at rich (industrialized) countries as a group, or at developing countries as a group." (Rogoff 1996, p.660)

In the current study, we reconsider the cross-country price-income relationship by focusing on heterogeneity between the inter-developed-country and inter-developing-country income effects on prices. Using the data on some 180 countries for 1980-2010, we estimate the cross-country price-income relationship while allowing for heterogeneity between the inter-developed-country and inter-developing-country effects. To explore sources of the documented heterogeneity, we examine relevance of the sectoral productivity differential effect à la Balassa (1964) and Samuelson (1964).

Our main findings are summarized as follows. While the positive price-income relationship is commonly portrayed as a robust phenomenon across a large number of countries, until the mid-1990s it is driven almost entirely by the inter-developed-country effect. Across developing countries, the effect of income on price is initially nil. In the first half of the 1990s, however, the inter-developing-country effect turns significantly positive and its magnitude grows substantially in the subsequent years.

Nonetheless, this transformation does not attain homogeneity of the price-income relationship between the developed and developing country groups. Specifically, we find that the magnitude of the inter-developed-country income effect on prices is far greater than that of the inter-developing-country effect.

More importantly, our results suggest that the developed and developing countries exhibit the positive price-income relationship for different reasons. Specifically, we find that the inter-developed-country income effect on price is attributable, at least partly, to the Balassa-Samuelson (B-S henceforth) effect. The inter-developing-country effect, however, is found clearly inconsistent with the B-S effect. The results are robust to controlling for the effects of a variety of real and financial variables including the output share of service, trade openness, government spending, exchange rate regimes, capital account openness, and natural resource abundance.

The remainder of this paper is organized as follows. Section 2 discusses the linkages between relative price, income, and sectoral productivity. Section 3 describes the data and presents the year-by-year Penn effect estimates for the full and stratified samples. In section 4, we test if the observed price-income association can be attributed to the B-S productivity differential effect. Section 5 implements panel estimations while incorporating various control variables for robustness. In section 6, we explore sources of the difference between the inter-developed-country and inter-developing-country price-income relationships. Finally, some concluding remarks are provided in section 7.

2. Price, income, and sectoral productivity

The Penn effect refers to the empirical positive effect of real *per capita* income on general prices. To understand why the effect arises, one needs a theory. To this end, the most eminent is the B-S theory that highlights the implications of international differences in relative sectoral productivities.[1] To see how the B-S theory and the Penn effect are related to each other, we consider below a simplified version of the B-S model consisting of two countries, each producing traded and non-traded goods competitively using labor as input.

The logged relative price of the two countries is expressed

$$p - p^* = \theta(p_N - p_N^*) + (1-\theta)(p_T - p_T^*) \quad (1)$$

for which θ is the share of non-traded goods, p_N and p_T denote respectively the non-traded and traded goods prices, and * indicates that the variables are of the reference country. Time subscripts are omitted for notational brevity.

In the standard B-S model, the following three key assumptions are made: competitive prices; inter-sectoral labor mobility within each country; and the law of one price (LOP) for traded goods.

With $w^{(*)}$ and $a^{(*)}$ respectively denoting wage and labor productivity in logs in the non-traded goods sector, competitive prices assure

$$p_N^{(*)} = w^{(*)} - a_N^{(*)} \quad (2)$$

Since labor is mobile between sectors, w is equalized between the two sectors within each country so that

$$w^{(*)} = p_T^{(*)} + a_T^{(*)} \quad (3)$$

From (2) and (3) we obtain

$$(p_N - p_T) - (p_N^* - p_T^*) = (a_T - a_N) - (a_T^* - a_N^*) \quad (4)$$

[1] There are other accounts that focus on inter-country differences in relative factor endowments and sectoral factor intensity (Bhagwati, 1984; Kravis and Lipsey, 1983) and the effect of non-homothetic demand structures (Bergstrand, 1991).

Equation (4) is a streamlined version of the key proposition of the B-S theory that the relative price of non-traded goods (to traded goods) is higher in a country with a higher relative productivity in the traded goods sector (over the non-traded goods sector). We emphasize that the B-S theory relates international difference in the relative prices of non-traded to traded goods, rather than the general price levels, to that in relative sectoral productivities.

In the price-income (i.e. the Penn effect) regression, the left-hand-side variable is cross-country difference in general price levels, rather than those in relative non-traded goods prices. The gap can be filled by the LOP assumption in the traded goods sector. Specifically, from (1), (4), and assuming $p_T = p_T^*$, we obtain

$$p - p^* = \theta[(a_T - a_N) - (a_T^* - a_N^*)] \qquad (5)$$

As comparison of (4) and (5) indicates, under the key assumptions made above, the cross-country difference in general price levels are accounted for by the same relative sectoral productivity differentials that determine cross-country difference in relative non-traded goods prices.

To relate price differentials to income differentials, an oft-used auxiliary assumption is that international productivity difference in the non-traded goods sector is less substantial than those in the traded goods sector. A convention is to assume non-traded goods to be traditional services such as haircut, while traded goods to be skill-intensive manufactures.[2]

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[2] However, more sophisticated services such as information technology and medical services have substantial international productivity differences and yet can still be largely non-traded.

We note, however, neither (4) nor (5) require that a country with a greater productivity advantage in the traded goods sector over the non-traded goods sector has a higher income level. Neither do they necessitate international productivity difference in the non-traded goods sector to be smaller than that in the traded goods sector. A higher income in one country than other can be attained via a higher productivity in either of the two sectors, or both. If a country has productivity advantage over other in both sectors in an equal proportion, (5) suggests that their price levels are the same although their income levels differ. Similarly, if productivity advantage of rich countries over poor ones is more substantial in the non-traded goods sector than in the traded goods sector, prices and income should be negatively associated with each other.

What is crucial in relating the Penn effect to the B-S effect is the correspondence between tradability and productivity of the sectors. For the B-S effect (i.e. the sectoral productivity differentials effect) to be a driver of the Penn effect (i.e. the positive income effect), it has to be the case that the sector whose products are highly traded is the sector that has substantial international productivity difference. The validity of this proposition turns out to be rather different between the inter-developed-country and inter-developing-country cases, as will be seen below.

3. The Penn effect estimates

3.1 Data and canonical estimates

The data we use come from the World Bank's World Development Indicators (WDI) Database. Our dataset spans the maximum of 182 countries for the period of

1980-2010. Due to missing observations, the effective number of countries varies by year.[3] See the data appendix for further details.

As a preliminary investigation, we estimate the canonical cross-country Penn effect regression equation

$$p_i = \alpha + \beta y_i + \varepsilon_i \ , \qquad (6)$$

for which p_i and y_i are country *i*'s general price level and *per capita* GDP for a given year, respectively.[4] Both variables are measured in logged relative terms to the US, the reference country denoted by * in the previous section. For the rest of the paper, variables are gauged in relative terms to the US observations unless otherwise noted.

In estimating (6) by pooling observations across all countries, we implicitly assume as many preceding studies that the price-income relationship is homogeneous regardless of whether it is considered within a group of developed countries, within a group of developing countries, or between developed and developing countries.

Table 1 presents the estimation results in five-year intervals. The heteroskedasticity-robust standard errors (White 1980) are provided in the parentheses. The top panel summarizes the estimates based on the maximum sample in each year. For comparison, the bottom panel shows the results with a fixed sample of 115 countries for which both price and income data are available throughout 1980-2010.

In both panels, the estimated effect of income on price is significantly positive in accordance with the consensus of the extant literature. Nevertheless, we notice substantial time variation in the magnitude of the Penn effect. The point estimates

3 The number of sample countries ranges from 125 in 1980 to 183 in 2010.
4 The price variable is the PPP conversion factor to market exchange rate ratio, while the income variable is the GDP per capita, PPP in constant 2005 international dollar.

