The Comparative Postwar Economic Performance of the G-7 Countries

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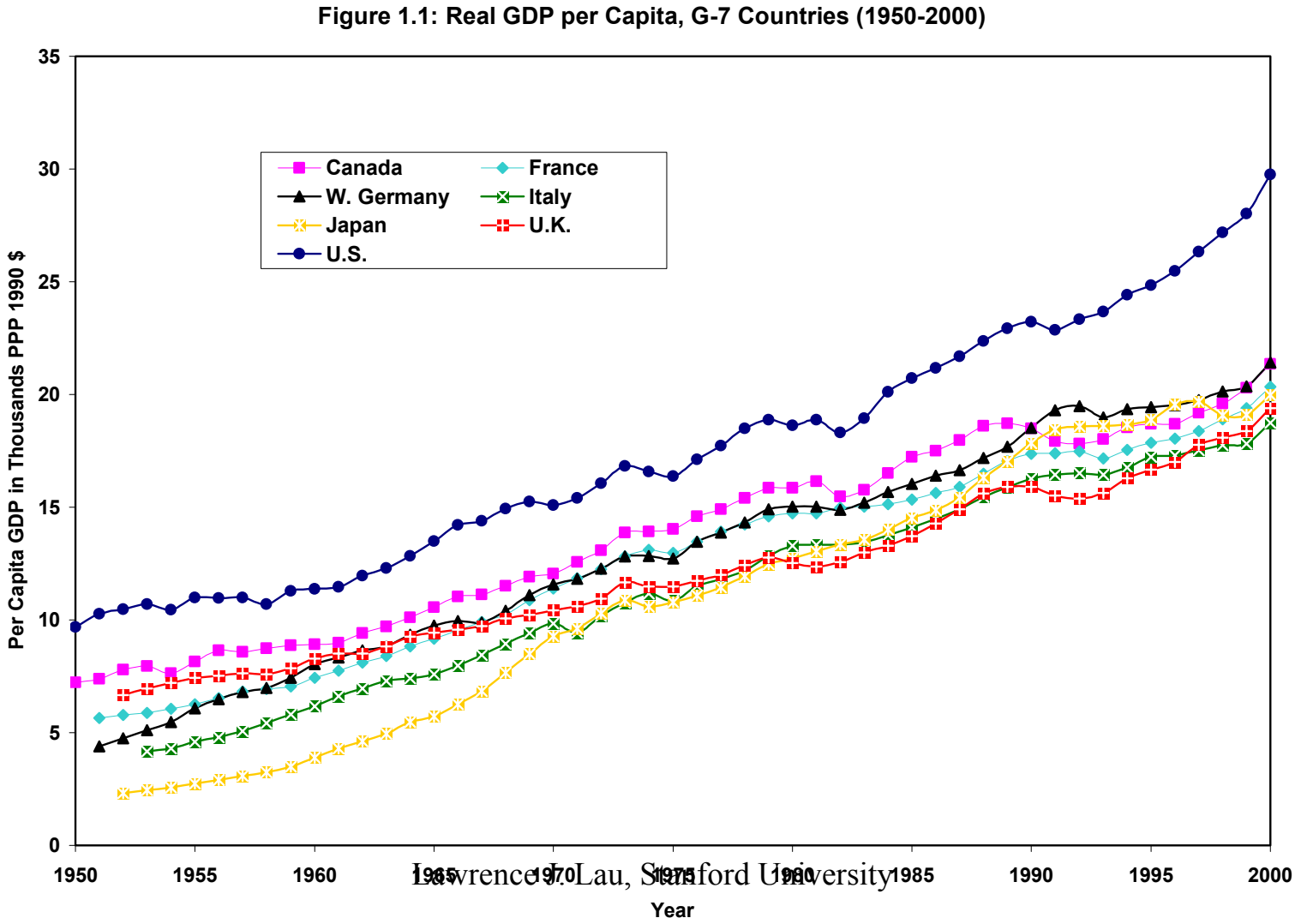
Preview

- What accounts for the differences in the levels and rates of growth of real output across the G-7 countries?
- The meta-production function approach
- Differences due to productive efficiency
- Differences due to the labor market
  - Human capital
  - Labor market institutions, practices and outcomes
  - Female labor force participation rates
- The case of "Constant Returns to Scale"

Real GDP per Capita, G-7 Countries '000 1990 PPP $ (1950-2000)



The Commodity-Augmenting Representation of Technical Progress

One specialization of

$Y = F(K, L, t)$ is

$Y^* = F(K^*, L^*)$, where

Y^*, K^*, and L^* are efficiency-equivalent quantities. Thus, in terms of measured quantities,

$$Y = A_0(t)\, F(A_K(t)K, A_L(t)L).$$

The Extended Meta-Production Function Approach: The Basic Assumptions (1)

(1) All countries have the same underlying aggregate production function F(.) in terms of standardized, or "**efficiency-equivalent**", quantities of outputs and inputs, i.e.

(1) $$Y^*_{it} = F(K^*_{it}, L^*_{it}) \ , \ i = 1,...,n.$$

The Extended Meta-Production Function Approach: The Basic Assumptions (2)

(2) The measured quantities of outputs and inputs of the different countries may be converted into the unobservable standardized, or "efficiency-equivalent", units of outputs and inputs by multiplicative country- and output- and input-specific time-varying **augmentation factors**, $A_{ij}(t)$'s, i = 1,...,n; j = output (0), capital (K), and labor (L):

(2) $$Y^*_{it} = A_{i0}(t)Y_{it} \ ;$$

(3) $$K^*_{it} = A_{iK}(t)K_{it} \ ;$$

(4) $$L^*_{it} = A_{iL}(t)L_{it} \ ; \ i = 1, \ldots, n.$$

The Extended Meta-Production Function Approach: The Basic Assumptions (2)

- In the empirical implementation, the commodity augmentation factors are assumed to have the constant geometric form with respect to time. Thus:

(5) $$Y^*_{it} = A_{i0}\,(1+c_{i0})^t Y_{it}\ ;$$

(6) $$K^*_{it} = A_{iK}\,(1+c_{iK})^t K_{it}\ ;$$

(7) $$L^*_{it} = A_{iL}\,(1+c_{iL})^t L_{it}\ ;\ i = 1,\ldots,n.$$

A_{i0}'s, A_{ij}'s = augmentation level parameters

c_{i0}'s, c_{ij}'s = augmentation rate parameters

The Extended Meta-Production Function Approach: The Basic Assumptions (2)

- For at least one country, say the ith, the constants A_{i0} and A_{ij}'s can be set identically at unity, reflecting the fact that "efficiency-equivalent" outputs and inputs can be measured only relative to some standard.
- The A_{i0} and A_{ij}'s for the U.S. are taken to be identically unity.
- Subject to such a normalization, the commodity augmentation level and rate parameters can be estimated simultaneously with the parameters of the aggregate production function.

The Meta-Production Function Approach

- It is important to understand that the meta-production function approach assumes that the production function is identical for all countries only in terms of the efficiency-equivalent quantities of outputs and inputs; it is not identical in terms of measured quantities of outputs and inputs
- A useful way to think about what is the same across countries is the following—the isoquants remain the same for all countries and over time with a suitable renumbering of the isoquants and a suitable re-scaling of the axes

The Extended Meta-Production Function Approach: The Basic Assumptions (3)

(3) The aggregate meta-production function is assumed to have a flexible functional form, e.g. the transcendental logarithmic functional form of Christensen, Jorgenson & Lau (1973).

The Extended Meta-Production Function Approach: The Basic Assumptions (3)

- The translog production function, in terms of "efficiency-equivalent" output and inputs, takes the form:

$$(8)\quad \ln Y^*_{it} = \ln Y_0 + a_K \ln K^*_{it} + a_L \ln L^*_{it} + B_{KK}(\ln K^*_{it})^2/2 + B_{LL}(\ln L^*_{it})^2/2 + B_{KL}(\ln K^*_{it})(\ln L^*_{it}),\ i = 1,\ldots,n.$$

- By substituting equations (5) through (7) into equation (8), and simplifying, we obtain equation (9), which is written entirely in terms of **observable** variables:

The Estimating Equation

(9) $\ln Y_{it} = \ln Y_0 + \ln A^*_{i0} + a^*_{Ki} \ln K_{it} + a^*_{Li} \ln L_{it}$
$+ c^*_{i0} t + B_{KK}(\ln K_{it})^2/2 + B_{LL}(\ln L_{it})^2/2 + B_{KL}(\ln K_{it})$
$(\ln L_{it}) + (B_{KK} \ln(1+c_{iK}) + B_{KL} \ln(1+c_{iL}))(\ln K_{it})t$
$+ (B_{KL} \ln(1+c_{iK}) + B_{LL} \ln(1+c_{iL}))(\ln L_{it})t$
$+ (B_{KK}(\ln(1+c_{iK}))^2 + B_{LL}(\ln(1+c_{iL}))^2$
$+ 2B_{KL} \ln(1+c_{iK}) \ln(1+c_{iL}))t^2/2,$

$i = 1,...,n$, where A^*_{i0}, a^*_{Ki}, a^*_{Li}, c^*_{i0} and c_{ij}'s, $j = K, L$ are country-specific constants.

Simultaneously Purely Capital- and Human-Capital Augmenting Technical Progress

$$Y = A_0(t)\, F(A_K(t)K, A_H(t)H, A_L(t)L)$$

$$= A_0 F(A_K(t)K, A_H H, A_L L)$$

$$= A_0 F(A_K K, A_H(t)H, A_L L)$$

$$= A_0 F(A(t)K^{\alpha}H^{\beta}, A_L L)$$

Also Known As Generalized Solow-Neutral Technical Progress

$$Y_{it} = A_{io}F(A_i(t)K_{it}^{\lambda}H_{it}^{1-\lambda}, L_{it})$$

The Estimated Translog Meta-Production Function Takes the Following Form:

$$(2.2)\ \ell nY_{it} = \ell nY_0 + \ell nA_{io} + (a_K + B_{KL})\lambda \ell nK_{it} + (a_K + B_{KL})(1-\lambda)\ell nH_{it} + a_L \ell nL_{it} + (a_K + B_{KL})\ell n(1+c_i)t$$

$$+ B_{KK}\lambda^2(\ell nK_{it})^2/2 + B_{KK}(1-\lambda)^2(\ell nH_{it})^2/2 + B_{LL}(\ell nL_{it})^2/2$$

$$+ B_{KK}\lambda(1-\lambda)(\ell nK_{it})(\ell nH_{it}) + B_{KL}\lambda(\ell nK_{it})(\ell nL_{it}) + B_{KL}(1-\lambda)(\ell nH_{it})(\ell nL_{it})$$

$$+ [B_{KK}\lambda(\ell nK_{it}) + B_{KK}(1-\lambda)(\ell nH_{it}) + B_{KL}(\ell nL_{it})]\ell n(1+c_i)t + B_{KK}(\ell n(1+c_i))^2 t^2/2 .$$

The Estimates of the Efficiency Parameters

Table 2.1: Estimates of the Efficiency Parameters A_{i0} and C_i

Country	A_{i0}	C_i (~1972, 1986~)	C_i (1973~1985)
Canada	0.69	0.067 (2.250)	0.063 (2.068)
France	0.75	0.094 (3.761)	0.087 (3.027)
West Germany	0.70	0.099 (4.348)	0.073 (2.858)
Italy	0.70	0.118 (4.112)	0.080 (2.917)
Japan	0.58	0.127 (3.793)	0.058 (2.349)
U. K.	0.61	0.063 (3.415)	0.059 (2.482)
U. S.	1	0.076 (4.342)	0.057 (2.680)

Note: Numbers in parentheses are asymptotic t-ratios.

