Lecture 2: Exchange Rates and Price Levels

PSE – APE Masters Year 1 (M1) – Macro 3

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Exchange Rate Definitions

Lecture 2: Exchange Rates and Price Levels

Today's lecture in four parts:

1. **Definitions:** nominal exchange rate, real exchange rate, terms of trade, tradable vs non-tradable goods
2. **PPP: theory and evidence:** Law of One Price, absolute and relative PPP – when does it hold?
3. **Tradables, nontradables, and Balassa-Samuelson:** why PPP fails, what determines the relative price of nontradables
4. **Project paper:** De Gregorio et al. (1994) – supply vs demand explanations for NT inflation

Motivating questions: Why do price levels differ so much across countries? Why does the real exchange rate move so much in the short run, but track inflation differentials in the long run?

Nominal Exchange Rate

The **nominal exchange rate** $\mathcal{E}$ is the domestic-currency price of one unit of foreign currency.

- Example: $\mathcal{E} = 0.93$ EUR/USD means one dollar costs 93 euro cents
- A rise in $\mathcal{E}$ = **nominal depreciation** — the domestic currency buys less foreign currency
- Convention throughout: $\mathcal{E}$ = domestic per unit of foreign; depreciation $\Leftrightarrow \mathcal{E} \uparrow$

What we set aside today:

- Multilateral vs bilateral: the nominal effective exchange rate (NEER) weights bilateral rates by trade shares — we focus on bilateral
- Nominal vs real: the nominal rate tells us the price of currencies; what matters for trade and welfare is the *real* rate, which we focus on today

Real Exchange Rate

The **real exchange rate** e measures the relative price of consumption baskets across countries:

$$e = \frac{\mathcal{E} P^*}{P}$$

where P = domestic price level, P^* = foreign price level (in foreign currency).

Interpretation:

- $e > 1$: foreign country is more expensive than home (in a common currency)
- $e < 1$: home country is more expensive than foreign
- $e = 1$: purchasing power parity (PPP) holds — same basket costs the same everywhere

Growth rate decomposition: Let $\dot{\mathcal{E}} \equiv \Delta \log \mathcal{E}$ denote the log-change (nominal depreciation rate). Then:

$$\Delta e = \dot{\mathcal{E}} + \pi^* - \pi$$

Real depreciation = nominal depreciation + foreign inflation − domestic inflation.

Terms of Trade

The **terms of trade** (ToT) measure the relative price of a country's exports vs imports:

$$\text{ToT} = \frac{P^X}{P^M}$$

- A rise in ToT = **improvement** — each unit of exports buys more imports; the country is richer in real terms
- Example: an oil exporter benefits when the oil price rises relative to manufactures

ToT vs RER:

- ToT: about the price of *what we trade* (export basket vs import basket)
- RER: about the *overall price level* relative to trading partners
- Related but distinct concepts.

Tradable and Non-Tradable Goods

A fundamental distinction for understanding the real exchange rate:

Tradable goods: can be traded internationally at low cost

- Commodities (oil, wheat, metals), manufactured goods, some services (financial, digital)
- Prices are linked across countries through international arbitrage

Non-tradable goods: transportation costs or other frictions prevent international trade

- Personal services (haircuts, healthcare, education, restaurants), housing, utilities, ...
- Prices clear *domestically* – no international arbitrage
- Typically **50–60% of GDP**

Empirical rule of thumb (De Gregorio et al., 1994): export share $> 10\%$ of production $\Rightarrow$ tradable. Result: all manufacturing + agriculture + mining + transport = tradable; other services = nontradable. The distinction is not sharp and shifts over time (e.g. financial services increasingly tradable).

PPP: Theory and Evidence

The Law of One Price

Law of One Price (LOOP): for a given good i, $P_i = \mathcal{E} P_i^*$.
Holds when identical goods trade freely — arbitrage eliminates price differentials:

- If $P_i < \mathcal{E} P_i^*$: buy at home, sell abroad → home price rises, foreign price falls → equalisation

When LOOP holds well:

- Commodities: gold, oil, wheat, soybeans — actively traded on global markets
- Luxury goods: Rolex, Hermès, Montblanc — high value relative to transport cost

When LOOP fails:

- Personal services: haircuts, healthcare, education, restaurants — non-tradable by nature
- Housing: cannot be shipped; prices reflect local supply and demand
- Why? Transportation costs, tariffs, local distribution costs, regulations

The Big Mac Index

A standardised product, same recipe worldwide — a simple test of LOOP. Big Mac RER: $e^{\text{BM}} = \mathcal{E}\, P^{\text{BM}*} / P^{\text{BM}}$. LOOP holds when $e^{\text{BM}} = 1$. ▸ Economist chart