Table 1. Canonical Penn effect estimates

	1980	1985	1990	1995	2000	2005	2010
A.. Maximum sample							
Income	.096**	.062*	.155**	.213**	.213**	.222**	.164**
	(.027)	(.028)	(.029)	(.025)	(.018)	(.017)	(.017)
Constant	-.230**	-.553**	-.355**	-.221**	-.368**	-.193**	-.152**
	(.053)	(.054)	(.029)	(.060)	(.045)	(.041)	(.040)
Adjusted R^2	.102	.040	.173	.362	.427	.530	.393
N	125	139	166	174	180	182	167
B. Fixed sample							
Income	.094**	.078*	.184**	.227**	.235**	.232**	.179**
	(.029)	(.031)	(.029)	(.028)	(.019)	(.020)	(.018)
Constant	-.235**	-.525**	-.201**	-.116†	-.238*	-.110*	-.082*
	(.061)	(.057)	(.065)	(.065)	(.044)	(.048)	(.043)
Adjusted R^2	.087	.078	.292	.452	.615	.589	.483
N	115	115	115	115	115	115	115

Notes: The entries summarize the estimation results of (6). **, * and † indicate statistical significance at 1%, 5% and 10% levels, respectively. The results in panel A are based on the data on the maximum sample available in each year. Those in panel B are obtained by using the data on the same 115 countries for all years. *N* denotes the number of observations.

indicate that the magnitude of the effect is more than doubled in a quarter century. The 2010 estimates suggest, however, a declining symptom in the most recent period. A thorough time profile of the coefficient estimates is drawn in Figure 1 with the 95 % confidence intervals. As the figure depicts, a significant shift in the Penn effect occurs from the late 1980s to the early 1990s. The chief driver of this shift turns out to be altering behavior of developing countries, as we will see in the next subsection.

Figure 1. Time profile of the canonical Penn effect estimates

Notes: The real line depicts the point estimates of the Penn effect. The dotted lines indicate the 95 % confidence intervals.

To highlight the problem of the convetional estimates, we repeat Rogoff's exercise using our 1990 data to provide a regression scatter plot as Figure 2-A.[5] A striking feature of the plot is that the high-income OECD countries, denoted by shaded

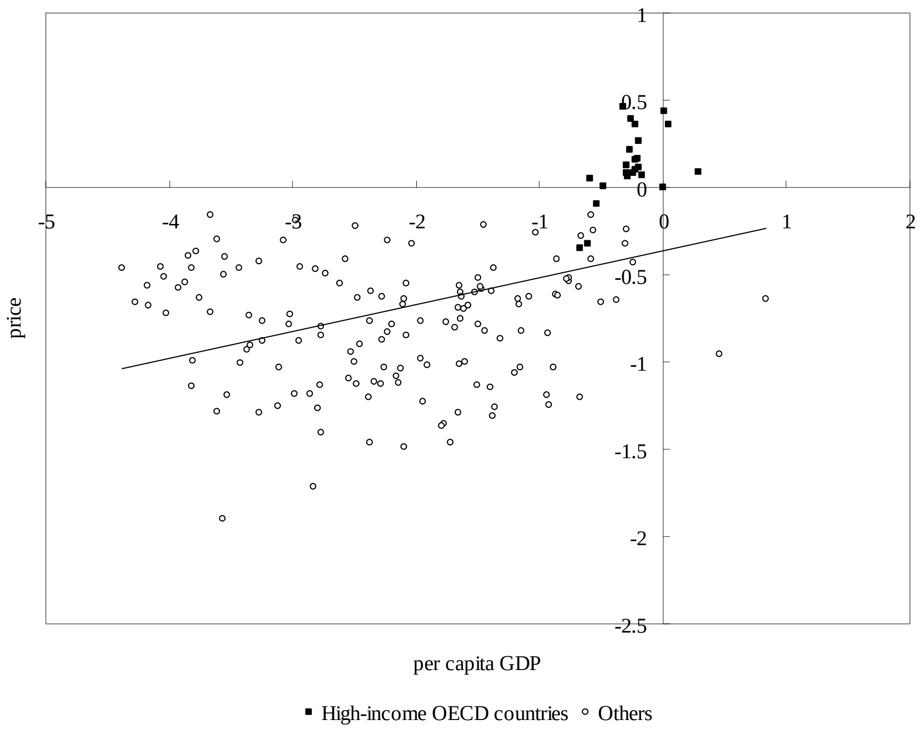
[5] Rogoff (1996) presents a regression scatter plot using the Penn World Table data on 100 countries for 1990. Ours uses the WDI data on 167 countries.

squares, uniformly deviate far upward from the regression line. In fact, Greece and Portugal aside, they are virtually outliers as a group. We also provide a plot for the 2005 data as Figure 2-B to indicate the persisting symptom of the problem. While there is a general tendency that very rich countries have higher prices than very poor ones, defining it as a linear homogenous relationship across countries over a wide income range is problematic. This is, of course, a reiteration of Rogoff (1996).

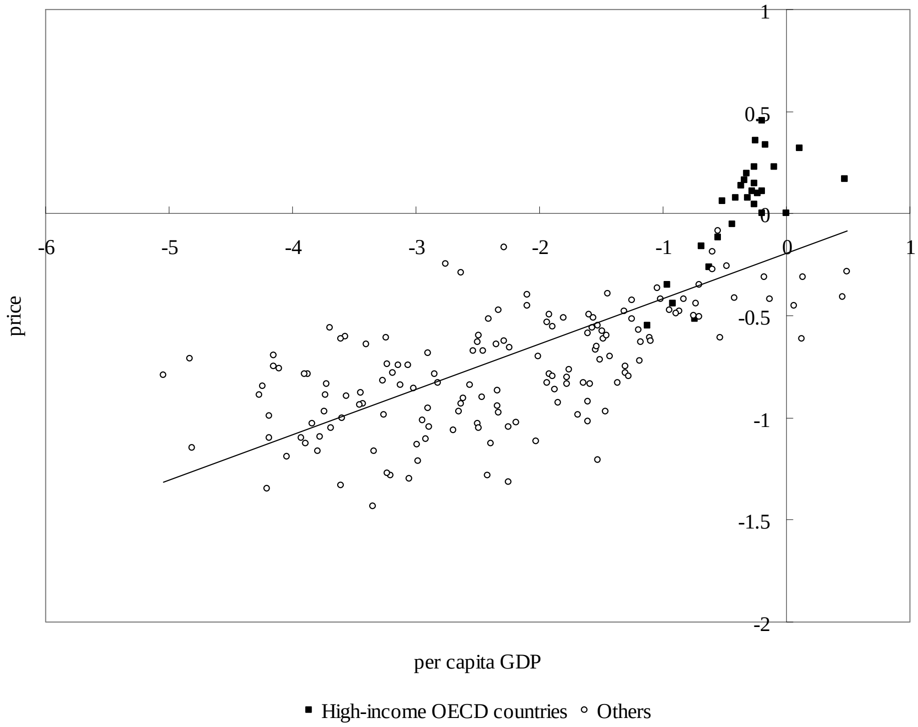
In view of Figure 2-B, we also notice in the high income range a non-negligible number of countries that have unambiguously lower prices than the OECD countries. That is, at the higher income end, countries diverge in their prices into two distinct groups. The canonical price-income regression line lies in-between to reflect the behavior of neither group. We will elaborate on the point later in section 6.

Figure 2. Cross-country price-income relationship

A. The 1990 data



B. The 2005 data



Notes: Price and income are both in logged relative terms to the US observation.

