Turn the Tables! Reframing Measurement of Capital in Japanese National Accounts

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Today's Topics Capital: Two Aspects of One Entity - Concepts of Capital Stock Capital Value and Depreciation Measurement in Japanese National Accounts - Net, CFC, and Gross Alternative Measurement - Price and Quantity of Capital Service Aggregating Capital - Land as a Capital - Capitalization of Software IT Capital and Price Statistics Capital Costs for Non-Market Production Conclusion: Proposals for Reframing

Two Aspects of Capital



Traditional Concepts of Capital Stock



Three Concepts of Capital Stock



Gross Capital Stock



Productive Capital Stock									
Consta	ant	Gross		Prc	ductive				
Qualit	У	Capital		Ca	pital Stock				
Investi	ment	Stock	¥*						
A t	=	$S_{t,0}^{G}$		S t,0	= At $d \tau$: age-efficiency profile				
A <i>t</i> -1	=	S ^{<i>G</i>} <i>S</i>^{<i>t</i>},1		S t, 1	$= d_1 A t_{-1}$				
A t-2	=	S <i>t</i> ,2		S t,2	$= d_2 A t_{-2}$				
A t-3	=	S ^{<i>G</i>} S ^{<i>t</i>} ,3		S <i>t</i> ,3	$= d_3 A t_{-3}$				
:									
•		•		•					
$At-\tau$	=	$S_{t,\sigma}^{G}$		$S_{t,\tau}$	$= d\tau A t - \tau$				

Constant Quality Investment		Rross Capital Stock	Cap	ita _{Net} Cap	I Stock
A t	=	$S_{t,0}^{G}$		$S_{t,0}^{N}$	= At d^{p}_{τ} : age-price profile
A <i>t</i> -1	=	S <i>t</i> ,1		S <i>t</i> ,1	$= d^{p}_{1}At_{-1}$
A t-2	=	S ^{<i>G</i>} S ^{<i>t</i>} ,2		$S_{t,2}^N$	$= d^{p}_{2}At_{-2}$
A t-3	=	S <i>t</i> ,3		S <i>t</i> ,3	$= d^{p}_{3}At^{-3}$
		:		•	
At- au	=	$S_{t,\tau}^{G}$		$S_{t,\tau}^N$	$= d^{p}_{\tau} A t_{\tau}$

Order of Magnitudes in Three Capital Stock

$$S_t^N = < S_t = < S_t^G$$

under Usual AEP



under one-hoss shay

$$S_t^N = S_t < S_t^G$$

under BGA

Age-Efficiency Profile and Age-Price Profile



Discount rate=0.05, Average Life Τιμε=20(δ=0.2057)

Geometric vs Hyperbolic

Geometric

- dτ=(1-δ) τ
- AEP and APP are identical
- Simplify Perpetual Inventory Method (possible to neglect the age structure for aggregating assets with different ages) $S_t = (1-\delta)S_{t-1} + A_t$
- The U.S. BEA, the Statistics Canada

Hyperbolic

- $d_{\tau} = (T \tau)/(T \beta \tau)$
- More Flexible
 - one-hoss shay in case of β =1
 - concave function in case of 0< β <1
 - straight line in case of $\beta = 0$
 - convex function in case of $\beta < 0$
- The U.S. BLS, Australian Bureau of Statistics

Capital Value and Rental Prices



 pA_t = value of new asset

 $pA_{t,\tau} =$ value of asset with age: τ $d^{P}_{t,\tau} = \frac{pA_{t,\tau}}{nA_{t}}$: age-price profile

Capital Value and Depreciation

The difference of Value $(P_{t-1,\tau} - P_{t,\tau+1}) = (P_{t,\tau} - P_{t,\tau+1}) - (P_{t,\tau} - P_{t-1,\tau})$

(P_{t-1, \u03c4} - P_{t, \u03c4 +1}) : time-series depreciation (Hill, Diewert), full depreciation (Oliner), economic depreciation and asset inflation (Hulten-Wykoff)

$(\mathsf{P}_{\dagger,\tau} - \mathsf{P}_{\dagger,\tau+1})$

: cross-section depreciation (Hill,Diewert), partial depreciation (Oliner), economic depreciation (Hulten-Wykoff)

 $(P_{t,\tau} - P_{t-1,\tau})$: revaluation

BEA's Revision in 1997

Wealth Account - Net Capital Stock Survival Function + Straight-line for Decay →Geometric Distribution as a Default - Gross Capital Stock → No Longer Produced! **Production Account** Consumption of Fixed Capital → Consistent with Stock Measurement **Time-series Depreciation** → Cross-section Depreciation