Country	$P^{\text{BM}*}$	$\mathcal{E}$	$\mathcal{E}\,P^{\text{BM}*}$	e^{BM}	$\mathcal{E}^{\text{PPP}}$
Switzerland	6.50	1.02	6.62	1.19	0.86
United States	5.58	1.00	5.58	1.00	1.00
Canada	6.77	0.75	5.08	0.91	0.82
Euro area	4.05	1.15	4.64	0.83	1.38
China	20.90	0.15	3.05	0.55	0.27
India	178	0.01	2.55	0.46	0.03
Russia	110	0.01	1.65	0.30	0.05

Source: The Economist, January 2019 / Schmitt-Grohé et al. (2022). $P^{\text{BM}*}$ in local currency; $\mathcal{E}$ in USD per unit of local currency. US is the reference country.

Why is the Big Mac 3$\times$ more expensive in the US than Russia? Tradable ingredients are a *small* share of cost; labour, rent, utilities (non-tradable) are the *large* share.

Purchasing Power Parity

Absolute PPP: generalisation of LOOP to *all goods*. Holds if $e = \mathcal{E} P^* / P = 1$.

- **PPP exchange rate:** $\mathcal{E}^{\text{PPP}} = P / P^*$ — the exchange rate that *would* make baskets equally expensive
  - $\mathcal{E} < \mathcal{E}^{\text{PPP}}$: domestic country is more expensive
  - $\mathcal{E} > \mathcal{E}^{\text{PPP}}$: domestic country is cheaper
- Requires: comparable price *levels* across countries (WB surveys every ≈6 years)
- If $\mathcal{E} < \mathcal{E}^{\text{PPP}}$ is the domestic currency overvalued, or is PPP just not a useful statistic?

Relative PPP: weaker condition — only requires the *change* in the RER to be zero:

$$\Delta e = 0 \quad \Longleftrightarrow \quad \dot{\mathcal{E}} = \pi - \pi^*$$

Depreciation rate = domestic inflation − foreign inflation. Requires only price *indices* (CPI, monthly).

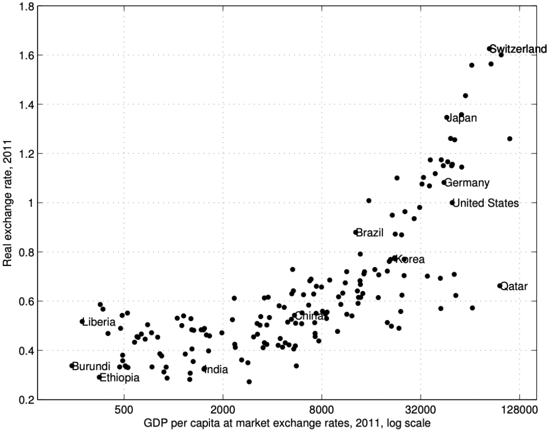
Absolute PPP Fails: The Evidence

Country	e	$\mathcal{E}$	$\mathcal{E}^{PPP}$
Switzerland	1.63	1.13	0.69
Australia	1.56	1.03	0.66
Japan	1.35	0.0125	0.00931
United Kingdom	1.12	1.60	1.43
Germany	1.08	1.39	1.28
United States	1	1	1
South Korea	0.7711	0.0009023	0.00117
China	0.54	0.15	0.29
Vietnam	0.33	4.88×10^{-5}	0.000149
India	0.32	0.02	0.07
Bangladesh	0.31	0.01	0.04
Pakistan	0.28	0.01	0.04
Egypt	0.27	0.17	0.62

SUW. e is RER, $\mathcal{E}$ is nominal exchange rate, $\mathcal{E}^{PPP}$ is nominal exchange rate that would set $e = 1$.

Key facts: Large, systematic deviations from absolute PPP. Switzerland: $e = 1.63$; Egypt: $e = 0.27$. The Big Mac RER tracks the ICP RER closely (correlation 0.81 across 57 countries) — some use in the simpler single-good measure.

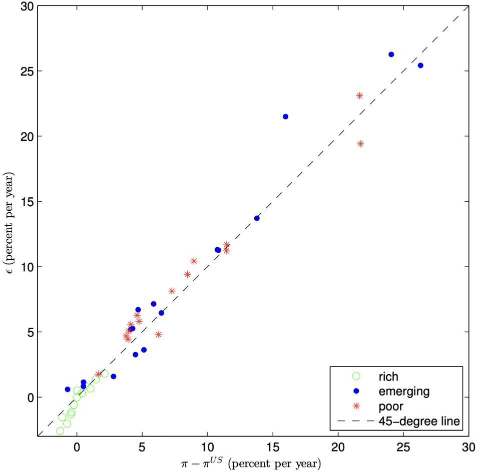
Rich Countries Are More Expensive: The Penn Effect



SUW. World Bank ICP 2011 and World Development Indicators.