3.2 Inter-developed-country and inter-developing-country effects

Upon the advent of comprehensive international data sets such as the WDI and the Penn Word Table, it has become a popular practice to pool observations on a vast number of countries, including both developed and developing ones, in estimating the cross-country price-income relationship.[6] Nevertheless, it should be recalled that in the seminal study Balassa (1964) considers the relationship *within* solely industrially developed countries. Furthermore, Balassa (1973, 1974) explicitly warns against

[6] The practice is quite common. See for instance Bergin et al. (2006), Frankel (2006), and Rogoff (1996) among many others.

extrapolating the price-income relationship observed for the developed countries to developed-developing country relationships.[7]

The crux of Balassa's argument is that developed and developing countries differ in the importance of the non-traded goods sector, natural resource endowment, height of tariffs, and amount of capital inflow. The differences can generate extra room for developing countries to deviate from the theoretical assertions of the B-S model.[8] Consequently, the price-income relationship may also differ substantially.[9] In this regard, what we find in the previous sub-section and what Rogoff (1996) finds are outcomes of the extrapolation Balassa repudiated decades earlier.

Of course, it is questionable if Balassa's argument remains as pertinent for developing countries in the 1990s and 2000s as it was in the 1960s and 1970s. Over the past decades many developing countries pursued market-liberalizing policies to participate in the global economy. In many countries, tariffs and other trade restrictions have been reduced, and their boosted growth potentials attract much international capital flow. In short, the world economic landscape has changed substantially.

The above discussion and the preliminary results in the previous sub-section motivate us to estimate the price-income relationship while allowing for heterogeneity between the developed and developing country groups. Specifically, we estimate

$$p_i = D_i(\alpha_1 + \beta_1 y_i) + (1 - D_i)(\alpha_2 + \beta_2 y_i) + \varepsilon_i \tag{7}$$

---

7 For instance, Balassa (1974, p.881) states "...I carefully refrained from extrapolating the relationships observed among developed countries to developed-developing country relationships....".

8 Edwards and Savastano (1999) provides a survey of studies on the B-S effect for developing countries. See also Choudhri and Khan (2005).

9 Some precursory evidence is reported by Kravis and Lipsey (1988), Cheung, Chinn and Fujii (2007), and Fujii (2011).

for which D_i is an indicator variable which takes a value of unity when economy *i* is a developed country, and is set equal to zero otherwise.

We adopt the WDI's classification scheme to define the developed countries to be the high-income OECD countries. There are several countries joined the OECD during the sample period to eventually become the high-income OECD countries. These countries are treated as developed countries only for the years they fully hold their OECD memberships.[10]

It is important to emphasize that the effect of being an industrially developed country is different from the effect of merely having a high level of income. For instance, oil-producing countries tend to have high income levels. Their economic structures are, however, rather distinctive due to heavy reliance on oil production, which is a focal point Balassa (1973, 1974) notes in arguing against the developed-developing extrapolation of the price-income relationship. Therefore, they are not included in the developed countries even though some have even higher income levels than the US'.

We note that (6) is a constrained version of (7) upon which $\alpha_1 = \alpha_2$ and $\beta_1 = \beta_2$ are imposed. The intercept equality constraint requires a developed country and a developing country to have an identical price level if they both were to have the same income level as the US. The slope equality constraint requires the marginal effect of income on price to be identical for the developed and developing countries. We test the validity of these constraints, rather than imposing them as in many extant studies.

The estimation results, summarized by Table 2, are remarkable in a few ways. First, for the developed countries, the Penn effect estimates appear far greater in magnitude than the full-sample estimates reported in Table 1. Second, the developing

[10] See the data appendix for the list of the developed countries.

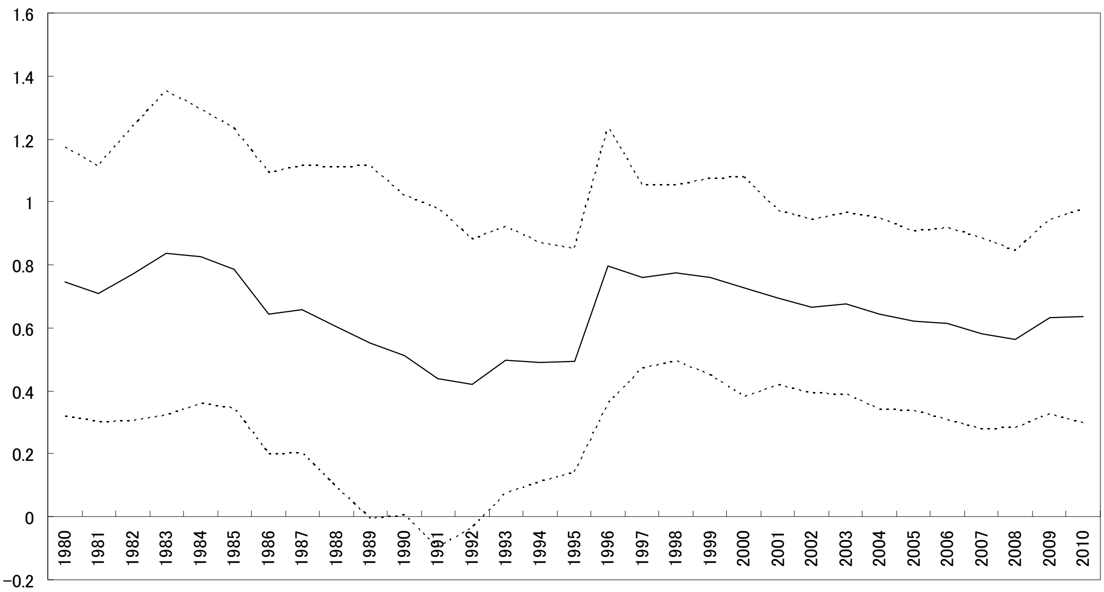
Table 2. Inter-developed-country and inter-developing-country Penn effects

	1980	1985	1990	1995	2000	2005	2010
A. Developed countries							
Income	.746**	.787**	.511*	.495**	.727**	.619**	.636**
	(.218)	(.226)	(.259)	(.182)	(.177)	(.145)	(.173)
Constant	.188**	-.123†	.255**	.286**	.033	.255**	.239**
	(.040)	(.071)	(.081)	(.072)	(.085)	(.071)	(.075)
n	23	23	23	23	27	28	26
B. Developing countries							
Income	-.011	-.009	.020	.111**	.150**	.140**	.093**
	(.026)	(.033)	(.025)	(.022)	(.019)	(.014)	(.016)
Constant	-.512**	-.756**	-.735**	-.521**	-.552**	-.436**	-.356**
	(.054)	(.074)	(.059)	(.056)	(.053)	(.033)	(.039)
n	102	116	143	151	153	154	141
Adjusted R^2	.404	.183	.480	.561	.518	.701	.565
χ^2 for slope equality	11.898**	12.072**	3.557†	4.370*	10.420**	10.795**	9.685**
χ^2 for intercept equality	107.269**	37.256**	95.539**	77.507**	34.085**	76.512**	48.531**
N	125	139	166	174	180	182	167

Notes: The entries summarize the estimation results of (7) in the main text. **, * and † indicate statistical significance at 1%, 5% and 10% levels, respectively. The χ^2 statistics for slope equality and intercept equality are calculated under the null hypotheses of $\beta_1 = \beta_2$ and $\alpha_1 = \alpha_2$, respectively. *N* denotes the total number of observations which is the sum of *n*'s of the two sub-samples.

Figure 3. Inter-developed-country and inter-developing-country Penn effect estimates

A. Inter-developed country effect



B. Inter-developing country effect

Notes: Figures A and B depict the inter-developed-country and inter-developing county Penn effect estimates by (7), respectively. The real line depicts the point estimates of the Penn effect coefficient while the dotted lines indicate the 95 % confidence intervals.

countries exhibit no significant income effect on price prior to the mid-1990s. The estimates for 1995 and on, however, reveal an emergence of a significantly positive but much milder Penn effect among the developing countries. In general, the Wald test statistics soundly reject both the intercept and slope homogeneity constraints between the two country groups.