The Measures of Relative Productive Efficiency

(2.3) $$E_{1i} = \frac{F_i(K_{US}, L_{US}, H_{US}, t)}{F_{US}(K_{US}, L_{US}, H_{US}, t)}.$$

(2.4) $$\frac{1}{E_{2i}} = \frac{F_{US}(K_i, L_i, H_i, t)}{F_i(K_i, L_i, H_i, t)}$$

(2.5) $$M = (E_{1i} E_{2i})^{1/2}$$

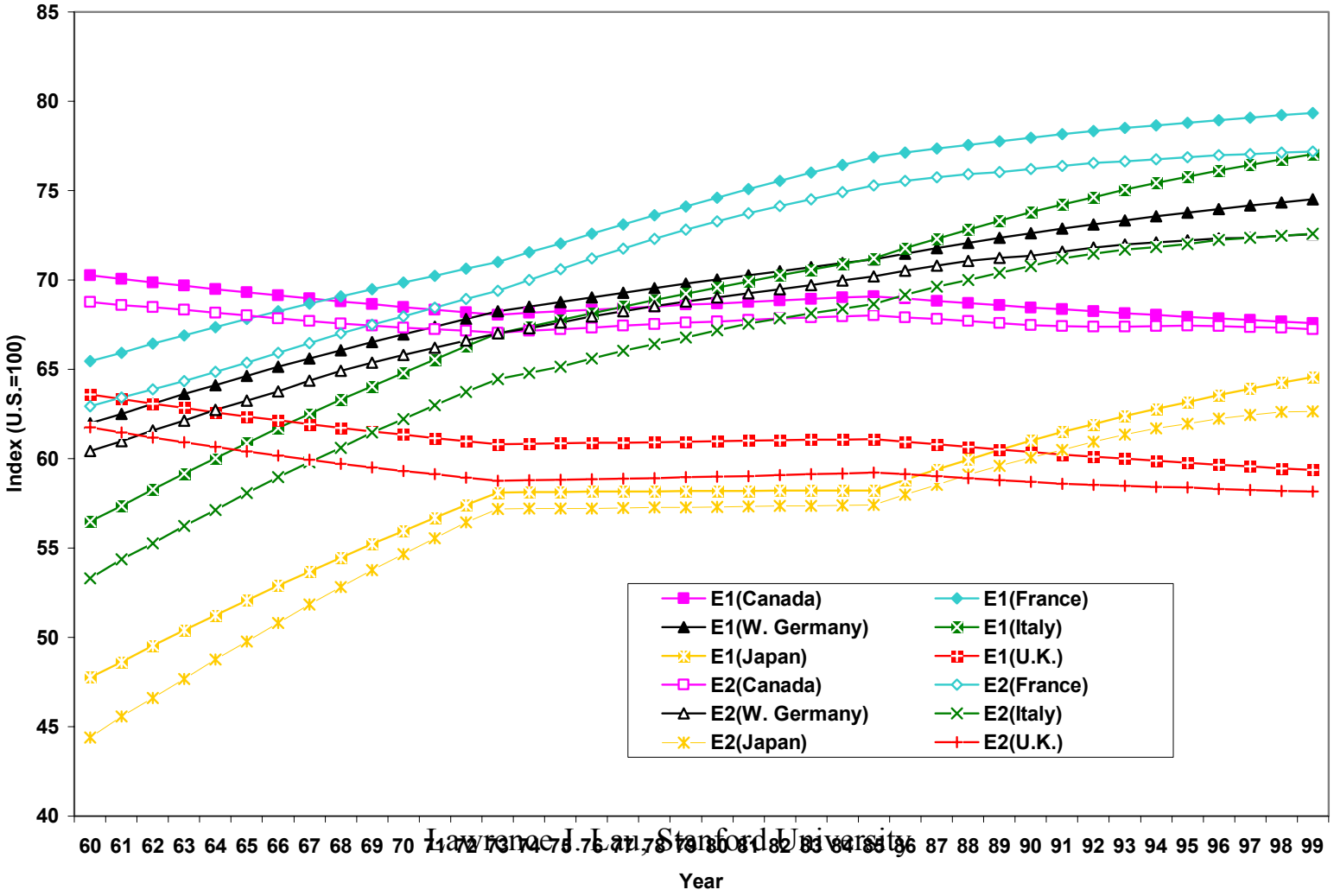
The Measures of Relative Productive Efficiency

Table 2.2: Productive Efficiency Relative to the United States, Selected Years

Country	1960	1970	1980	1990	1999
France:					
E1	65.5	69.8	74.6	78.0	79.3
E2	62.9	68.0	73.3	76.2	77.2
M	64.2	68.9	73.9	77.1	78.3
Italy:					
E1	56.5	64.8	69.6	73.8	77.0
E2	53.3	62.2	67.2	70.8	72.6
M	54.9	63.5	68.4	72.3	74.8
West Germany:					
E1	62.0	66.9	70.0	72.6	74.5
E2	60.4	65.8	69.0	71.4	72.6
M	61.2	66.4	69.5	72.0	73.5
Canada:					
E1	70.3	68.5	68.7	68.5	67.6
E2	68.8	67.3	67.7	67.5	67.2
M	69.5	67.9	68.2	68.0	67.4
Japan:					
E1	47.8	56.0	58.2	61.0	64.6
E2	44.4	54.7	57.3	60.1	62.7
M	46.0	55.3	57.7	60.5	63.6
U.K.:					
E1	63.6	61.3	61.0	60.4	59.4
E2	61.7	59.3	59.0	58.7	58.2
M	62.7	60.3	60.0	59.5	58.8

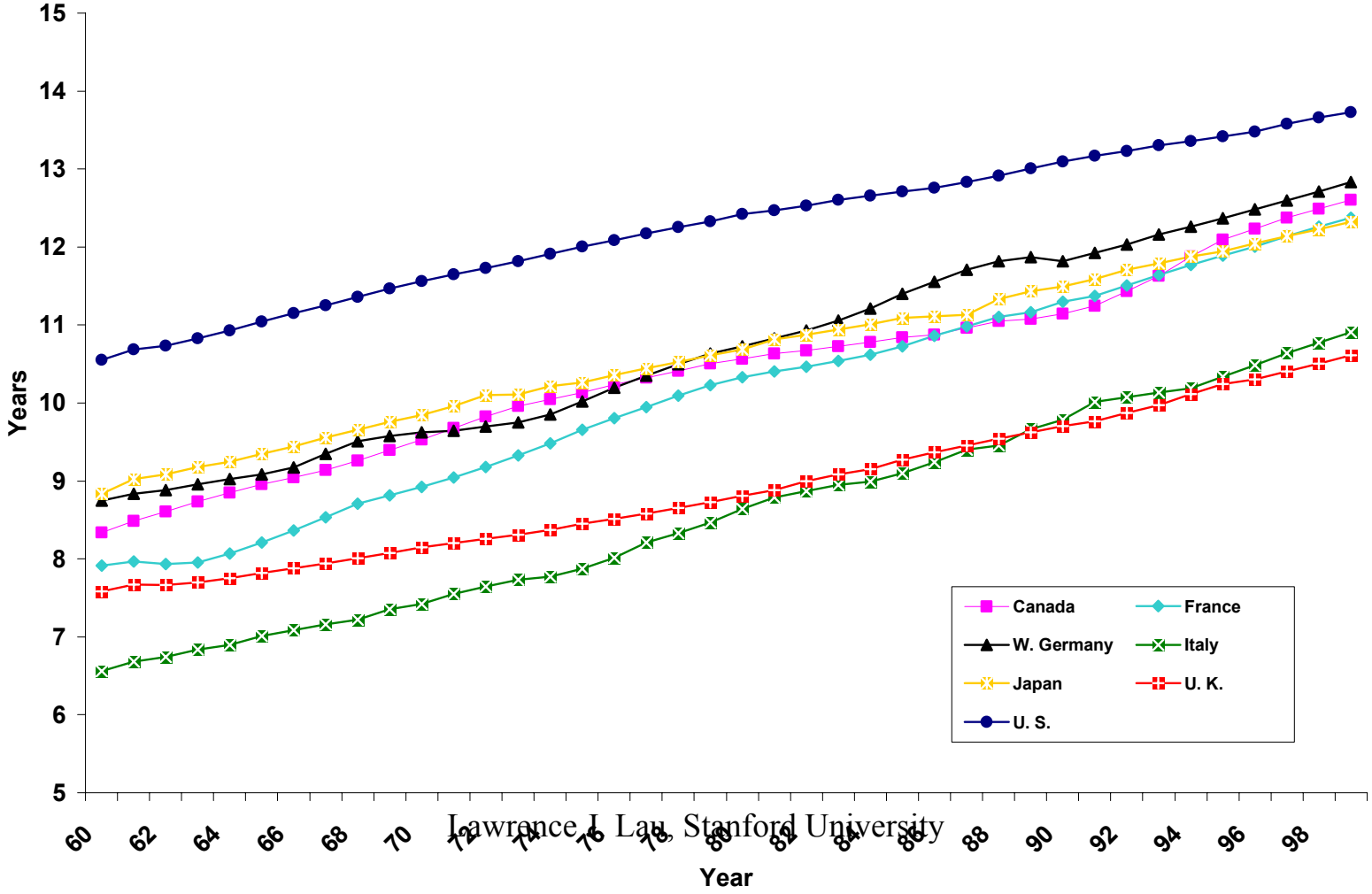
The Measures of Relative Productive Efficiency

Figure 2.1: Productive Efficiency of the G-7 Countries Relative to the U.S. (U.S.=100)



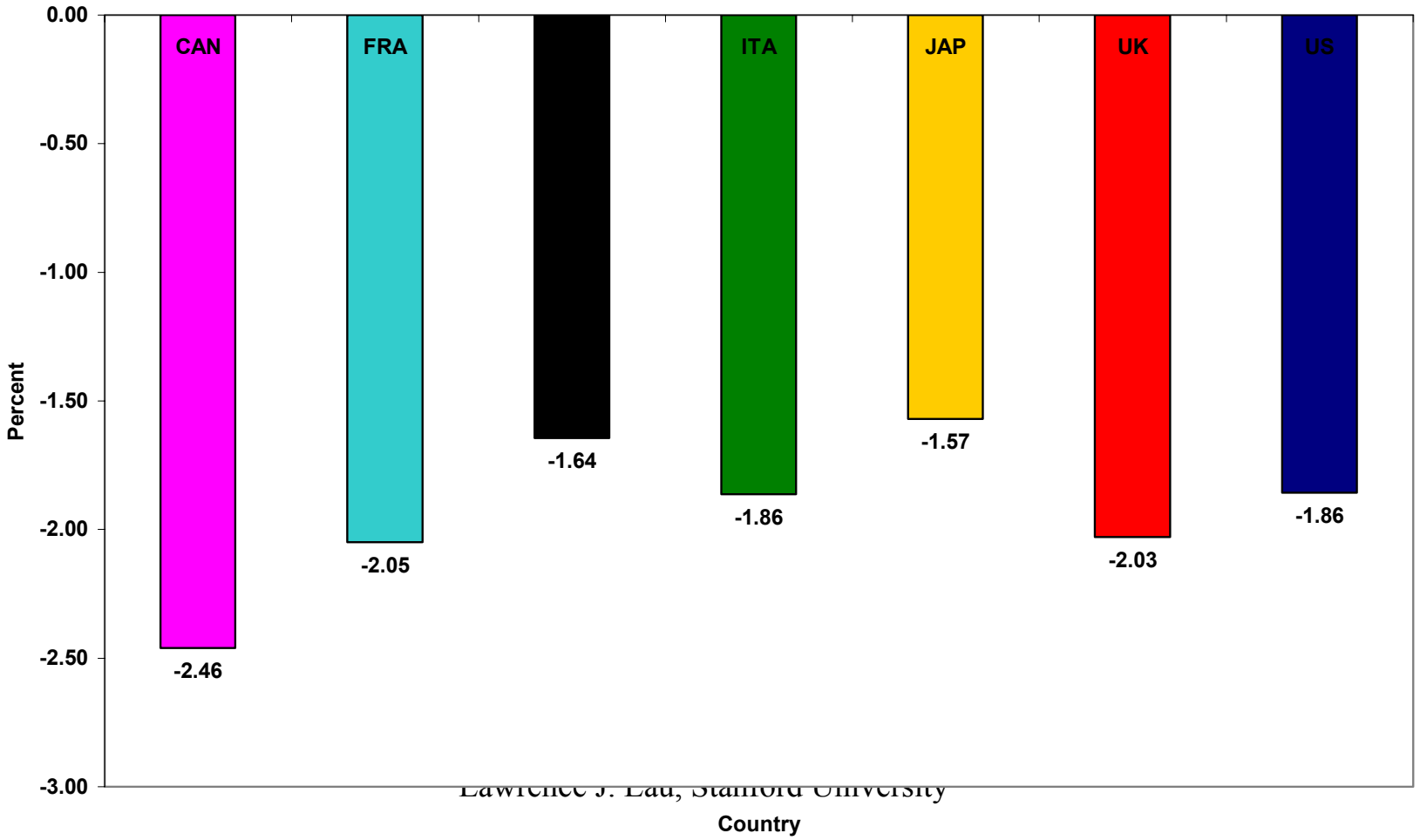
Average Human Capital of G-7 Countries

Figure 3.1: Human Captial of the G-7 Countries
(Average Number of Years of Schooling of the Working Age Population)