Poorer countries are systematically cheaper — the **Penn effect**. At market exchange rates, US GDP per capita is $32\times$ India's; at PPP rates, only $11\times$. PPP exchange rates give a better measure of comparative living standards. *This is not random — we need a theory.*

Relative PPP Holds in the Long Run



SUW. Data: 45 countries, 1960–2017.

Takeaway: Countries with higher average inflation tend to have depreciating currencies at the same rate. Relative PPP holds well in the **long run**.

Tradables, Nontradables, and Balassa-Samuelson

Why Does PPP Fail? The Tradables–Nontradables Decomposition

The price level is an average of P^T and P^N: $P = \varphi(P^T, P^N)$ (homogeneous degree-1 aggregator, increasing in both inputs). With LOOP for tradables ($P^T = \mathcal{E} P^{T*}$):

$$e = \frac{\mathcal{E} P^*}{P} = \frac{\varphi^*\left(1,\ P^{N*}/P^{T*}\right)}{\varphi\left(1,\ P^N/P^T\right)}$$

PPP holds ($e = 1$) *only if* the relative price of nontradables P^N/P^T is the same in both countries.

Three sources of PPP failure:

- **Non-tradable goods:** services, housing, local transport (≈50–60% of GDP) do not trade. India is cheap not because of currency manipulation — Indian nontradables (labour-intensive services) are cheap because wages are low.
- **Home bias:** even if all goods trade, different consumption weights ($\gamma \neq \gamma^*$) cause $e \neq 1$ when relative prices move. ▸ Appendix
- **Trade barriers:** tariffs raise domestic price of importables → domestic country appears more expensive. ▸ Appendix

What Determines P^N / P^T?

We know *that* PPP fails because non-tradable goods and home bias create differences in P^N / P^T across countries.

Now: what *determines* the relative price of nontradables?

Two effects:

Supply side (Balassa-Samuelson): P^N / P^T is pinned by sectoral productivity differentials. Countries with fast tradable-sector productivity growth have high P^N / P^T. This is the long-run equilibrium condition.

Demand side (income and fiscal): demand shifts toward NT goods — from income growth or government spending — raise P^N / P^T when markets are not perfectly integrated. Matters especially when the NT supply curve is not flat.

De Gregorio et al. (1994) test these two channels empirically. But first: the supply-side theory in detail.

Balassa-Samuelson: Motivation

Puzzle: Why are rich and fast-growing countries consistently more expensive?

- Japan 1960–1990: GDP per capita quadrupled; yen appreciated in real terms
- China in recent decades: rapid growth, gradual real appreciation
- Not special cases — this is the Penn effect from Slide 10 at work

Intuition: As an economy grows, productivity typically rises fastest in tradeable manufacturing goods.

- This pushes up wages *economy-wide* since workers can move between sectors
- The service sector (nontradable) must pay higher wages but gets no productivity gain
- $\Rightarrow$ Services become relatively more expensive
- $\Rightarrow$ The country's overall price level rises relative to poorer countries

Important: "more expensive" means appreciated real exchange rate. I.e. price level is high accounting for both prices and the nominal exchange rate.

The **Balassa-Samuelson model** formalises this intuition.

Balassa-Samuelson: The Model

Two sectors: tradable (T) and nontradable (N). Single factor: labour L. Linear production:

$$Q^T = a_T L^T \qquad Q^N = a_N L^N$$

where a_T, a_N are labour productivity. Labour market: $L^T + L^N = L$ (fixed total supply).

Key assumption: Labour is perfectly mobile across sectors $\Rightarrow$ wages equalise to a single W.

Perfect competition $\Rightarrow$ zero profits in each sector:

$$P^T a_T = W \qquad \text{(T sector)} \qquad P^N a_N = W \qquad \text{(N sector)}$$

Divide first equation by second:

$$\boxed{\frac{P^N}{P^T} = \frac{a_T}{a_N}}$$

The relative price of nontradables equals the ratio of tradable to nontradable labour productivity.

Balassa-Samuelson: Mechanism and Cross-Country Implication

Mechanism: Suppose a_T rises (productivity boom in manufacturing).