Figure 3 provides thorough time profiles of the coefficient estimates of (7) and the 95 % confidence intervals. The Penn effect among the developed countries, drawn in the upper chart, is significantly positive and largely stable through the three decades albeit a temporary exception occurs around 1991. The effect for the developing countries, on the other hand, exhibits a drastic shift from the late 1980s to the early 1990s, turning from nil to significantly positive. This is what lies behind the shift in the constrained coefficient estimates documented in section 3.1. We additionally note that the inter-developed-country and inter-developing-country effect estimates differ strikingly in magnitude without showing any sign of convergence over time.

4. Is it the Balassa-Samuelson effect?

4.1 Sectoral productivity and tradability

To account for the heterogeneity in the Penn effect estimates, it is worth relating (6) to the B-S effect as (5). From the B-S perspective, the results in section 3 may be interpreted that, for the developed countries as a group, we find the significant Penn effect presumably because their income differential is driven chiefly by the productivity differential in the traded goods sector. For the developing countries on the other hand, the cross-country productivity differential is not biased for the traded goods sector until the early-1990s, resulting in the initial absence of the Penn effect.

Subsequently, however, the productivity differential becomes increasingly biased for the traded goods sector so that the Penn effect emerges to manifest the B-S effect.

To test the conjecture above, it is necessary to gauge productivity by sector. Due to paucity of data on sectoral productivity, we construct proxy measures by following Hsieh (1982), Marston (1987), and Canzzoneri, Cumby and Diba (1999) to adopt the average product of labor approach.[11] It is well known that for the Cobb-Douglas type production function, a competitive equilibrium sets the marginal product of labor to be proportional to the average product of labor in each sector. Canzzoneri et al. (1999) further shows for a wider variety of production technologies that the proportionality property holds in equilibrium if both labor and capital are mobile between sectors.[12] Assuming the inter-sectoral factor mobility, we construct our sectoral productivity measures below.

The WDI contains value added and employment data for three sectors – agriculture, industry and service.[13] From these data, we construct the following measure of sectoral labor productivity

$$a_{i,j} = \log(V_{i,j} / L_{i,j}), \qquad (8)$$

---

[11] Alternatively, total factor productivity (TFP) is used by, for instance, De Gregorio, Giovannini and Wolf (1994), Chinn (2000), and Kakkar (2003) that consider smaller sets of countries. The TFP approach requires data on sectoral capital stock and labor shares that are not available for a large number of countries in our sample.

[12] Specifically, suppose that an economy consists of the non-traded and traded goods sectors competitively producing respective goods using capital and labor. If both factors are mobile between sectors, $\partial Y_j / \partial L_j = \psi_j (Y_j / L_j)$ holds in equilibrium for a variety of production technologies including the CES technology. The Cobb-Douglas production function makes a familiar case in which ψ_j indicates the labor share. See Canzzoneri et al. (1999) for further details.

[13] The three sectors fully comprise the national economy.

where $V_{i,j}$ is the value added of sector *j* of country *i* in constant dollar terms.[14] $L_{i,j}$ indicates the number of employees and is obtained by

$$L_{i,j} = \gamma_{i,j}\delta_i H_i, \quad (9)$$

for which $\gamma_{i,j}$ is the employment in sector *j* as a percentage of total employment, δ_i is the ratio of employment to population, and H_i is the population of country *i*. For all variables, time subscripts are suppressed for brevity.

An essential feature of the B-S model is that sectors are dichotomized into either of traded or non-traded goods. In reality, however, most if not all products contain some non-traded components. Acknowledging difficulty of precisely quantifying the extent of product tradability, we make general inferences from available data regarding tradability of agriculture, industry and service products as follows.

Figure 4-A shows average ratios of trade to value added by sector separately for the developed and developing country samples. Due to data constraints, the ratios for the sum of agriculture and industry are compared to the ratios for service.[15] For the developed (developing) countries, on average the ratio for agriculture and industry is 6.3 (3.4) times as high as it is for service. As an additional piece of information, Figure 4-B depicts the average share of service trade in all trade. While the share of service trade is consistently higher for the developing countries, no less than 70 % of their total trade takes place in agriculture and industry. In other words, for both the developed and developing countries, vast majority of international trade is non-service trade.

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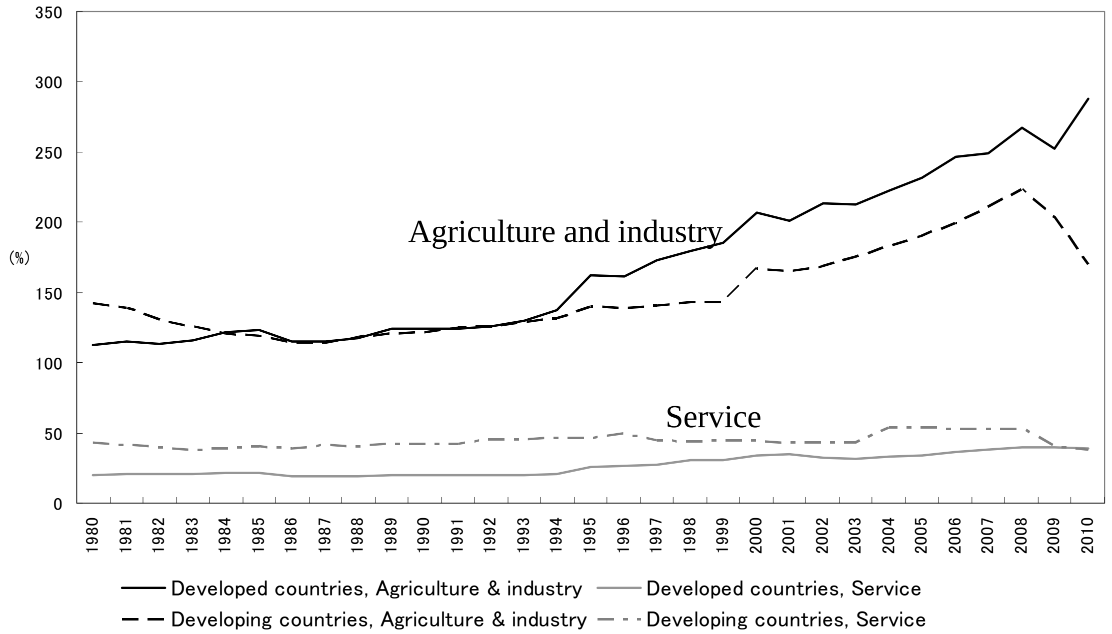
[14] The WDI report data on value added per worker for agriculture, but not for industry or service. For consistency, we use (8) for all three sectors.