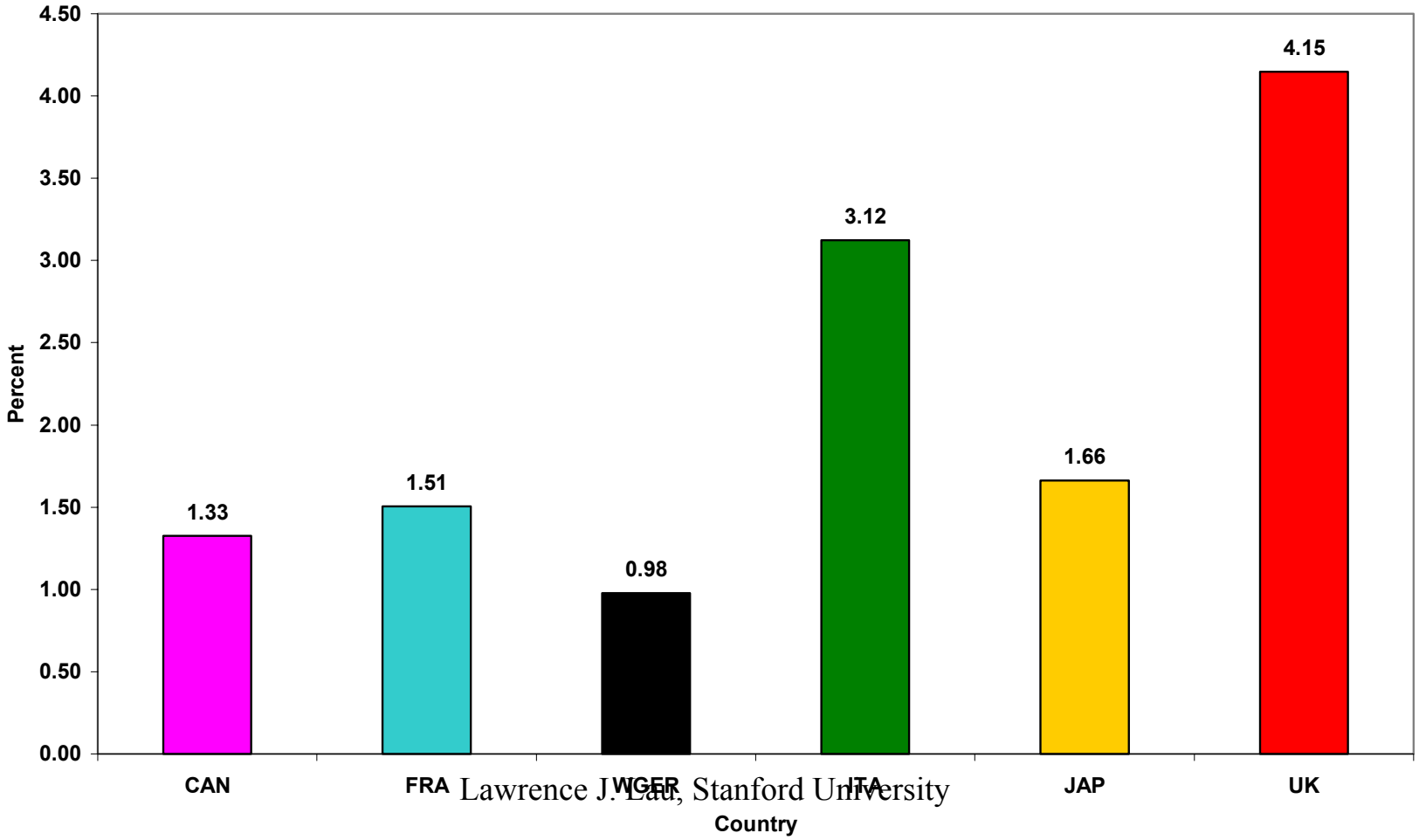
Hypothetical Output Losses in 1999 under the Assumption of No Growth in H

Figure 3.2: Hypothetical Output Losses in 1999 under the Assumption that Average Human Capital Has Not Grown Since 1960 (Percent of Real GDP)



Hypothetical Output Gains in 1999 under the Assumption of U.S. Average H

Figure 3.3: Hypothetical Output Gains in 1999 under the Assumption that All Other G-7 Countries Have the Same Average Human Capital as the U.S.(Percent of Real GDP)



Decomposition of the Labor Input

(4.1) $L=(L/E).(E/LF).(LF/N).N$

where L is the number of labor hours, E is the aggregate number of employed individuals, LF is the labor force, and N is the working-age population. The ratios in parentheses can be interpreted as hours per employee, the employment rate (or one minus the unemployment rate), and the labor force participation rate, respectively.

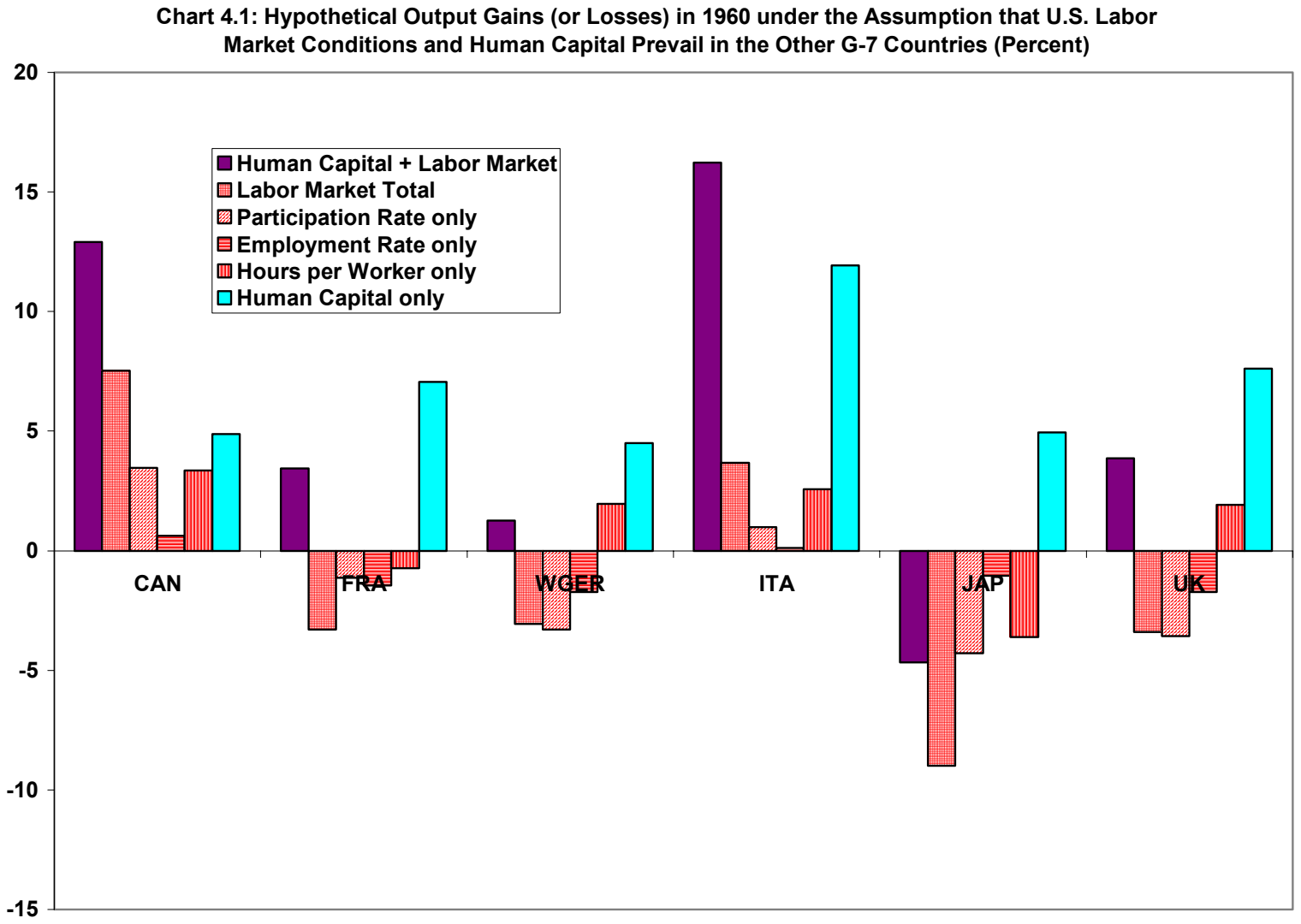
The Levels and Average Rates of Growth of Selected Labor Market Indicators

Table 4.1: The Levels and Average Annual Rates of Growth of Selected Labor-Market Indicators
Group-of-Seven (G-7) Countries