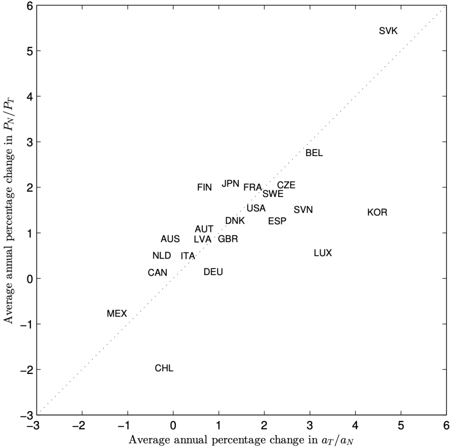
- Law of one price pins P^T at the world price; zero-profit condition $P^T a_T = W$ forces wages up
- Higher wages raise costs in the NT sector (no productivity gain) $\Rightarrow$ P^N rises
- $\Rightarrow P^N / P^T = a_T / a_N$ rises: the country's nontradables become more expensive $\Rightarrow$ real appreciation

Cross-country: The RER is $e = \varphi^*(1, a_T^*/a_N^*) \ / \ \varphi(1, a_T/a_N)$.

- Domestic a_T / a_N grows faster than foreign $\Rightarrow e \downarrow$ (real appreciation)
- Faster-growing countries become more expensive over time

Penn effect explained: Rich countries have high a_T / a_N (advanced manufacturing, technology) $\Rightarrow$ expensive nontradables $\Rightarrow$ high overall price level relative to poor countries.

Balassa-Samuelson: Empirical Evidence



SUW. 23 OECD countries, 1996–2015.

Takeaway: Countries where tradable-sector productivity grows faster (relative to nontradables) tend to have faster NT price inflation. Consistent with BS model.

Balassa-Samuelson: Limitations

The BS scatter establishes a strong long-run correlation — consistent with $P^N / P^T = a_T / a_N$.

But BS is a **long-run supply-side theory**. In practice:

- Countries deviate substantially from the BS prediction year-to-year
- Demand-side factors — income growth, government spending on services — can push P^N / P^T above the BS supply equilibrium
- Our assumption of CRS + labour-only production is a simplification. If supply curves slope upward, demand shifts can change relative prices.

Empirical question for De Gregorio et al. (1994): In the data, how much of the rise in NT prices is explained by supply (TFP differential) vs demand (income growth, fiscal policy)? Is the supply curve really flat — or does demand also matter?

Project Paper:
De Gregorio, Giovannini & Wolf (1994)

DGW (1994): Overview and Research Question

Citation: De Gregorio et al. (1994) — "International evidence on tradables and nontradables inflation," *European Economic Review* 38(6): 1225–1244.

Research question: What drives the differential between nontradable and tradable goods inflation across OECD countries in 1970–85? Supply (Balassa-Samuelson) or demand (income, fiscal)?

Main findings:

- BS (supply) explains almost all NT inflation in the **long run**
- Income growth and government spending (demand) **dominate in the short run**
- Exchange rate regime has an independent effect on relative inflation correlations

Context: During 1970s–80s disinflation, exchange-rate-based stabilisations were accompanied by real appreciation. Understanding NT price dynamics is central to understanding this episode.

DGW: Theoretical Framework — Supply Side

Production: $Y_T = \theta_T L_T^{\alpha_T} K_T^{1-\alpha_T}$ and $Y_N = \theta_N L_N^{\alpha_N} K_N^{1-\alpha_N}$.
Under small open economy + perfect capital mobility: the world return on capital R is pinned by the tradable sector, which pins wages W, which then pins P^N.

Key result (DGW eq. 6):

$$\hat{P} \equiv \Delta \log\left(\frac{P^N}{P^T}\right) = \frac{\alpha_N}{\alpha_T}\hat{\theta}_T - \hat{\theta}_N$$

where $\hat{\theta}_T, \hat{\theta}_N$ are TFP growth rates in the tradable and nontradable sectors.

- Faster tradable TFP growth ($\hat{\theta}_T \uparrow$) $\Rightarrow$ higher relative NT prices
- Faster NT TFP growth ($\hat{\theta}_N \uparrow$) $\Rightarrow$ lower relative NT prices (NT goods cheaper to produce)
- The ratio α_N/α_T of labour shares generalises the SUW single-factor result: set $\alpha_T = \alpha_N = 1$ and $K = 0$ to recover $\hat{P} = \hat{\theta}_T - \hat{\theta}_N = \hat{a}_T - \hat{a}_N$
- **Under perfect capital mobility:** demand has *no effect* on relative prices (supply curve is flat — S1 in DGW Fig. 1)