Capital Stock in the Japanese National Accounts



Net Capital Stock in the Japanese National Accounts JSNA-NCS

- Six Tangible Assets
 - :1)dwellings, 2)other building, 3)other structures,
 4)transport equipment, 5)other machinery and equipment, 6)cultivated assets
- One Intangible Assets
 - : custom software, only
- Depreciation Distribution
 - : Straight-line for infrastructure
 - Geometric for other assets
- Benchmark Year
 - : 1970 National Wealth Survey
- Underestimate?
 - : 30-40 percent lower than our estimates in 2000 due to too-high depreciation rates ?

Consumption of Fixed Capital in the Japanese National Accounts

JSNA-CFC

- Prices
 - : Based on Historical Prices (Book-Value)
- CFC in the 1993 SNA
 - : "Its value may deviate considerably from depreciation as recorded in business accounts or as allowed for taxation purpose, especially when there is inflation" (paragraph 6.179)

Gross Capital Stock in the Japanese National Accounts

GCSPE(Gross Capital Stock of Private Enterprises)

- Coverage
 - All assets, except residential owned by company Excluding Non-profit Institution
- No Assets Classification
- No Investment in Current Prices
- Overestimate as Production Capacity?
 - : 20 percent higher than our estimates in 2000

Alternative Estimates Periods - 1960-2000 (1955-2000 for Capital Stock) Classification - 102 Asset Classification by 70 Sectors Assets: 90 Tangible Assets, 5 Intangible Assets (3 Software, others), 3 Inventories, 4 Types of Land Sectors: 45 industries, Government, Household, 23 Infrastructures Geometric Approach - AEP=APP

Price and Quantity of Capital Service

Basic Assumption

– $K_t^{kj} = \phi^{kj}S_t^{kj}$, ϕ = annualization factor (constant) Capital Service Prices

 $- P^{K,kj}_{t} = (r^{j}_{t} - \pi^{k}_{t})P^{A,k}_{t-1} + \delta^{k}P^{A,k}_{t}$

: Capital Service Price= Opportunity Cost of Financial Assets -Revaluation+Cross-section Depreciation

$$- V^{K,j}_{t} = \sum_{k} P^{K,kj}_{t-1} K^{kj}_{t}$$

- Endogenous Rate of Return (after tax rate of return on equity) by Industry
- Japanese Tax Structure
 - Corporate income tax, business income tax, property tax, acquisition tax, capital consumption allowance, income allowance and reserves, special depreciation, capital gain tax, dividend tax

Capital Stock and Services in Japan : In Case of Fixed Assets

	Z	Ζ*	K		GCSPE
1960-65	9.11	7.80	13.88	<	11.55
1965-70	10.44	9.53	12.27	<	12.45
1970-75	9.56	9.25	9.96	<	10.10
1975-80	6.15	6.18	5.81	<	6.38
1980-85	4.80	4.69	5.24	<	6.72
1985-90	5.04	4.87	6.02	<	6.79
1990-95	4.42	4.40	5.08	<	5.15
95-2000	2.56	2.60	2.49	<	3.48
60-2000	6.51	6.16	7.59	<	7.83

Source: Nomura[2004a]

Capital Stock and Services in Japan : In Case of Total Assets

	Z	Ζ*	K		ref:GCSPE
1960-65	4.97	3.64	9.85	<<	11.55
1965-70	5.94	4.93	9.76	<<	12.45
1970-75	5.43	5.05	8.17	<<	10.10
1975-80	3.79	3.57	4.67	<<	6.38
1980-85	2.73	2.57	3.87	<<	6.72
1985-90	2.69	2.68	4.94	<<	6.79
1990-95	2.42	2.52	3.82	<<	5.15
95-2000	1.74	1.73	2.05	<<	3.48
60-2000	3.72	3.34	5.89	<<	7.83

Source: Nomura[2004a], GCSPE is defined by fixed assets only.