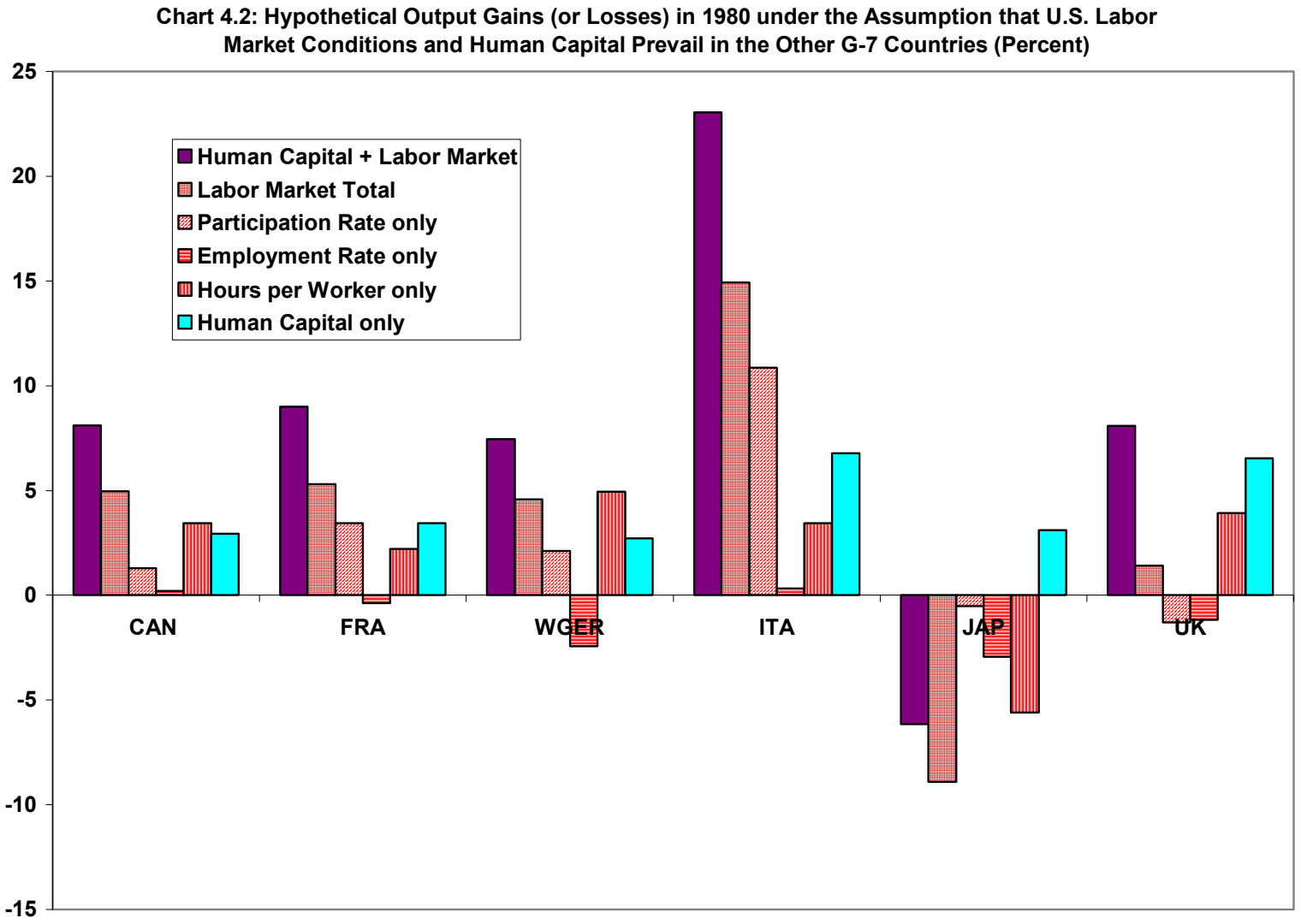
	Output per Capita (1990 US$)		Output per Labor-Hour (1990 US$)		Physical Capital per Labor-Hour (1990 US$)		Human Capital per Working-Age Population (Years)		Average Hours Worked per Employee per Year (Thou.)		Employment Rate (%)		Labor Force Participation Rate (%)		Female Labor Force Participation Rate (%)	
Levels																
	1960	1997	1960	1997	1960	1997	1960	1997	1960	1997	1960	1997	1960	1997	1960	1997
Canada	8916	20206	13.94	24.96	19.09	53.18	8.34	12.38	1.916	1.768	89.9	90.3	59.4	70.9	32.0	67.8
France	7441	18404	8.62	28.95	11.46	68.02	7.91	12.14	2.120	1.688	98.5	87.4	66.7	65.9	n.a.	59.7
W.Germany[1]	8298	18846	8.90	27.06	13.40	71.68	8.75	12.26	1.969	1.623	99.0	91.7	70.5	68.6	49.3	61.8
Italy	6169	17448	8.00	29.51	13.58	88.95	6.56	10.64	1.925	1.629	94.1	85.7	62.7	60.2	36.7	44.1
Japan	3899	19693	3.44	19.82	4.19	74.34	8.84	12.14	2.383	1.911	98.3	96.6	76.0	78.0	n.a.	63.7
U.K.	8292	17630	9.26	22.06	16.26	62.99	7.59	10.41	1.982	1.758	98.5	94.4	70.4	74.6	48.5	67.5
U.S.[2]	11379	26284	15.06	29.71	34.91	65.43	10.55	13.56	2.076	1.860	94.5	94.9	64.5	76.6	42.5	71.1

	Average Annual Rates of Growth (percent p.a.), 1960-1997							
Canada	2.2	1.6	2.9	1.07	-0.2	0.01	0.5	2.1
France[3]	2.6	3.4	4.9	1.16	-0.6	-0.32	0.0	0.8
W.Germany[1]	2.6	3.5	5.1	1.00	-0.6	-0.23	-0.1	0.6
Italy	3.0	3.7	5.3	1.32	-0.4	-0.25	-0.1	0.5
Japan[4]	4.7	5.0	8.0	0.86	-0.5	-0.05	0.1	1.0
U.K.	2.2	2.5	3.8	0.86	-0.3	-0.11	0.2	0.9
U.S.[2]	2.3	1.9	1.7	0.68	-0.3	0.01	0.5	1.4

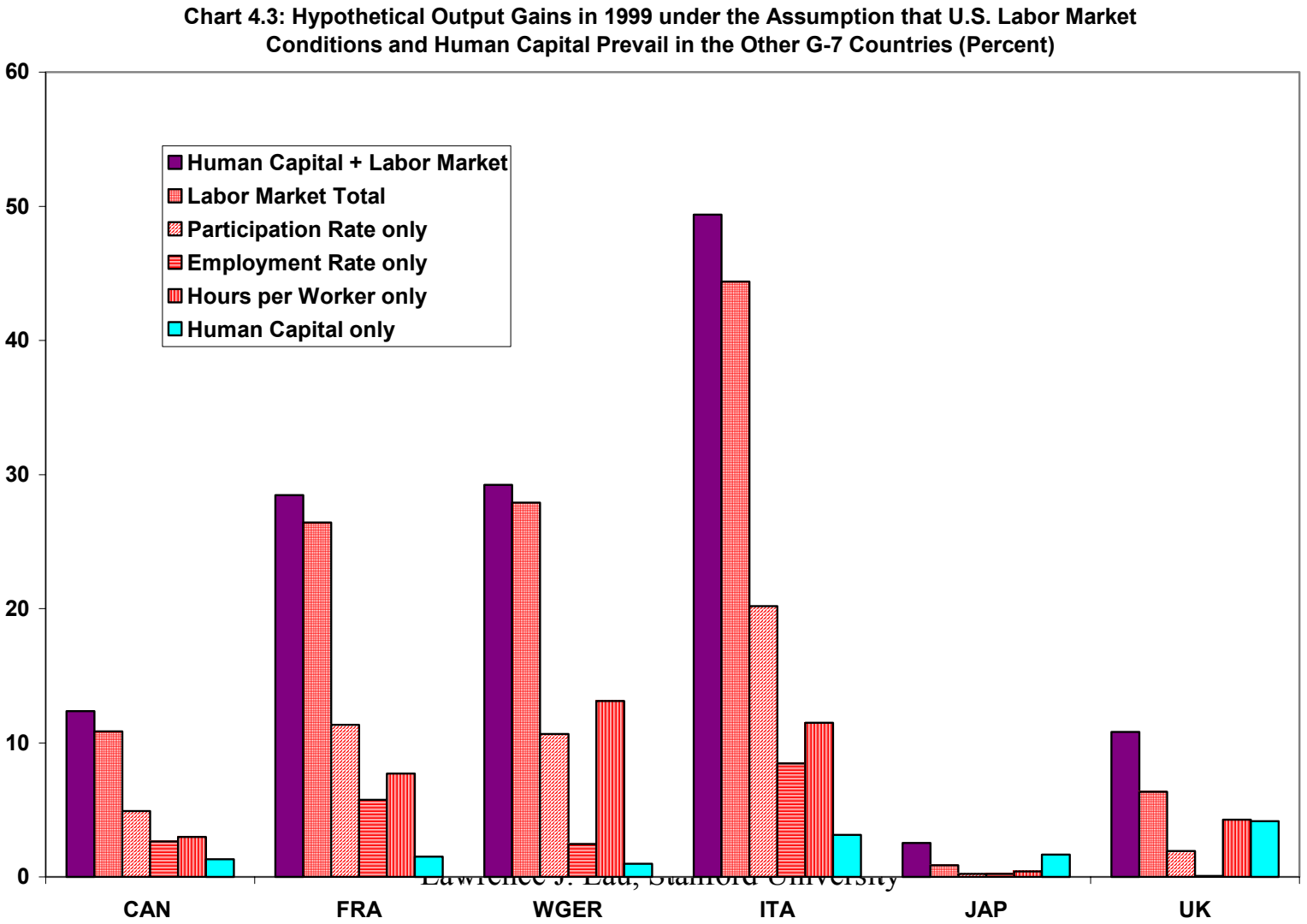
Hypothetical Output Gains (or Losses), 1960, U.S. Labor Market Outcomes



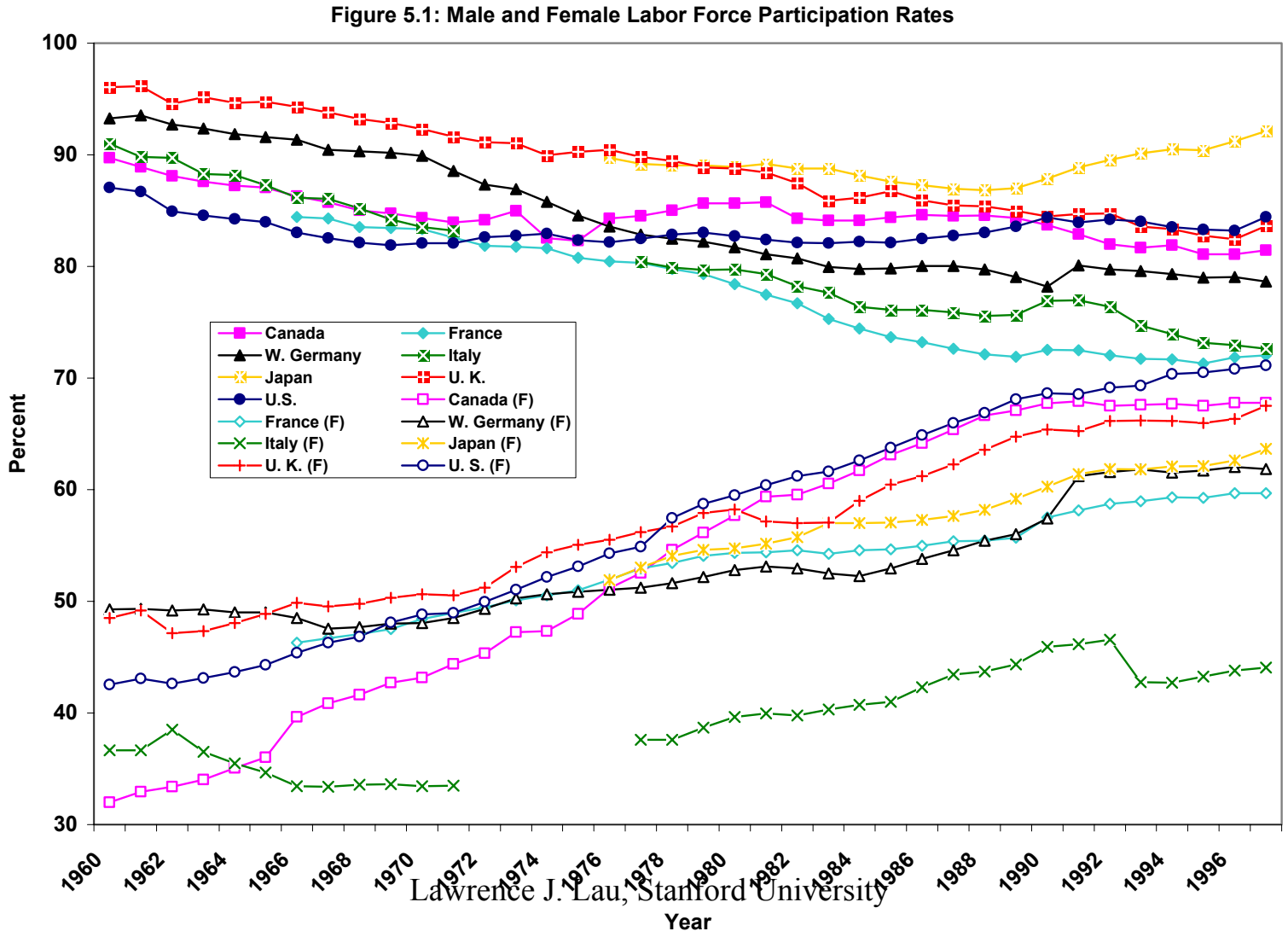
Hypothetical Output Gains (or Losses), 1980, U.S. Labor Market Outcomes