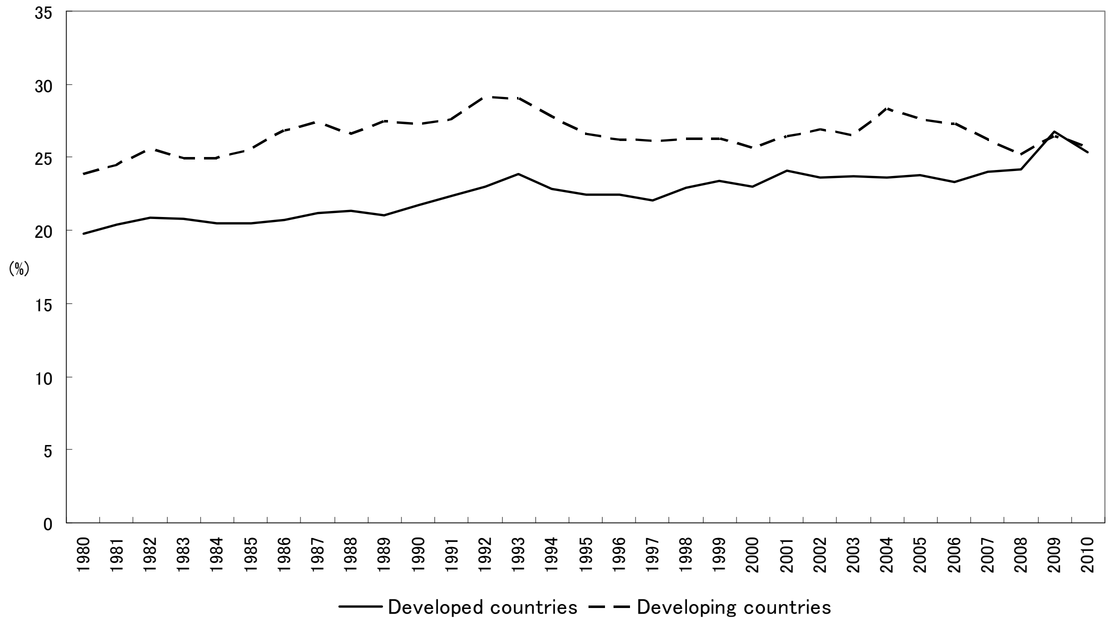
[15] The WDI reports the sectoral trade share only for service. While the remainder is the share of agriculture and industry trade, the breakdown between the two sectors is not available. For this reason, we compare the sum of agriculture and industry to service.

Figure 4. Tradability

A. Ratio of trade to value added by sector



B. Share of service trade in total trade



Notes: Figure A shows the ratio of total trade to value added by sector for the developed and developing countries separately. Figure B exhibits the share of service trade in all trade.

Overall, it is reasonable to consider that agricultural and industrial products are generally much more traded than services. Therefore, we use agriculture and industry as a proxy for the traded goods sector whereas service for the non-traded goods sector.

4.2 Estimating the sectoral productivity differential effect

Using the sectoral productivity variables defined above, we first estimate as a benchmark specification

$$p_i = \mu + \theta(a_{i,T} - a_{i,N}) + \varepsilon_i \tag{10}$$

where subscript T (N) indicates the traded (non-traded) sector approximated by agriculture and industry (service), and all are in relative terms to the US.[16] Unfortunately, missing observations are prevalent for the variables required to construct the productivity proxy measures. In particular, data on the ratio of employment to population are available only from 1991. Also, the end period is set to 2008 since the US data are available (in the current data set) only through that year. Consequently, the effective number of countries is reduced and the sample period is shortened.

Panel A of Table 3 presents the results in three-year intervals. By imposing homogeneity between the developed and developing country groups, (10) fails to attain significance of the productivity differential effect estimates. To confirm that the insignificance is not an artifact of the shrunk sample size, we re-estimate (6) using the identical country samples to report the results in Panel B. As shown, the income effect on price is significantly positive across years as before. In addition, comparison of the adjusted R^2 indicates that (10) fits the data rather poorly.

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[16] For $a_{i,T}$, we use a weighted average of $a_{i,j}$ s for agriculture and for industry. The weights are determined by their relative shares in the total value added.

Table 3. Productivity differential effect and Penn effect

	1991	1994	1997	2000	2003	2006	2008
A. Productivity							
Productivity differential	-.064	.122	.021	-.030	-.135	-.010	.028
	(.157)	(.160)	(.153)	(.077)	(.082)	(.082)	(.080)
Constant	-.469**	-.609**	-.579**	-.663**	-.648**	-.500**	-.286**
	(.072)	(.062)	(.054)	(.048)	(.048)	(.047)	(.046)
Adjusted R^2	-.015	-.005	-.012	-.010	.010	-.011	-.013
N	56	72	78	88	93	86	70
B. Income							
Income	.375**	.383**	.365**	.330**	.346**	.370**	.375**
	(.054)	(.046)	(.039)	(.026)	(.034)	(.032)	(.031)
Constant	.009	-.015	-.022	-.182**	-.128*	.009	.141**
	(.091)	(.069)	(.059)	(.044)	(.056)	(.048)	(.044)
Adjusted R^2	.572	.611	.643	.629	.644	.713	.715
N	56	72	78	88	93	86	70

Notes: The entries in Panel A summarize the estimation results of (10). The entries in Panel B are the estimates of (6) for the same sample countries as in the Panel A. **, * and † indicate statistical significance at the 1%, 5% and 10% levels, respectively. *N* denotes the number of observations.

Table 4. Inter-developed-country and inter-developing-country productivity differential effects

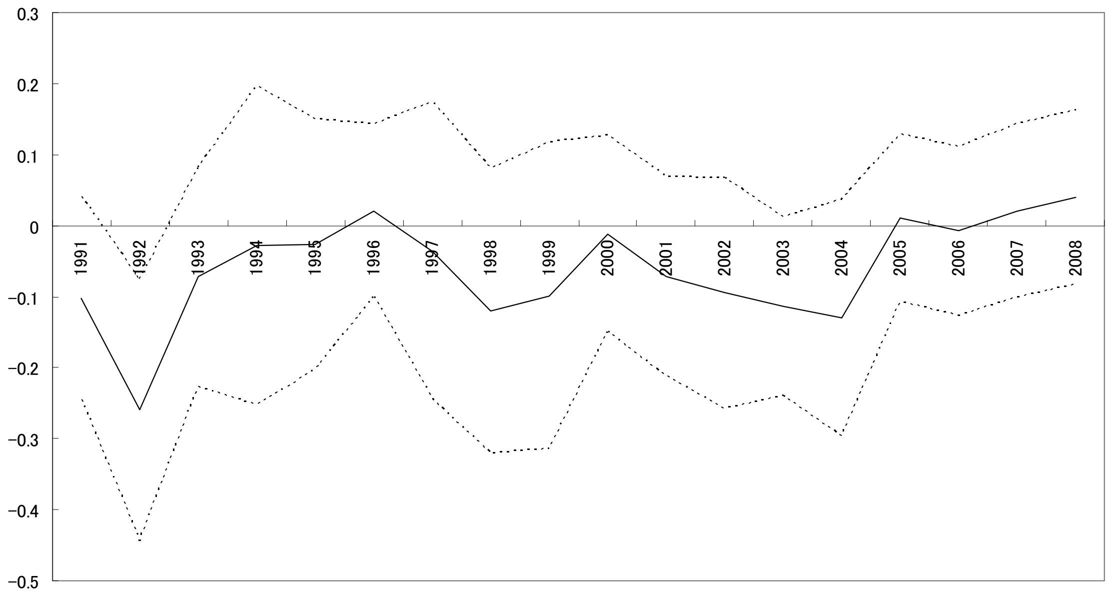
	1991	1994	1997	2000	2003	2006	2008
A. Developed countries							
Productivity differential	.215	.089	.501*	.398**	.423**	.363*	.210
	(.139	(.148)	(.208)	(.143)	(.154)	(.141)	(.205)
Constant	.118*	.073	-.116	-.252**	-.092†	-.019	.098*
	(.048)	(.053)	(.074)	(.065)	(.055)	(.050)	(.046)
n	19	19	24	26	26	26	24
B. Developing countries							
Productivity differential	-.101	-.028	-.035	-.011	-.113†	-.007	.039
	(.072)	(.114)	(.106)	(.070)	(.064)	(.060)	(.062)
Constant	-.783**	-.855**	-.797**	-.853**	-.875**	-.725**	-.499**
	(.056)	(.050)	(.046)	(.046)	(.035)	(.035)	(.037)
n	37	53	54	62	67	60	46
Adjusted R^2	.722	.600	.546	.448	.650	.650	.622
χ^2 for slope equality	4.08*	.39	5.27*	6.53*	10.32**	5.81*	.63
χ^2 for intercept equality	146.74**	160.51**	60.01**	56.03**	141.21**	129.07**	100.19**
N	56	72	78	88	93	86	70

Notes: The entries summarize the estimation results of (11). **, * and † indicate statistical significance at 1%, 5% and 10% levels, respectively. The χ^2 statistics for slope equality and intercept equality are calculated under the null hypotheses of $\beta_1 = \beta_2$ and $\alpha_1 = \alpha_2$, respectively. *N* denotes the total number of observations which is the sum of *n*'s of the two sub-samples.