DGW: Theoretical Framework — Plot

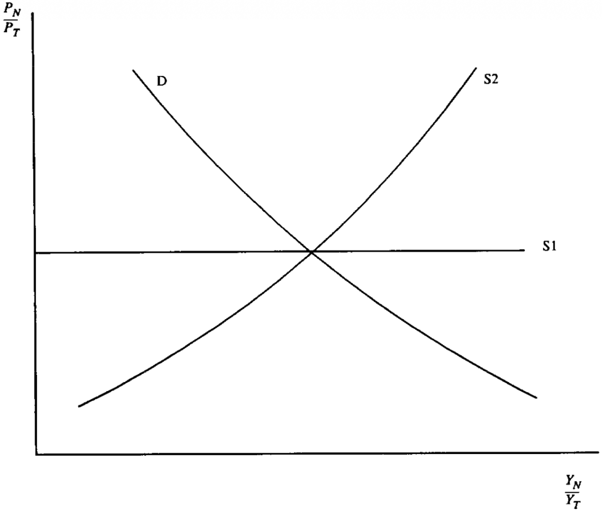


Fig. 1. Equilibrium relative price and production of nontradable goods.

Source: De Gregorio et al. (1994)

DGW: Theoretical Framework — Demand Side

Under imperfect capital mobility the supply curve slopes upward (S2 in Fig. 1) — demand shifts also affect relative prices.

- Generalises the CRS demand curves from slide 15 — now demand shifts raise prices as well as quantities until capital flows restore equilibrium
- $\approx$ DRS in the short run, CRS in the long run

Demand mechanism 1 — Income growth: Stone-Geary utility with subsistence tradable consumption $\bar{C}$. Income elasticity of NT demand > 1. As income rises, households shift demand toward nontradables $\Rightarrow P^N/P^T$ rises.

Demand mechanism 2 — Government spending: In DGW's model, government spending falls entirely on NT goods. Bigger government $\Rightarrow$ more demand for nontradables $\Rightarrow P^N/P^T$ rises.

DGW: Basic Fact — NT Prices Rose Everywhere ‣ Data

Mean annual change in $\log(P^N/P^T)$ across 14 OECD countries, 1970–85:

Country	Mean (%/yr)	Std Dev
Japan	3.35	2.42
Belgium	2.47	2.02
France	1.97	1.63
Netherlands	1.45	3.73
Italy	1.73	3.25
Germany	1.34	1.75
United States	1.12	2.20
Canada	-0.03	2.83

Source: De Gregorio et al. (1994), Table 2 (selected countries).

NT inflation exceeded T inflation in **13 of 14 countries** (Canada is the only exception). Average > 1 pp per year. Japan highest at 3.35 pp. Core EMS countries show much lower dispersion — suggesting exchange rate regime matters.

DGW: Direct Balassa-Samuelson Validation

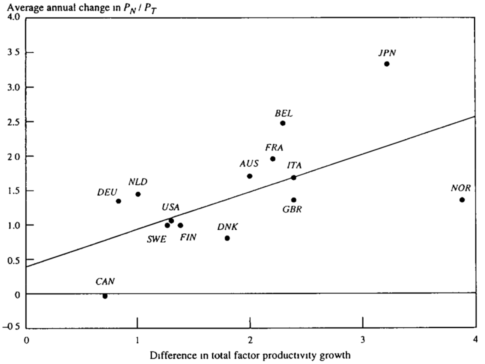


Fig. 3. Differential factor productivity growth and relative price of nontradables (1970–85, percentage).

Source: De Gregorio et al. (1994)

Takeaway: Countries with higher TFP growth in tradables (relative to nontradables) tend to have faster NT price inflation — consistent with the BS supply-side prediction (eq. 6). But the scatter is noisy: some countries above the line, some below. Demand-side variation is also at work.

DGW: Demand-Side Evidence

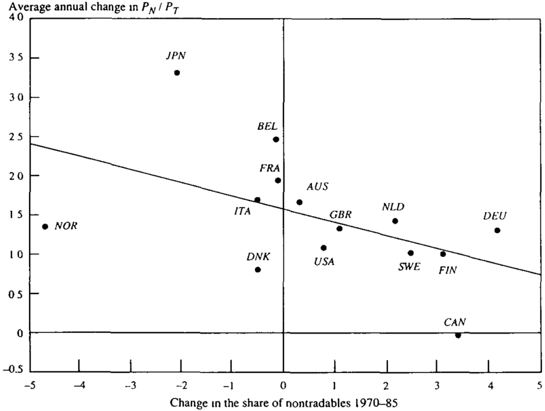


Fig. 2. Changes in share and relative price of nontradables (1970–85, percentage).