Hypothetical Output Gains (or Losses), 1999, U.S. Labor Market Outcomes



Male and Female Labor Force Participation Rates



Decomposition of the Labor Force Participation Rate

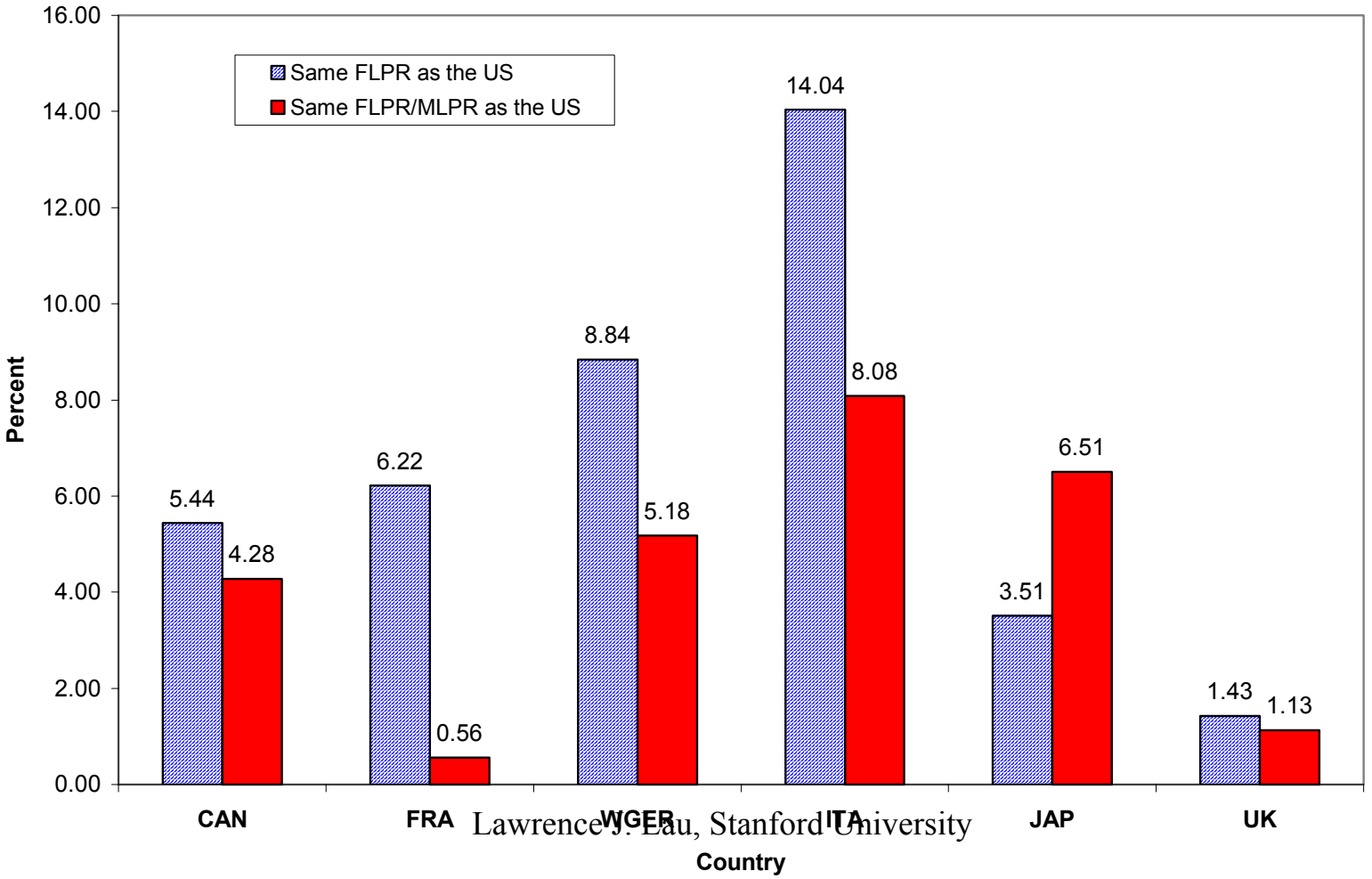
(5.1) $L = (L/E)\,(E/LF)\,[LFf/Nf)\,Nf + (LFm/Nm)\,Nm]$

where (LFf/Nf) and (LFm/Nm) are the female and male labor force participation rates, respectively, and Nf and Nm are the male and female working-age populations, respectively. Equation (5.1) can be further rewritten in the form:

(5.2) $L = (L/E)\,(E/LF)\,[(LFf/Nf)\,(Nf/N) + (LFm/Nm)\,(Nm/N)]\,N$

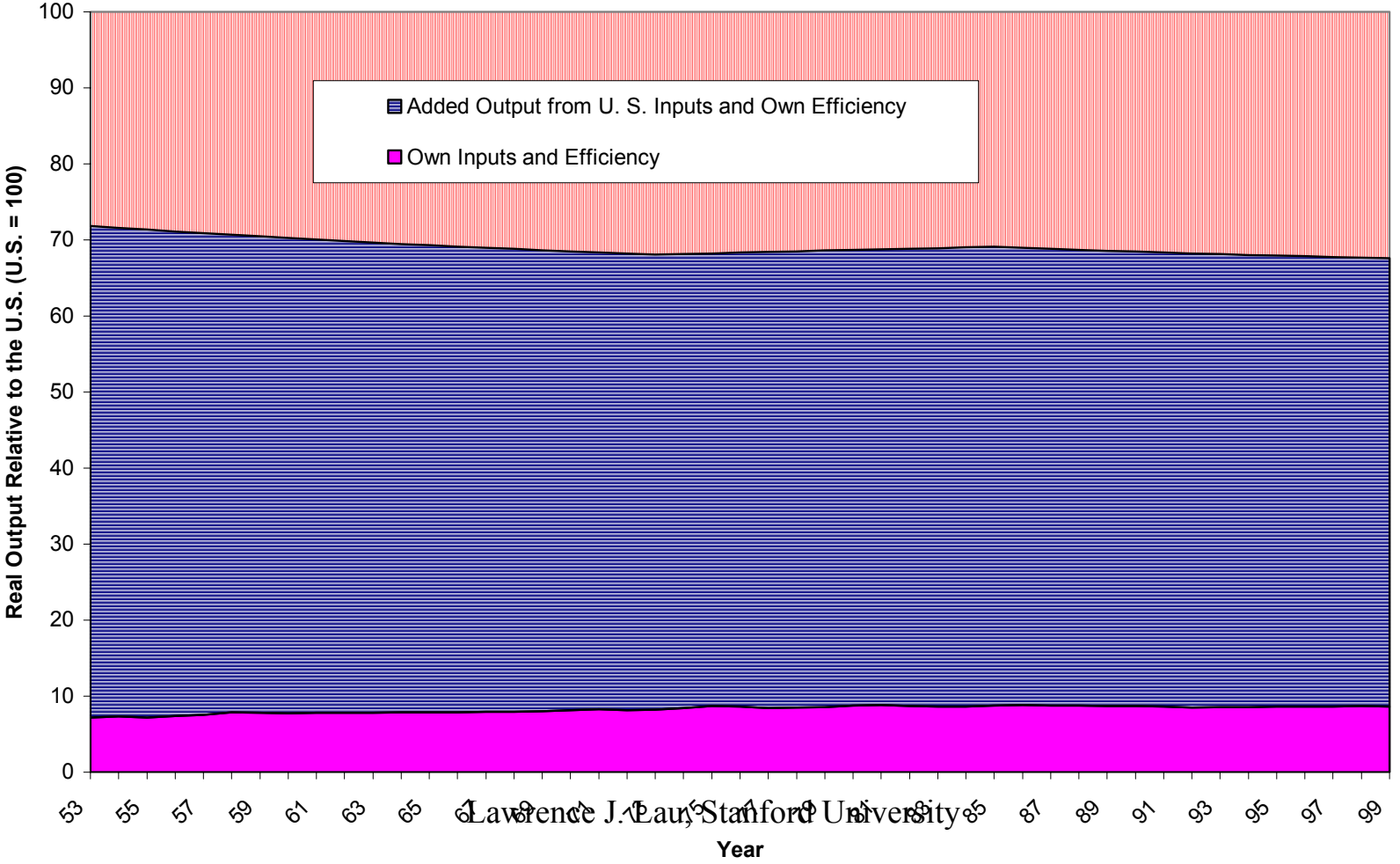
The Effects of Differences in the Female Labor Force Participation Rate

Figure 5.2: The Effects of Differences in the Female Labor Force Participation Rates



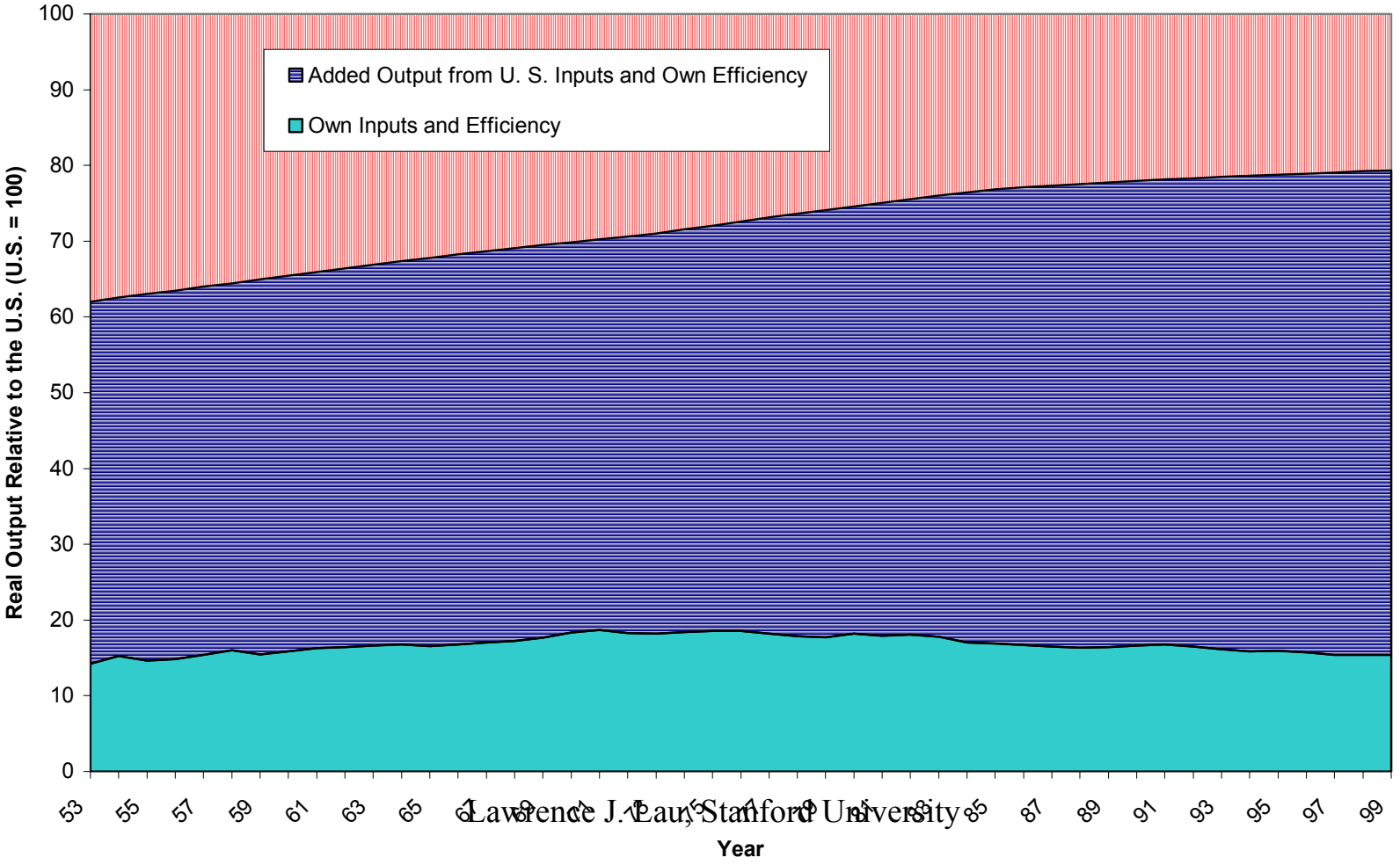
The Sources of Differences in Real Output Relative to the United States--Canada