Figure 5. Inter-developed-country and inter-developing-country productivity differential effects

A. Developed countries

B. Developing countries



Notes: Figures A and B depict the inter-developed-country and inter-developing county productivity differential effect estimates, respectively. The real line depicts the point estimates while the dotted lines indicate the 95 % confidence intervals.

To allow the sectoral productivity differential effect to vary between the inter-developed-country and inter-developing-country cases, we next estimate

$$p_i = D_i[\mu_1 + \theta_1(a_{i,T} - a_{i,N})] + (1 - D_i)[\mu_2 + \theta_2(a_{i,T} - a_{i,N})] + \varepsilon_i \quad . \tag{11}$$

The results are reported in Table 4. Also, the coefficient estimates and the 95% confidence bounds are drawn in Figure 5. The results reveal striking difference in the sectoral productivity differential effects between the two country groups. For the developed countries, the effect of the productivity differentials is always positive, and it is often significant to be consistent with the B-S theory. On the contrary, the effect for the developing country group is mostly negative though generally insignificant. The results suggest that the B-S effect is relevant only to the inter-developed-country price differential, and not to the inter-developing-country one.

While we find in section 3.2 that both the developed and developing countries exhibit significant Penn effect since the mid-1990s, the results in this section suggest that only the inter-developed-country Penn effect can be regarded a manifestation of the B-S effect. We next examine if the conclusion survives more elaborated estimations.

5. Panel estimates and extended specifications

5.1 Panel estimates

The year-by-year estimates thus far allow us to study the time evolution of the effects at the cost of limiting the degrees of freedom in each estimate. Given the limited data availability, the cost can be potentially large by making it difficult to detect significant effects when present. The problem becomes exacerbated when incorporating a number of control variables as will be done in the next sub-section.

To alleviate the potential problem, we implement a panel estimation of (11) by pooling observations across years to boost the test power[17]

$$p_{i,t} = D_{i,t}[\sum_t \mu_{1,t} + \theta_1(a_{i,T,t} - a_{N,i,t})] + (1 - D_{i,t})[\sum_t \mu_{2,t} + \theta_2(a_{i,N,t} - a_{i,N,t})] + \varepsilon_{i,t}. \quad (12)$$

The panel specification constrains the coefficients on the productivity differential terms, θ_1 and θ_2, to be constant across years. According to our findings in the previous sections, the price-income relationships appear relatively stable since the mid-1990s. By taking into account also the data availability of the control variables to incorporate in the next sub-section, we estimate (12) using the 1996-2004 data so that the results in this and next sub-sections can be directly compared.

The estimates of (12) are summarized in column 1 of Table 5. Via the panel approach, the sectoral productivity differential effect turns out to be significant for both the developed and developing country groups but with opposite signs. That is, the sectoral productivity differential effect is significantly positive for the developed countries, but it is significantly negative for the developing countries. The perverse effect implies that among the developing countries, ones with more substantial productivity advantage in the service sector tend to have higher price levels. The negative effect by itself does not necessarily refute the B-S effect among the developing countries. From our discussion in section 2, however, we note that in order to reconcile the negative productivity effect with the B-S theory, price and income levels need to be negatively related to each other across the developing countries. This is clearly not the case as the result in section 3.2 (Figure 3-B) confirms the presence of the significantly positive inter-developing-country Penn effect over the corresponding sample period.

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[17] The sound rejection of the intercept homogeneity assumption in section 3.2 suggests that the year-specific constants need to be included separately for the developed and developing country groups.

Table 5. Panel estimates

	1	2	3	4	5
A. Developed countries					
Productivity	.405**	.614**	.476**	.586**	.184*
	(.053)	(.052)	(.044)	(.047)	(.072)
Service share		3.334**	1.518**	1.434**	.222
		(.266)	(.431)	(.413)	(.474)
Trade openness		-.107**	-.236**	-.280**	-.210**
		(.032)	(.052)	(.055)	(.048)
Government spending		-.151	.113	.538	.949**
		(.371)	(.363)	(.378)	(.361)
Intermediate regime			.202**	.039**	.139**
			(.048)	(.011)	(.047)
Fixed regime			.127**	.112**	.082**
			(.033)	(.032)	(.028)
Capital account			.125**	.125**	.039†
			(.018)	(.018)	(.020)
Population density				.039**	.031**
				(.011)	(.008)
Income					.630**
					(.079)
B. Developing countries					
Productivity	-.069*	-.040†	-.025	.011	-.017
	(.027)	(.024)	(.026)	(.027)	(.023)
Service share		.491**	.712**	.716**	.376**
		(.086)	(.104)	(.102)	(.085)
Trade openness		.092**	.085**	.031	-.032
		(.024)	(.024)	(.024)	(.023)
Government spending		.862**	.265	.662**	.063
		(.212)	(.223)	(.245)	(.300)
Intermediate regime			-.00008	.003	.026
			(.033)	(.032)	(.027)
Fixed regime			.094**	.094**	.097**
			(.034)	(.034)	(.027)
Capital account			.011	.016†	.012
			(.009)	(.009)	(.008)
Population density				.046**	.026**
				(.009)	(.009)
Income					.197**
					(.020)
Adjusted R^2	.563	.659	.719	.731	.799
N	755	748	683	683	683

Notes: The entries summarize the results of estimating (12) and its extended specifications using the 1996-2004 data. **, * and † indicate statistical significance at 1%, 5% and 10% levels, respectively.

5.2 Extended specifications with controls

In revisiting Figure 2, we notice that for a given level of income, prices tend to be more widely dispersed among the developing countries than the developed countries. This implies that factors other than income exert more substantial influences on prices of the developing countries. It is thus worth examining if incorporating relevant control variables significantly alters the findings in the previous sub-section.

As factors to distinguish developing countries from developed ones in the price-income relationship, Balassa (1973, 1974) refers to relative importance of non-traded goods sectors, openness for trade, extents of capital flow, and natural resource abundance. Some of these factors are found empirically important (Clague, 1986; Kravis and Lipsey, 1987). More recently, Broda (2006) finds for developing countries that nominal exchange rate regimes significantly affect price levels. Drawing upon these and other studies, we consider the following variables as controls – the share of service sector in GDP, trade openness, government spending relative to GDP, exchange rate regimes, capital account openness, and population density. We discuss each briefly below.

The output share of the non-traded sector is an indicator of structural difference of economies. It can be shaped by various factors including factor endowments and trade policy. An inflationary effect of a rising service share is reported by, for instance, Clague (1986) and Kravis and Lipsey (1983, 1987). Further, the recent literature on international trade (Melitz, 2003) shows that productivity gains of firms determine endogenously the non-traded share. Bergin et al. (2006) numerically simulates the dynamic interaction between productivity shocks and tradability to report that rise in the non-traded share amplifies the B-S effect. In the current analysis, we use the value added share of service as a proxy while expecting a positive coefficient.

Trade openness, gauged by the ratio of foreign trade to national output, reflects the degree to which forces of international trade drive the traded goods prices toward uniformity across countries. The sign of the trade openness effect depends on the level of income (Kravis and Lipsey, 1987). By pulling a country's price level towards the world average, a higher propensity to trade is expected to exert a negative (positive) effect on price for countries with higher (lower) income.