Source: De Gregorio et al. (1994)

Key observation: 8 of 14 countries experienced *both* a rise in P^N / P^T *and* a rise in the NT output share — **positive co-movement** of price and quantity. Conclusion: demand-side factors are at work.

DGW: Short-Run Regression (eq. 13)

$$\log\left(\frac{P^N_{i,t}}{P^T_{i,t}}\right) = \beta^i_0 + \beta_1\theta_{i,t} + \beta_2 g_{i,t} + \beta_3 \log y_{i,t} + \beta_4 \Delta\pi_{i,t} + \varepsilon_{i,t} \quad (1)$$

- $\theta_{i,t} = (\alpha_N/\alpha_T)\hat{\theta}_T - \hat{\theta}_N$: weighted TFP differential (BS supply effect; expect $\beta_1 > 0$)
- $g_{i,t}$: government expenditure / GDP (demand; expect $\beta_2 > 0$ if supply curve not flat)
- $\log y_{i,t}$: per-capita income (income demand; expect $\beta_3 > 0$)
- $\Delta\pi_{i,t}$: change in aggregate inflation (disinflation; expect $\beta_4 < 0$)

Estimation: SUR in first differences with common $\beta_1, \beta_2, \beta_3, \beta_4$ across countries.

- First differences: remove country fixed effects (permanent productivity level differences)
- Common coefficients: BS and demand mechanisms assumed structurally identical across OECD
- **Test:** $\beta_2 = \beta_3 = 0$ would confirm pure BS / flat supply curve

DGW: Long-Run Regression (eq. 14)

Key question: Does the short-run relationship also hold in the long run?

Long-run specification: Estimate on **15-year country averages** (one observation per country) rather than annual data:

$$\Delta \log(P_i^N / P_i^T) = \alpha + \beta_1^{LR} \Delta\theta_i + \beta_2^{LR} \Delta g_i + \beta_3^{LR} \Delta \log y_i + u_i \tag{2}$$

Long-run results:

- TFP differential ($\hat{\beta}_1^{LR} \approx 0.74$): rises from 0.23 in the short run – **not significantly different from 1** (the pure BS prediction)
- Government spending and income growth: **become insignificant** in the long run

Interpretation: BS theory is right in the long run. Demand effects are transitory – they average out over 15 years. This long-run regression is the source of the "Long run" row in Table 8.

DGW: Regression Results (Table 7)

Regression	β_1 (TFP)	β_2 (Govt)	β_3 (Income)	β_4 (Disinflation)	N
(1)	0.234	1.974	0.281	–	210
	(0.018)	(0.119)	(0.030)		
(2)	0.234	1.846	0.272	-0.045	210
	(0.015)	(0.104)	(0.025)	(0.010)	
(7)	0.328	–	–	–	210
	(0.013)				

DGW Table 7. Standard errors in parentheses. SUR in first differences, 14 countries, 1970–85.

- **All three channels significant:** TFP differential (BS), government spending, income growth
- $\beta_2 \approx 1.5$–2.0: 1 pp rise in govt spending share $\Rightarrow$ 1.5–2% rise in relative NT price
- $\beta_3 \approx 0.28$: 5% income growth $\Rightarrow$ ≈1.4% rise in relative NT price
- Rejection of $\beta_2 = \beta_3 = 0$: supply curve is **not flat** – demand matters in the short run

DGW: Short Run vs Long Run (Table 8)

When estimated with **annual data (short run):** demand effects dominate. When estimated with **15-year averages (long run):** TFP differential dominates.

	Actual	TFP diff.	Govt spending	Income growth	Residual
Short run	1.31%	0.42	0.10	0.61	0.18
Long run	1.31%	1.24	0.00	0.07	0.00

Source: De Gregorio et al. (1994), Table 8. Average annual increase in P^N/P^T accounted for by each factor (percentage points per year).

- **Short run:** income growth accounts for nearly half (0.61/1.31) of the rise. TFP explains only 0.42.
- **Long run:** TFP accounts for 95% (1.24/1.31). Demand effects vanish.
- **Bottom line:** Balassa-Samuelson is right in the long run. But in the short run — over the business cycle or a decade of policy — demand shifts are the dominant driver.