Figure 6.1: Canada



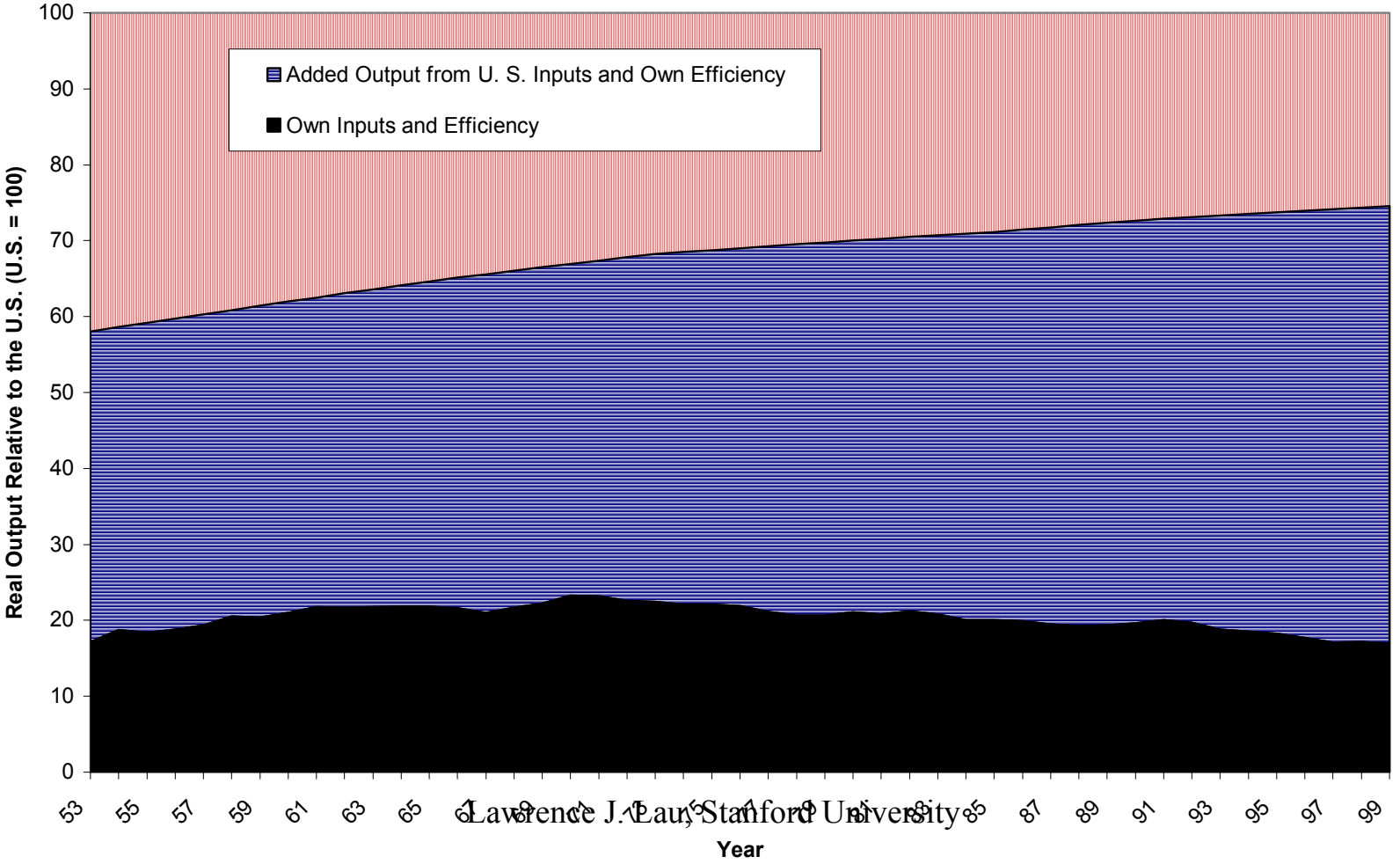
The Sources of Differences in Real Output Relative to the United States--France

Figure 6.2: France



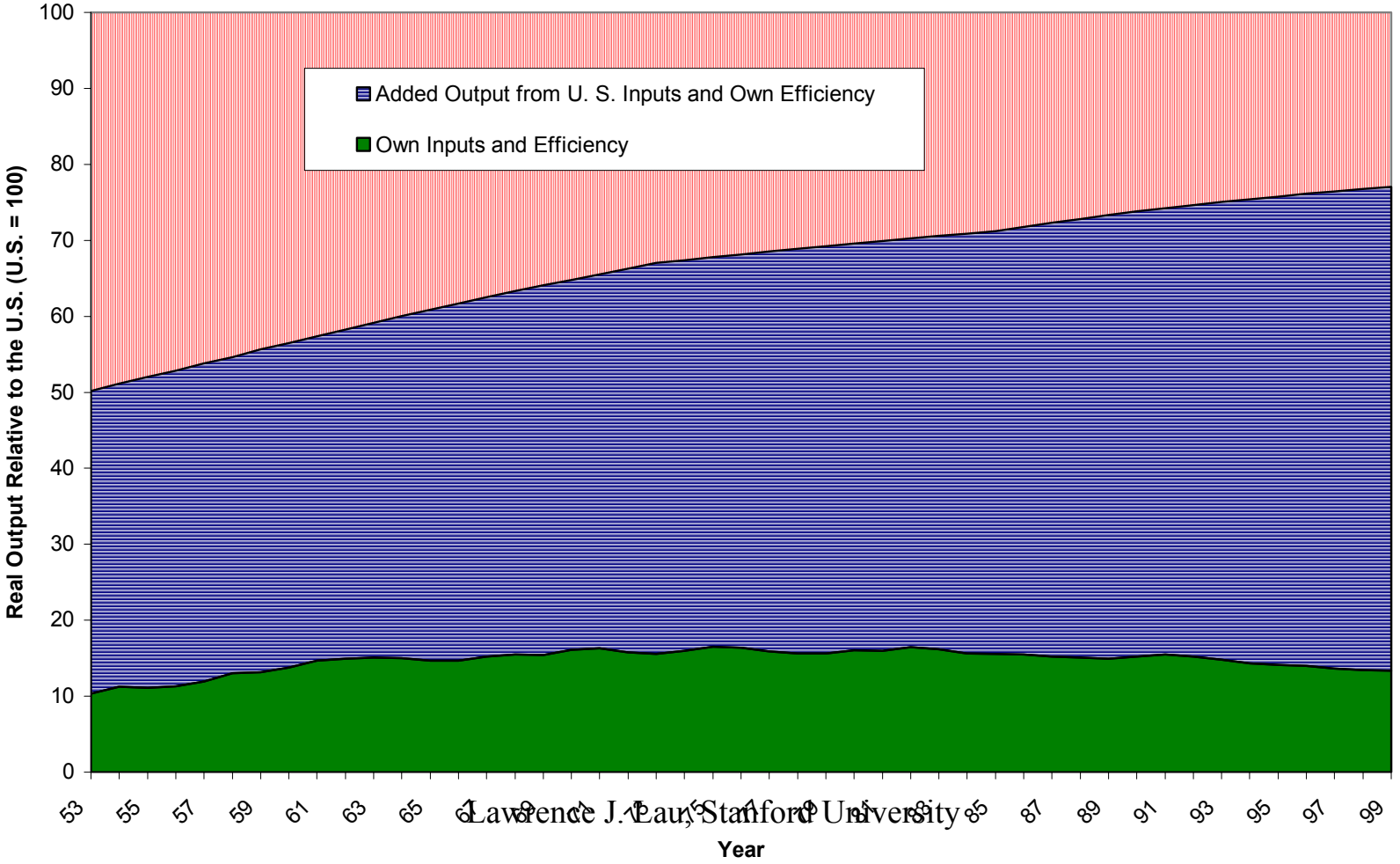
The Sources of Differences in Real Output Relative to the United States—W. Germany

Figure 6.3: Germany



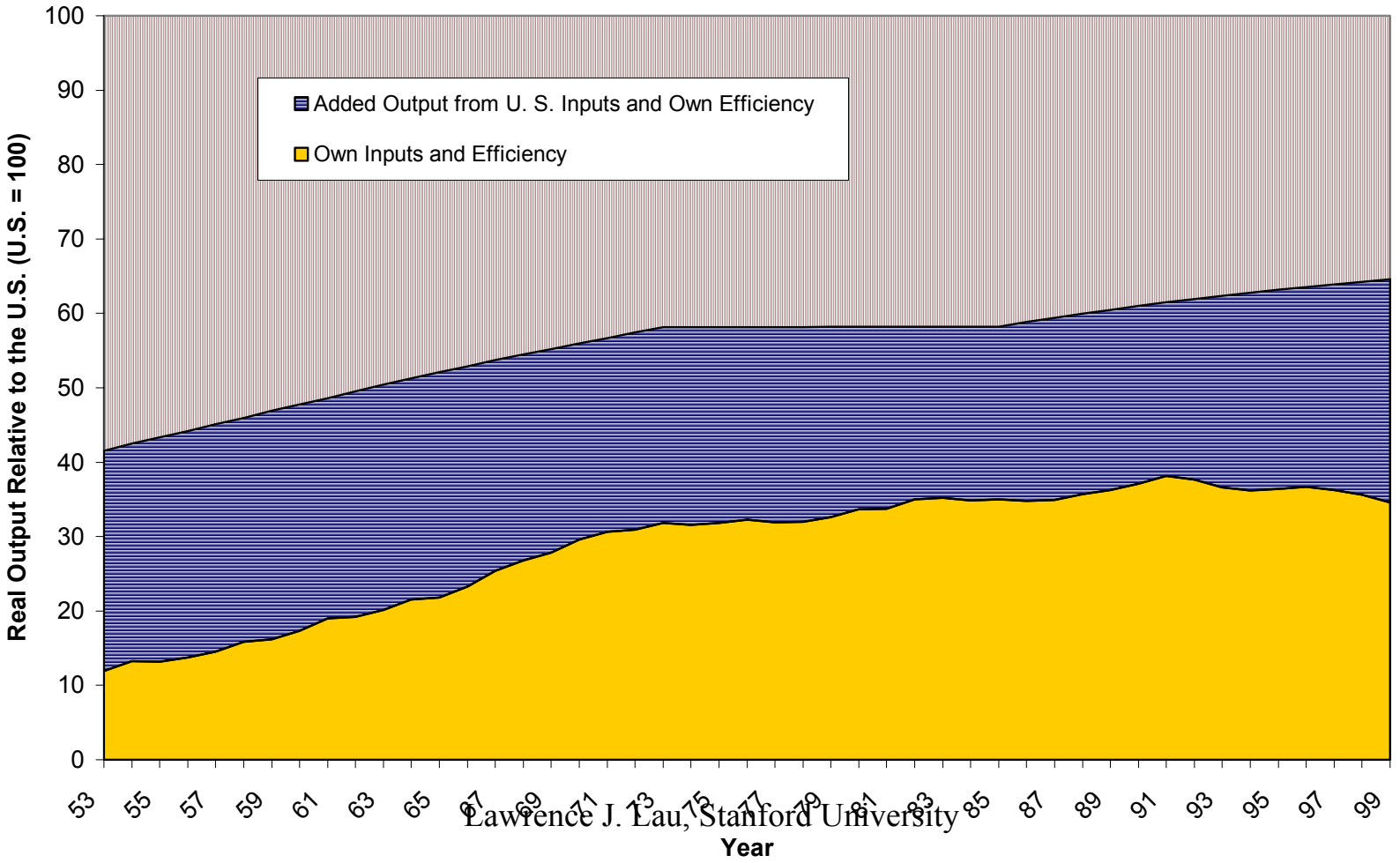
The Sources of Differences in Real Output Relative to the United States--Italy