While the B-S theory focuses solely on the supply-side, empirically demand-side factors may also matter to prices. In particular, a demand shift between traded goods and non-traded goods can alter their relative prices. Froot and Rogoff (1991) studies the implications of a disproportionate fall of the government spending on non-traded goods for European economies. Similarly, De Gregorio et al. (1994) reports empirical evidence that real government expenditure over GDP exerts a significant positive effect on price levels of OECD countries. We thus include the variable as a potential demand shifter toward the non-traded goods.

A country can have a higher price level than other with an identical income level by having a more inflation-receptive financial system. For instance, Broda (2006) reports that the price levels of developing countries with fixed exchange rate regimes are twenty percent higher than those with flexible regimes. To capture the effect, we incorporate the de facto exchange rate regime classification developed by Levy-Yeyati and Sturzenegger (2003, 2005).[18] Specifically, we adopt their three-way classifications

[18] It is well known that de jure measures of exchange rate arrangement such as the IMF's official classification do not necessarily reflect the actual regimes in place (Reinhart and Rogoff, 2004). To construct a de facto measure, Levy-Yeyati and

to introduce intermediate regime and fixed regime dummies to capture their price effects relative to a flexible regime.[19] Due to limited availability of the data, adopting the variables constrains the sample period to end in 2004.

Additionally we gauge the extent of general capital account openness by using the index due to Chinn and Ito (2006). The index summarizes the information on the existence of multiple exchange rates, restrictions on current account and capital account transactions, and requirement to surrender of export proceeds. A higher value of the index indicates a more open capital account which tends to accommodate a higher price level according to Broda (2006).

Finally, we include population density for the following reasons. While natural resource abundance is considered an important price determinant of developing countries (Balassa, 1973; Clague and Tanzi, 1972), it is hard to directly gauge the abundance of diverse natural resources across countries. In a large sample of countries, however, land area per head (i.e. inverse of population density) is expected to be correlated with availability of mineral and other natural resource endowments (Keesing and Sherk, 1971). Further, population density tends to reflect availability of good soils, water supply, and trade access (Gallup, Sachs and Mellinger, 1999). The variable allows also an intuitive interpretation that, as an indicator of relative scarcity of land, rise in population density puts an upward pressure on prices of non-traded goods such as housing and office rent. Thus, holding all else equal, a more densely populated country is conjectured to have a higher price level.

Sturzenegger apply cluster analysis using three classification variables - volatility of nominal exchange rates, volatility of their rates of changes, and volatility of international reserves. See Levy-Yeyati and Sturzenegger (2003, 2005) for details.

[19] Intermediate regimes include dirty float and crawling peg regimes. Inconclusive cases are dropped from the sample.

We extend (12) by adding the above-introduced variables as controls. Some variant specifications are estimated to examine if incorporating the controls significantly alters the productivity differential effect estimates. Columns 2 to 4 of Table 5 present the results. The chief findings are summarized as follows.

The effects of the control variables are found generally significant with expected signs. For both the inter-developed-country and inter-developing-country estimates, a higher service share, a rigid exchange rate regime, and a higher population density tend to lead to a higher price level.[20] The effect of trade openness depends on income level as conjectured. While it is significantly negative for the developed countries, the sign is reversed for the developing countries.[21] While a higher government spending share lifts prices solely of the developing countries, the inflationary effect of a more open capital account appears significant only for the developed countries.

More importantly, we find crucial difference in the robustness of the sectoral productivity differential effects between the developed and developing country estimates. Specifically, while the positive productivity differential effect among the developed countries is quite robust to addition of the controls, the negative effect for the developing countries gets washed away. That is, the sectoral productivity differential is not a significant determinant of the inter-developing-country price differential once other relevant effects are controlled for.

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[20] The fixed exchange rate regime dummy yields a significantly positive coefficient estimate for both the developed and developing countries. That is, countries adopting a fixed regime tend to have higher prices than those with a flexible regime, holding all others constant. The effect of an intermediate regime is also significantly positive for the developed countries. For the developing countries, however, the results suggest that adopting an intermediate regime is no more inflationary than a flexible regime.

[21] Once the income level is controlled for, the trade openness has price reducing effect for both country groups as presented in column 5.

Column 5 of Table 5 contains the additional estimates when simultaneously including the productivity differential and income variables with all the controls. Both variables have a significant positive effect on prices of the developed countries, suggesting that the B-S effect is important but only part of the inter-developed-country Penn effect. For the developing countries, the effect of income is significantly positive in the presence of the other controls while that of the productivity differential is not. Thus, the inter-developing-country price-income association, while significantly positive, cannot be attributed to the B-S effect.

In sum, the results in this section suggest that sectoral productivity differential has rather different implications for the developed and developing countries. Specifically, the price-income relationship across the developed countries is consistent with the B-S assertion, and at least part of their Penn effect is regarded a manifestation of the B-S effect. In contrast, the inter-developing-country Penn effect cannot be reconciled with the B-S effect, and hence, it must be driven by other forces.

6. Exploring sources of the difference

Recall that in section 3.1 we observe diverging price trends at the higher end of the income range in Figure 2-B. Further in section 3.2, we emphasize that the effect of being an industrially developed economy is different from the effect of merely having a high income level. To elaborate on these points, we examine how the results change if we stratify the countries solely by income level. Specifically, we define the higher-income countries to be ones whose *per capita* income equals or exceeds the minimum of the high-income OECD countries'. That is, the higher-income countries include all the developed countries and the developing countries with the matching

Table 6. Income-stratified panel estimates

	1	2	3	4	5
A. Higher-income countries					
Productivity	.015	.222	.080	.090	-.083
	(.061)	(.156)	(.138)	(.140)	(.051)
Service share		2.080*	1.208	1.199	.208
		(1.036)	(.993)	(.994)	(.326)
Trade openness		-.110**	-.113**	-.122**	-.154**
		(.022)	(.024)	(.030)	(.021)
Government spending		.019	.267	.343	.089
		(.520)	(.533)	(.536)	(.298)
Intermediate regime			.104*	.100†	.102**
			(.050)	(.051)	(.033)
Fixed regime			.066†	.063	.068**
			(.040)	(.041)	(.029)
Capital account			.140**	.140**	.034**
			(.022)	(.022)	(.010)
Population density				.007	.001
				(.012)	(.008)
Income					.676**
					(.056)
B. Other countries					
Productivity	-.071*	-.048†	-.026	-.008	-.003
	(.029)	(.026)	(.027)	(.030)	(.027)
Service share		.416**	.633**	.649**	.415**
		(.081)	(.102)	(.102)	(.093)
Trade openness		-.062	-.015	-.023	-.047
		(.038)	(.036)	(.037)	(.032)
Government spending		.632**	.037	.216	.070
		(.224)	(.243)	(.275)	(.327)
Intermediate regime			-.002	-.00008	.018
			(.032)	(.032)	(.029)
Fixed regime			.085*	.087*	.102**
			(.035)	(035)	(031)
Capital account			.012	.013	.012
			(.009)	(.009)	(.009)
Population density				.019†	.022*
				(.011)	(.011)
Income					.160**
					(.023)
Adjusted R^2	.556	.637	.709	.710	.797
N	755	748	683	683	683

Notes: The higher-income countries are the countries whose *per capita* income equals or exceeds that of the minimum of the high-income OECD countries. See the notes to Table 5.

income level.[22] Using this definition, we repeat our exercises while allowing separate coefficient estimates for the higher-income countries and the remaining countries.