DGW: Conclusions and Implications for the Project

Main findings:

1. NT inflation exceeded T inflation in 13 of 14 OECD countries, 1970–85
2. **Short run:** income growth (demand) dominant; TFP differential secondary
3. **Long run:** TFP differential (BS) dominant; demand effects disappear

Replication and project idea:

- Data: OECD STAN or EU KLEMS (TFP and prices by sector); IMF IFS/WEO (govt spending, income); classify sectors as T or NT, replicate main results.
- Seemingly unrelated regression (SUR): easy to do, or use modern panel methods.
- Extensions: extend sample to post-1985; emerging markets (stronger BS effects expected); role of exchange rate regime

Lecture Conclusion

Three take-aways from today:

1. **PPP doesn't hold** in the short run or in levels, primarily because non-tradable goods (≈half of GDP) cannot be arbitraged internationally. The real exchange rate fluctuates enormously in the short run. Relative PPP holds in the long run.

2. **Balassa-Samuelson:** $P^N / P^T = a_T / a_N$ – countries with fast productivity growth in tradables develop expensive nontradables $\Rightarrow$ real appreciation $\Rightarrow$ the Penn effect.

3. **In the short run, demand matters too** (De Gregorio et al., 1994): income growth and government spending drive NT prices above what BS alone would predict. The distinction between short-run and long-run determinants is important.

References I

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Appendix

Appendix: Trade Barriers and PPP

Setup: Suppose there is a tariff τ on imports. The domestic price of the imported good is $P = (1+\tau)\mathcal{E}P^*$. The real exchange rate for this good becomes:

$$e = \frac{\mathcal{E}P^*}{P} = \frac{1}{1+\tau} < 1$$

Interpretation: A tariff makes the domestic country appear *cheaper* at market exchange rates – one unit of foreign basket buys less than one unit of domestic basket. The domestic consumer pays the world price plus tariff; the RER reflects this as a domestic price premium.

Implications:

- Countries with higher tariff barriers appear more expensive to foreign buyers (RER < 1 from their perspective)
- Trade liberalisation tends to raise RER as import prices converge toward world prices
- This is a separate channel from nontradability – even fully tradable goods deviate from LOOP if tariffs differ

Source: Schmitt-Grohé et al. (2022), Ch. 9, slides 50–52.

Appendix: Home Bias and PPP Failure

Setup: Two tradable goods b (beef) and c (cars). Both satisfy LOOP: $P_b = \mathcal{E} P_b^*$ and $P_c = \mathcal{E} P_c^*$. But consumption weights differ:

$$P = P_b^{\gamma} P_c^{1-\gamma} \qquad P^* = P_b^{*\gamma^*} P_c^{*1-\gamma^*} \quad (\gamma \neq \gamma^*)$$

Compute the RER:

$$e = \frac{\mathcal{E} P^*}{P} = \frac{\mathcal{E} P_b^{*\gamma^*} P_c^{*1-\gamma^*}}{P_b^{\gamma} P_c^{1-\gamma}} = \left(\frac{P_c}{P_b}\right)^{\gamma-\gamma^*}$$

Interpretation: Even with LOOP for every good, $e \neq 1$ whenever $\gamma \neq \gamma^*$ and relative prices $P_c / P_b \neq 1$.

- Argentines weight beef heavily (γ high); Germans weight cars heavily (γ^* low)
- When the relative price of beef rises, Argentina appears cheaper relative to Germany (in common currency)
- Home bias in consumption baskets is thus a source of persistent PPP deviations even when all goods trade freely

Source: Schmitt-Grohé et al. (2022), Ch. 9, slide 54.

Appendix: Price Indices and Standards of Living

Why PPP rates matter for welfare comparisons:

At market exchange rates, US GDP per capita $\approx 32\times$ India's. At PPP exchange rates, the ratio falls to $\approx 11\times$.

Market exchange rates are determined by the prices of *tradable* goods (those that flow through international markets). But welfare depends on the consumption of *all* goods, including nontradables. In poor countries, nontradables (services, housing) are cheap — so a dollar goes further.

International Comparison Programme (ICP): World Bank surveys that construct comparable price levels across countries, allowing PPP exchange rates to be computed from actual price-level data. Published approximately every 6 years.

The PPP adjustment is especially large for poor countries with cheap services — India, sub-Saharan Africa, Southeast Asia. It is small for countries with similar price structures to the US (e.g. Western Europe, Australia).

Source: Schmitt-Grohé et al. (2022), Ch. 9, slides 24–28.

DGW: Exchange Rate Regime and Inflation Correlations

Average pairwise inflation correlation among country groups:

Variable	Core EMS	Non-core	Full OECD
Tradable goods inflation	0.93	0.76	0.62
Nontradable goods inflation	0.94	0.79	0.58
Tradable TFP growth	0.59	0.37	0.44
Income growth	0.65	0.34	0.46

Source: De Gregorio et al. (1994), Table 5 (summary). Core EMS: BEL, DNK, FRA, GER, NLD.