Figure 6.4: Italy



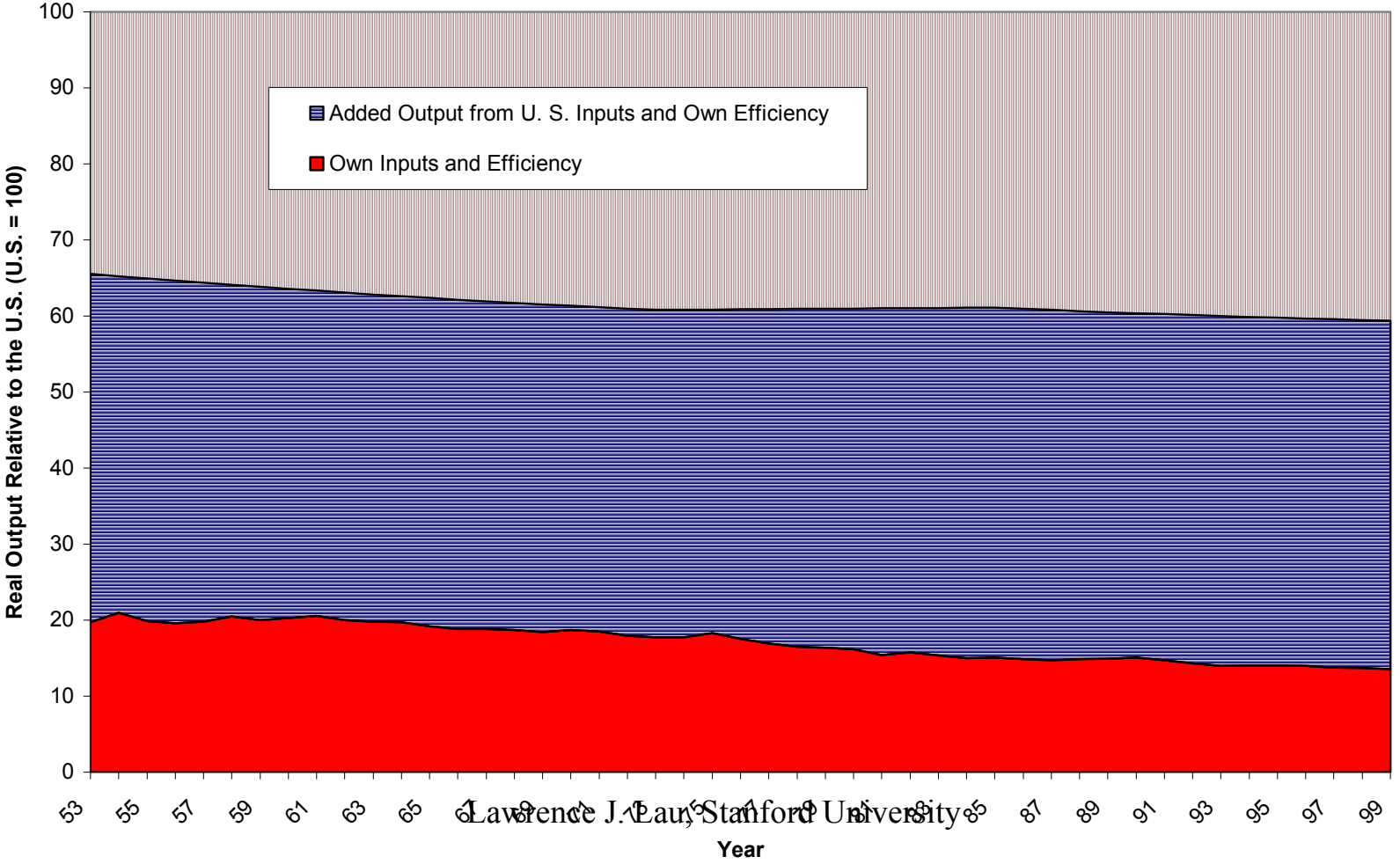
The Sources of Differences in Real Output Relative to the United States--Japan

Figure 6.5: Japan



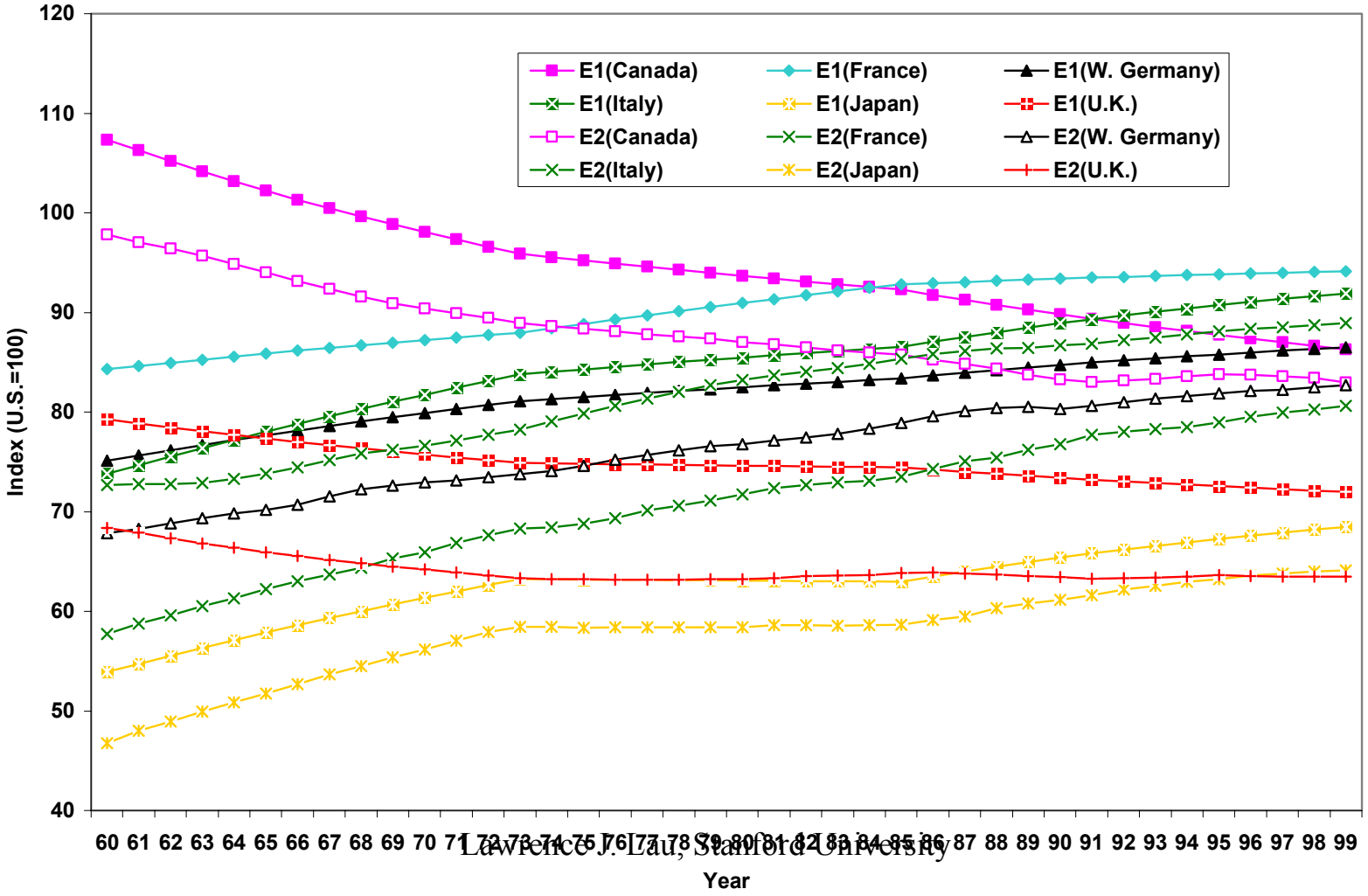
The Sources of Differences in Real Output Relative to the United States—U. K.

Figure 6.6: U. K.



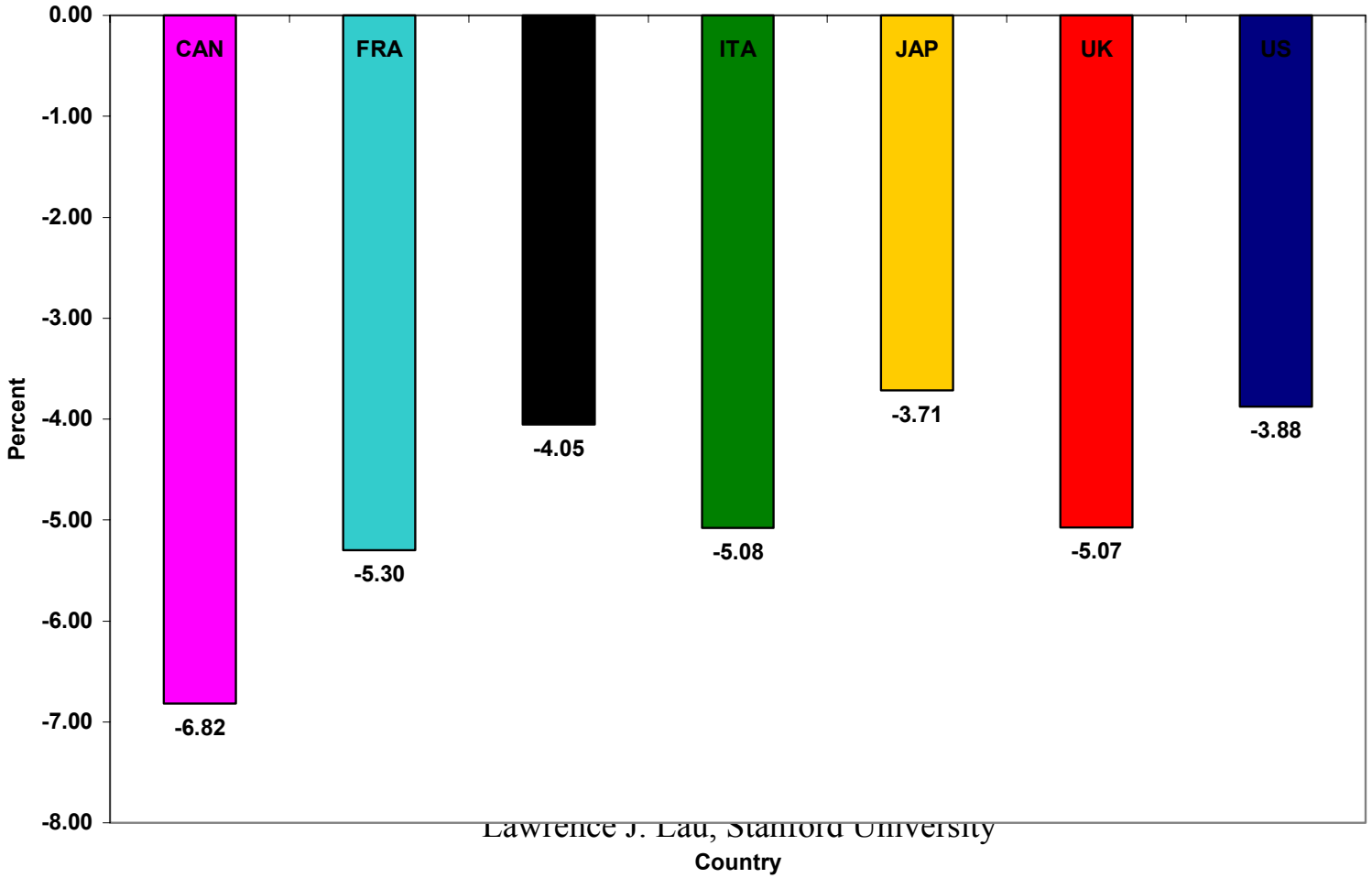
The Measures of Relative Productive Efficiency (CRS)

Figure 2.1 Productive Efficiency of the G-7 Countries Relative to the U.S. (U.S.=100) (CRS)