Classifying the countries solely by the income threshold leads to crucially different results. Specifically, the panel estimation results summarized in Table 6 indicate that the productivity differential effect is insignificant for the higher-income countries irrespective of inclusion of the control variables. The effect for the remaining countries is perversely signed and generally insignificant. In other words, the B-S effect loses its relevance once we group countries solely by income level.

What is behind the apparent difference between the development-based and income-based stratified-sample estimates? As the source of the difference, we focus on the behavior of the higher-income developing countries. Table 7 compares the higher-income developing countries to the developed countries by their correlation matrices of the focal variables. A few observations are in order.

Table 7 Correlations

	Price	Income	Traded productivity
A. Developed countries			
Income	.81		
Traded productivity	.85	.93	
Non-traded productivity	.87	.88	.89
B. Higher-income developing countries			
Income	.48		
Traded productivity	.14	.69	
Non-traded productivity	.68	.83	.34

Notes: The entries indicate correlations among the denoted variables for the developed country sample and the high-income developing country sample for 1996-2004.

[22] The countries are listed in the data appendix.

First, in contrast to the high correlations between the price and productivity variables exhibited by the developed countries, the corresponding correlations for the higher-income developing countries are rather low. Particularly the correlation between price and traded-goods sector productivity is only .14 as compared to .85 of the developed countries'. Second, the traded-goods sector productivity also shows a weaker correlation with the income level among the higher-income developing countries than the developed countries. Importantly, for the higher-income developing countries, income is more strongly correlated with the non-traded goods sector productivity than the traded-goods sector productivity. This makes a contrast to the developed countries whose income shows a higher correlation with the traded-goods sector productivity. Third, the productivity variables are highly correlated between the two sectors for the developed countries, but not for the higher-income developing countries.

The first and second observations above imply that the behavior of the higher-income developing countries crucially deviate from the assertion of the B-S theory. Both price and income differentials among the high-income developing countries tend to move together more with the productivity difference in the non-traded goods sector than that in the traded-goods sector. This, combined with the third observation above, helps explain why we obtain negative coefficient estimates on the sectoral productivity differential variable for the developing country group in section 5. Recall from our discussion in section 2 that, in order to attribute the Penn effect to the B-S effect, the sector whose products are highly traded needs to be the sector that has substantial international productivity difference. This sectoral correspondence between tradability and productivity, while satisfied by the developed countries, is violated by the developing countries.

According to the third observation noted above, the developed countries with a higher productivity in the traded goods sector tends to have also a higher productivity in the non-traded goods sector. While this may be due partly to the fact that the service sector is partially traded rather than non-traded, it may also be an indication that the B-S theory awaits a refinement when the information and skill-intensive modern service sector grows to play an increasingly important role in generating national income.

7. Conclusion

Conventional wisdom in international macroeconomics is that price and income levels are positively associated with each other across countries. While the positive effect of income on price is widely documented, a closer view of the data casts doubt on reliability of the canonical cross-country regression to reflect the genuine relationship, as succinctly put by Rogoff (1996). The issue, despite its importance, has long been neglected in the literature. To fill in the crucial gap, we provide a closer view of the cross-country price-income relationship while focusing on significant heterogeneity between the inter-developed-country and inter-developing country effects.

Our main findings are summarized as follows. While the conventional cross-country regression obtains significant Penn effect estimates, the magnitude of the estimates increases substantially from the late 1980s to the early 1990s as the inter-developing-country effect turns from nil to significantly positive. The stratified sample estimates further uncover crucial heterogeneity in the price-income relationship between the developed and developing country groups, not only in terms of magnitude of the Penn effect but also in terms of their sources. That is, the developed and developing countries exhibit the positive price-income relationship for different reasons.

More specifically, we find that the inter-developed-country relationship can be attributed, at least partly, to the B-S effect. In contrast, the newly-emerged significant but milder inter-developing-country income effect on price is clearly at odds with the B-S effect, and hence requires other explanation. The conclusion remains intact after controlling for the effects of cross-country differences in the service sector share, trade openness, government spending, exchange rate regimes, capital account openness, and population density as a proxy for natural resource abundance.

In exploring sources of the difference, we find an indication that the developed and developing countries differ in the primary sector whose international productivity differentials are associated with international price differentials. For the developed countries, a higher relative productivity in the traded goods sector is more strongly correlated with a higher price level, consistently with the assertion of the B-S theory. On the contrary, for the developing countries with the similarly high level of income, a higher relative productivity in the service sector (i.e. largely non-tradable sector) is more strongly associated with a higher price level.

What generates the inter-developing-country positive price-income association if it does not derive from the B-S effect? One possibility is that, despite the massive efforts by the International Comparison Program (ICP), the cross-country price comparison has yet to fully net out the effect of quality difference. As Bils and Klenow (2001) shows with the US consumer expenditure survey data, as households get richer they tend to consume not only more but also better goods. This can generate positive association between price and income levels, which may also be observed (indeed more likely) in the cross-country data if product quality differences are not fully controlled for. In fact, handling of product quality differences remains one of the main challenges in international price comparisons (Deaton and Heston, 2010). Even with the impressive progress made by the ICP over the years, the task becomes notoriously difficult as we expand the income range of countries to compare.

Testing the conjecture is rather challenging in the international context since it requires information on quality aspects of goods and services around the globe. This and other extensions are saved for future research.

Data appendix

A. Source

The main data are extracted from the WDI database in March 2012. The de facto exchange rate regime classification data (updated in December 2005) are downloaded from Eduardo Levy-Yeyati's homepage at the Universidad Torcuato Di Tella (http://www.utdt.edu).

B. Country lists

1) Full list of the sample countries/economies:

Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Dem. Rep. Congo, Rep. Congo, Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Korea, Kuwait, Kyrgyz Republic, Lao PDR, Latvia, Lebanon*, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Macao, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Fed. Sts. Micronesia, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Rwanda, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovak Republic, Slovenia, Solomon Islands, South Africa, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe

*For the analyses in sections 4, 5 and 6, we exclude Lebanon from the sample because its service trade as % of GDP often exceeds its all trade as % of GDP at the data source, which is not possible.

2) Developed countries (i.e. the high-income OECD countries):
Australia, Austria, Belgium, Canada, Czech Republic (1996-), Denmark, Finland, France, Germany, Greece, Hungary (1997-), Iceland, Ireland, Israel, Italy, Japan, Korea (1997-), Luxembourg, Netherlands, New Zealand, Norway, Poland (1997-), Portugal, Slovak Republic (2001-), Spain, Sweden, Switzerland, United Kingdom, United States.

The countries joined the OECD after 1980 and before 2010 are Czech Republic (December 1995), Hungary (May 1996), Korea (December 1996), Mexico (May 1994), Poland (November 1996), and Slovak Republic (December 2000). Of these, Mexico is classified as a middle-income country. Chile, Estonia, Israel, and Slovenia joined the OECD in 2010 and hence are treated as developing countries in this paper.

3) Higher-income developing countries/economies:
Antigua and Barbuda (1996-2010), Argentina (1997-98), Bahamas (1980-2010), Bahrain (1980-2008), Barbados (1980-89, 1997-2009), Brunei Darussalam (1980-2009), Croatia (1997-2008), Cyprus (1983-2010), Equatorial Guinea (2001-2010), Estonia (2001-08), Gabon (1980-86, 1996-2003), Hong Kong (1980-2010), Israel (1980-2010), Kuwait (1980-89, 1996-2007), Macao (1982-2010),Malta (1996-2010), Malaysia (1997), Mexico (1997-2001), Oman (1983-87, 1996-2009), Palau (1996-2001),Qatar (2000-09), Saudi Arabia (1980-2010), Seychelles (1996-2010), Singapore (1980-2010), Slovenia (1996-2010), St. Kitts and Nevis (1996-2008), Trinidad and Tobago (1980-85, 1997-201), United Arab Emirates (1980-2010), Venezuela (1997).

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