EMS core countries have **much higher** inflation correlations than correlations among their underlying fundamentals (TFP growth, income). Post-EMS (1979–85) vs pre-EMS (1971–78): inflation correlations rise but fundamental correlations fall in the core. $\Rightarrow$ Exchange rate regime itself has an independent effect on relative inflation.

Appendix: DGW — Data and Tradability Classification

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Sample: 14 OECD countries (AUS, BEL, CAN, DNK, FIN, FRA, GER, ITA, JPN, NLD, NOR, SWE, GBR, USA), 1970–85. OECD International Sectoral Database, 20 sectors.

Tradability rule: export share $> 10\%$ of total sector production $\Rightarrow$ tradable.

Sector	1970	1975	1980	1985	Mean	T/NT
Agriculture	17.3	24.3	28.1	24.7	23.6	T
Mining	29.6	36.9	27.9	31.4	31.5	T
Manufacturing	32.5	47.1	53.1	48.3	45.2	T
Transportation	22.9	28.0	31.5	28.8	27.8	T
Other services	1.3	1.9	2.2	2.1	1.9	NT

Source: De Gregorio et al. (1994), Table 1. Export shares (%) of total sector output.

Other services ($\approx$50–60% of GDP) = nontradable. Transportation is tradable — perhaps surprising. The $> 10\%$ rule is a simple, replicable criterion.

Appendix: DGW — Production Function Derivation (eqs. 1–6)

Setup: Cobb-Douglas production:

$$Y_j = \theta_j L_j^{\alpha_j} K_j^{1-\alpha_j}, \quad j \in \{T, N\}$$

Perfect competition ⇒ cost minimisation. Unit cost in sector j:

$$c_j = \frac{1}{\theta_j} \left(\frac{W}{\alpha_j}\right)^{\alpha_j} \left(\frac{R}{1-\alpha_j}\right)^{1-\alpha_j}$$

Zero-profit: $P_j = c_j$. For the tradable sector, small open economy + perfect capital mobility pins R at the world rate R^*. This pins W from $P^T = c_T$, which then pins $P^N = c_N$.

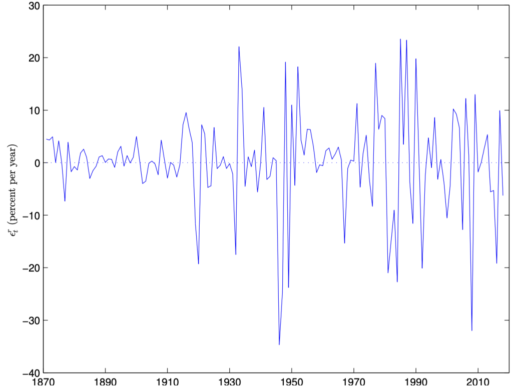
Log-differentiating and substituting:

$$\hat{P} \equiv \Delta \log\left(\frac{P^N}{P^T}\right) = \frac{\alpha_N}{\alpha_T}\,\hat{\theta}_T - \hat{\theta}_N$$

This is DGW eq. (6). The key assumption is that R is pinned externally — if capital is not perfectly mobile, R responds to domestic conditions, and demand factors enter.

Source: De Gregorio et al. (1994), pp. 3–5, eqs. 1–6.

Relative PPP Fails in the Short Run



SUW. Annual data, 1870–2018.

The real exchange rate fluctuates enormously year-to-year. Standard deviation of annual real depreciation: **9.3%** for the USD/GBP pair over 1870–2018.

PPP puzzle: Relative PPP holds in the long run (inflation differentials $\rightarrow$ depreciation) but fails dramatically in the short run. What drives short-run deviations?

Appendix: How Wide Is the Border? (Engel-Rogers)

Question: Even for nominally tradable goods, how much does crossing a national border raise price dispersion?

Engel and Rogers (1996): Compare price variation for 14 consumer goods across 23 US and Canadian cities. Distance between cities within a country vs across the border.

Finding: Crossing the US-Canada border is equivalent in price-dispersing terms to adding **thousands of miles** of distance within a country. The border effect is large even between two highly integrated economies with no tariffs, same language, close cultural ties.

Implications:

- Nominal exchange rate volatility is a major source of the border effect — sticky prices in local currency create RER movements when $\mathcal{E}$ fluctuates
- Even without tariffs, borders matter for price levels: distribution costs, local regulations, market segmentation
- Suggests that LOOP fails even for tradables in the short run — relevant for understanding the PPP puzzle

Big Mac Index

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