Land as a Capital

Share of Land to Total Capital Stock in 2000

- 23.6 percent in the U.S. (Jorgenson-Landefeld. 2005)
- 43.5 percent in Japan (Nomura, 2004)

Impacts to TFP

- Canada: Neglecting of land and inventories leads to a decline in average TFP growth rates of 0.1 percent per year during 1963-96 (TFP Growth=0.5-0.6), Diewert-Lawrence (2000)
- Japan: Neglecting of land and inventories leads to a decline in average TFP growth rates of 0.7 percent per year during 1960-2000 (TFP Growth=1.5), Nomura (2004)

Impacts to Relative Prices in 1990 (Nomura, 2004)

- Relative Price of Capital Stock between the U.S. and Japan 1.31 for fixed assets \rightarrow 3.05 for total assets
- Relative Price of Capital Services between the U.S. and Japan 1.36 for fixed assets \rightarrow 1.70 for total assets

Endogenous Ex-Post RoR



Source: Nomura (2004)

Capitalization of Software

Japanese National Accounts

- Custom Software, only
- Benchmark Input-Output Table
 - 1995:
 - Custom Software
 - 2000:

Custom Software, Prepackaged Software

Methodology to Estimate Own-Account Software

- Recommendations by the OECD Task Force on Software Measurement in the National Accounts:
- BEA Methodology by Industry: 1997, 1999, 2003

International Comparison of Software Professionals

	Year	Share to total	ISCO-213	ISCO-312	ISCO- 213/
		employees			(213+312
Greece	1998	0.2	7444	7196) 50.8
Spain	1998	0.3	44026	34107	56.3
France	1998	0.4	196705	99011	66.5
Netherlands	1998	0.9	100765	82144	55.1
U.S.	2000	1.3	1633280		
Sweden	1999	1.3	75881	24474	75.6
Japan	2000	1.4	753493	363753	67.4

Data: Employee Base, U.S. (Occupational Employment and Wages, BLS), Japan(Population Census, MIC), Others(OECD, Ahmad [2003]) Classification: U.S. SOC-15-1020,30, 50 and JSCO-06 correspond to ISCO-213

International Comparison of Own-Account Software Investment Share to GDP

United States (2000) Denmark (1997) **Japan** (2000) **Belgium**(2000) **Sweden (1999) Australia (1998/99)** Netherlands (1998) **Canada** (1998) **United Kingdom (1999) Finland** (1995) **France (1998) Italy (1998) Spain** (1996)



0.4

0.8

0.6

Source: Japan (Nomura, 2004), U.S. (BEA), Belgium (Hermans, 2002), others (Ahmad, 2003)

0.2

 $\mathbf{0.0}$

International Comparison of Total Software Investment Share to GDP

Sweden (1999) United States (2000) Japan (2000) Denmark (1997) Australia (1998/99) Netherlands (1998) **Canada** (1998) **Belgium**(2000) **France (1998) Italy (1998) Spain (1996) United Kingdom (1999) Finland** (1995)



 0.0
 0.5
 1.0
 1.5
 2.0
 2.5

 Source: Japan (Nomura,2004), U.S. (BEA), Belgium (Hermans, 2002), others (Ahmad, 2003)



Source: Japan (Nomura, 2004), U.S. (BEA)

IT Capital Contribution Share to Total Capital Service



Industry Capital Input Contributions in Japan, 1960-1977



Industry Capital Input Contributions in Japan, 1977-1995

Other Service Finance and Insurance Communications Public Administration Wholesale and Retail Household Electronic Components Other Electrical Mach Electricity Construction Computers Chemical Products Medical Care Machinery excl Computers Printing and Publishing Road Transportation Motor Vehicles **Railroad Transportation** Education Foods Other Manufacturing **Precision Instruments Communications Equipment** Metal Products Iron and Steel Research **Real Estate** Agriculture, Forestry, Fishery Gas Supply Petroleum Refining Non-ferrous Metal Stone, Clay, Glass Storage Facility Service Textile Air Transportation Paper and Pulp Other Transportation Equipment Apparel Rubber Products Water Supply **Coal Products** Furniture and Fixture Woods and Related Products Leather Products Other Mining Coal Mining Water Transportation

-0.1



Industry Capital Input Contributions in Japan, 1995-2000

Other Service Finance and Insurance Household Communications Public Administration Wholesale and Retail **Electronic Components** Construction Other Electrical Mach Medical Care Chemical Products Railroad Transportation Electricity Printing and Publishing Foods **Communications Equipment** Other Manufacturing **Real Estate** Road Transportation Motor Vehicles Computers Machinery excl Computers Petroleum Refining **Precision Instruments** Water Transportation Education Research Gas Supply Stone, Clay, Glass Water Supply Iron and Steel Non-ferrous Metal Paper and Pulp Rubber Products Other Transportation Equipment Air Transportation Agriculture, Forestry, Fishery Apparel Storage Facility Service Coal Products Metal Products Other Mining Woods and Related Products Leather Products Coal Mining Furniture and Fixture Textile



0.2

0.1

0.0

Industry Productivity Growth in the U.S., 1977-2000

Computers and Office											
Electronic Components											
Coal Mining											
Agriculture											
Communications Equipment											
Rubber and Plastic											
Textiles, Apparel, Leather											
Wholesale Trade											
Primary Metal											
Other Electrical Mach											
Non Energy Mining											
Finance											
Fabricated Metal											
Stone, Clay, Glass											
Food and Tobacco											
Transportation Equipment											
ruments and Miscellaneous											
Electricity											
Lumber, Wood, Furniture											
Paper											
Real Estate (rental)											
Transportation											
Retail and Eating											
Communications											
Government Enterprises											
Government Education											
overnment excl. Education											
Household											
Other Services											
Computer Services											
Motor Vehicles											
Chemicals											
ofessional and Social Svcs.											
siness Svc excl. Computer											
Petroleum Refining											
Aachinery excl. Computers											
Printing and Publishing											
Education, private											
Gas											
Construction											
Oil and Gas Mining				Note	e Indue	stries d	orted h	v produ	ctivity	orowth	
Legal								J Produ			
Health private				Ibro	enson-	Ho-Sti	roh(20)	(05)			
Insurance	1.			Joig	ensou-		1011(20)	ψ3)			
	04	0.00	0.00	0.02	0.04			<u> </u>	10	0 10	0 1
-0.	.04	-0.02	0.00	-0.02	0.04	 U.(<u>10</u> 0	.08 (0.12	-0.14

Other

Pr Bi

Industry Productivity Growth in Japan, 1977-2000

Electronic Components Computers Communications Communications Equipment Petroleum Refining Textile Other Electrical Mach Gas Supply Non-ferrous Metal Precision Instruments Wholesale and Retail **Finance and Insurance** Chemical Products Coal Products Air Transportation Other Transportation Agriculture, Forestry, Fishery Motor Vehicles Paper and Pulp Electricity Machinery excl Computers Other Manufacturing Iron and Steel Storage Facility Service Rubber Products Metal Products Stone, Clay, Glass Coal Mining Apparel Public Administration Household Printing and Publishing Other Service Leather Products Woods and Related Products Water Transportation Furniture and Fixture Other Mining Construction Research **Railroad Transportation Road Transportation** Water Supply Foods Real Estate Education Medical Care -0.02 -0.01 0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07

Comparison of Computer Price at 5-digit SIC between the U.S. and Japan



(a) Personal Computers

(b) General Purpose Computers & Servers

WPI/CGPI and PPI: 5-digit SIC

Source: Nomura-Samuels (2004)

Price Aggregation at the Most Detailed Item

Price Aggregation in the Most Detailed Item

- BOJ's CGPI Laspeyres:
 Defined by Carli Price Index (Simple Arithmetic Average)
 - :ESRI uses CGPI Laspeyres at the Most Detailed Level
- BOJ's CGPI Chained-Las:
 Defined by Jevons Price Index (Simple Geometric Average)
- Carli Price Index has an Upward Bias (Fisher, Diewert)

Who Extrapolate Prices Backward?

Price Statistics

Prices for National Accounts

U.S. BLS-PPI

BEA-Price

Japan BOJ-CGPI



Prices for Investment as a Composite Goods

Why the Investment Price for Computer Declines Faster than Producer's Price in BEA

 Investment Prices Should Be Defined by Purchaser's Prices

Prices Can be Estimated and Revised Separately

- Investment Goods is Defined by Final Goods
- Embodiment: Software → Computer → Office
 Building

Capital Service Cost for Non-Market Production



(a) for 93 SNA Concepts

(b) for Non-Market Production

Additional Capital Service Cost for Non-Market Production

Source: Author's Estimate

Conclusion: Proposals for Reframing Measurement of Capital in the Japanese National Accounts

- (i) Capitalization of Software
- (ii) Reframing Net Capital Stock and Consumption of Fixed Capital
- (iii) Gross Capital Stock to Productive Capital Stock
- (iv) Constant-Quality Prices in Japan
- (v) Empirical Studies for AEP and APP in Japan
- (vi) Measurement of Price and Quantity of Capital Services
- (vii) Land as a Capital
- (viii)Capital Service cost for Non-Market Production