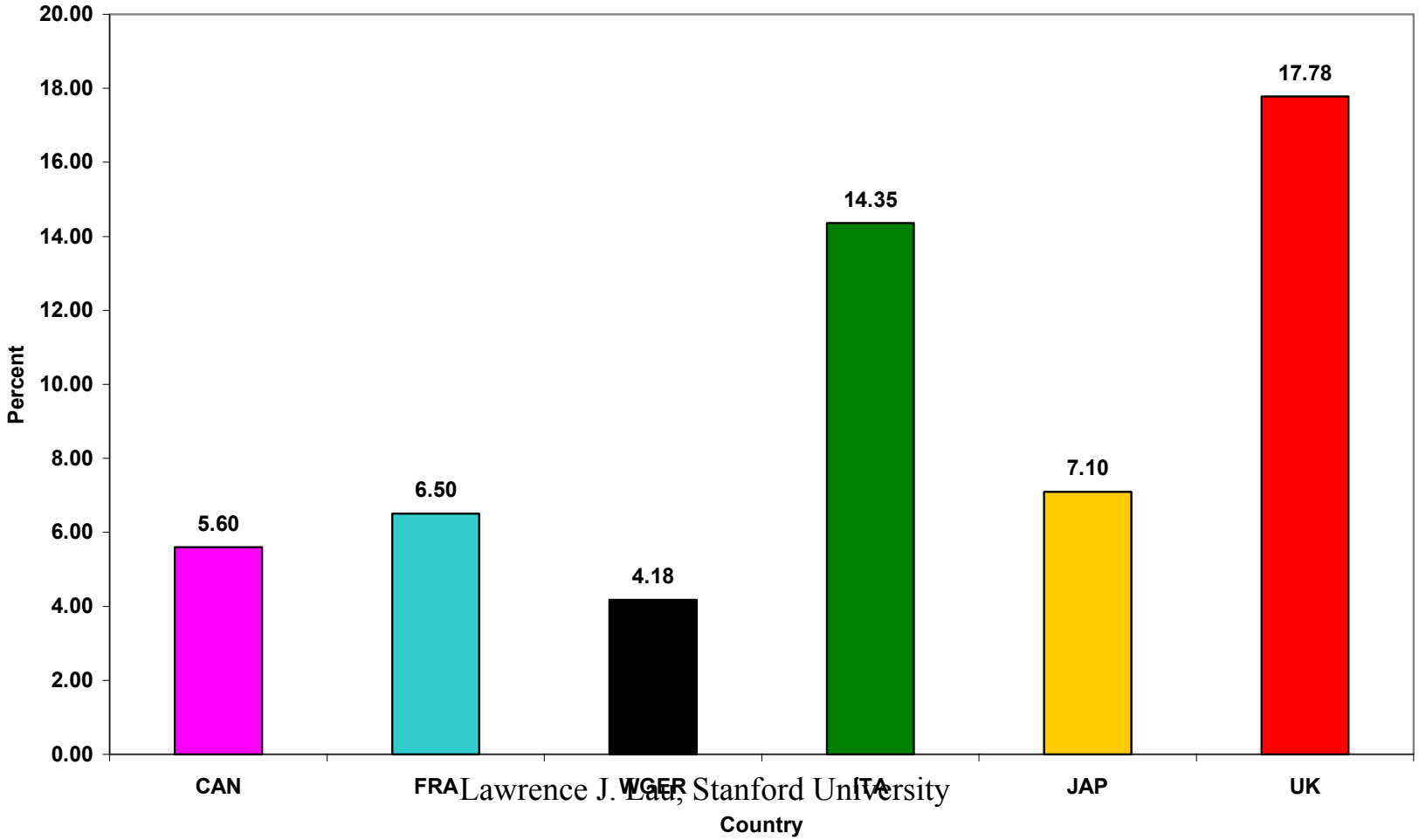
Hypothetical Output Losses in 1999 under the Assumption of No Growth in H (CRS)

Figure 7.1: Hypothetical Output Losses in 1999 under the Assumption that Average Human Capital Has NOT Grown Since 1960 (Percent of Real GDP)



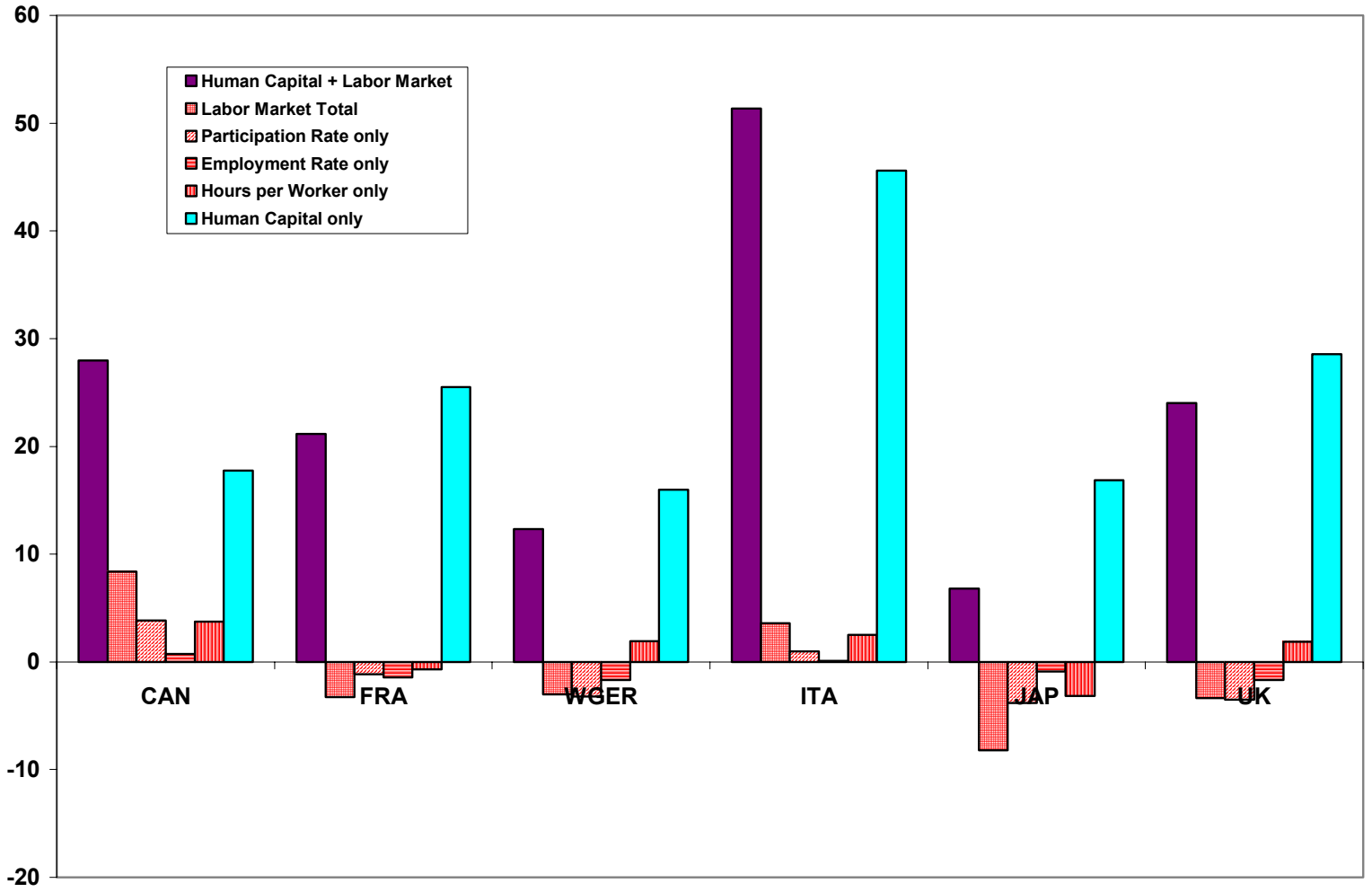
Hypothetical Output Gains in 1999 under the Assumption of U.S. Average H (CRS)

Figure 7.2: Hypothetical Output Gains in 1999 under the Assumption that All Other G-7 Countries Have the Same Average Human Capital as the U.S.(Percent of Real GDP)



Hypothetical Output Gains (or Losses), 1960 (CRS)

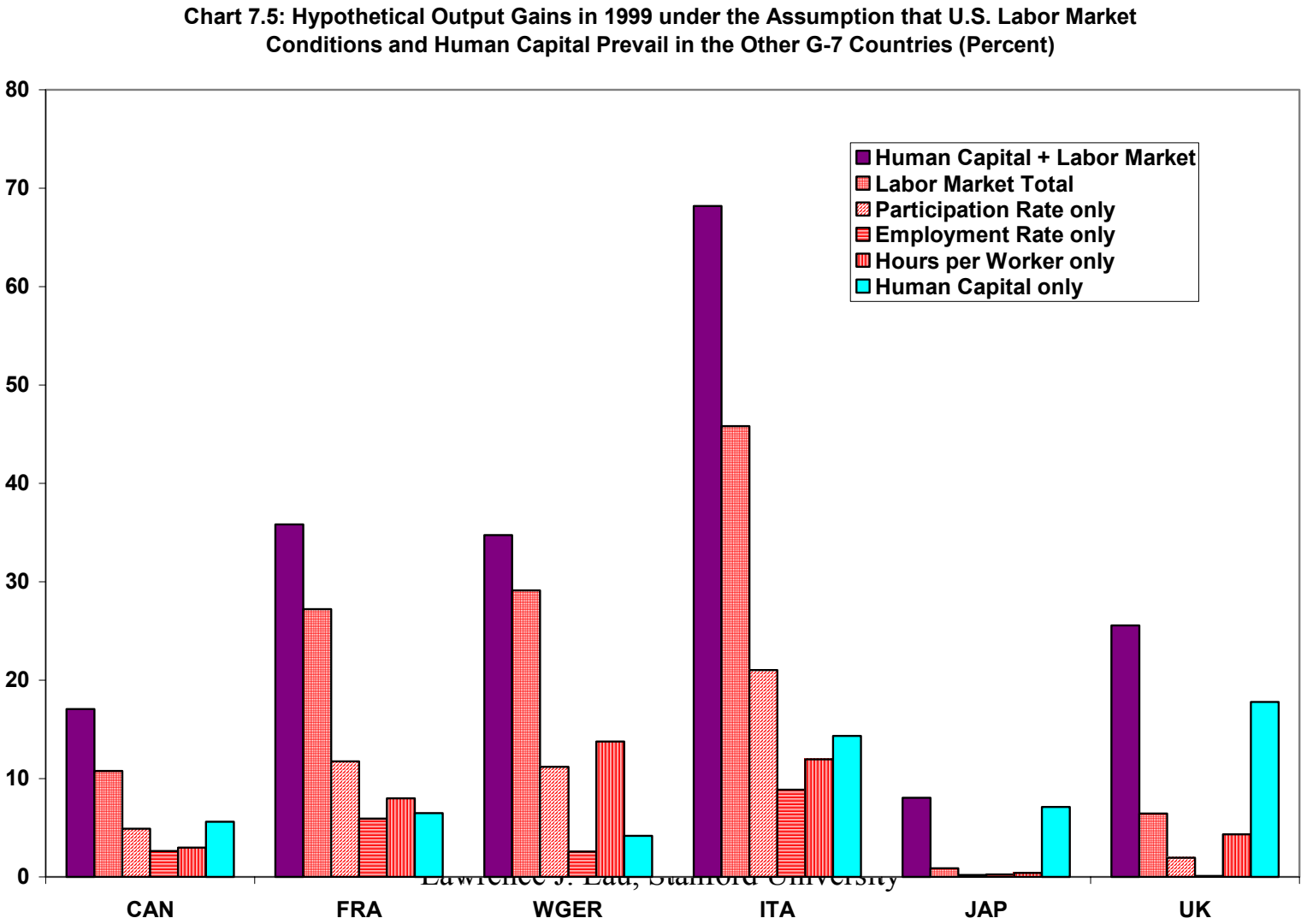
Chart 7.3: Hypothetical Output Gains (or Losses) in 1960 under the Assumption that U.S. Labor Market Conditions and Human Capital Prevail in the Other G-7 Countries (Percent)



Hypothetical Output Gains (or Losses), 1980 (CRS)

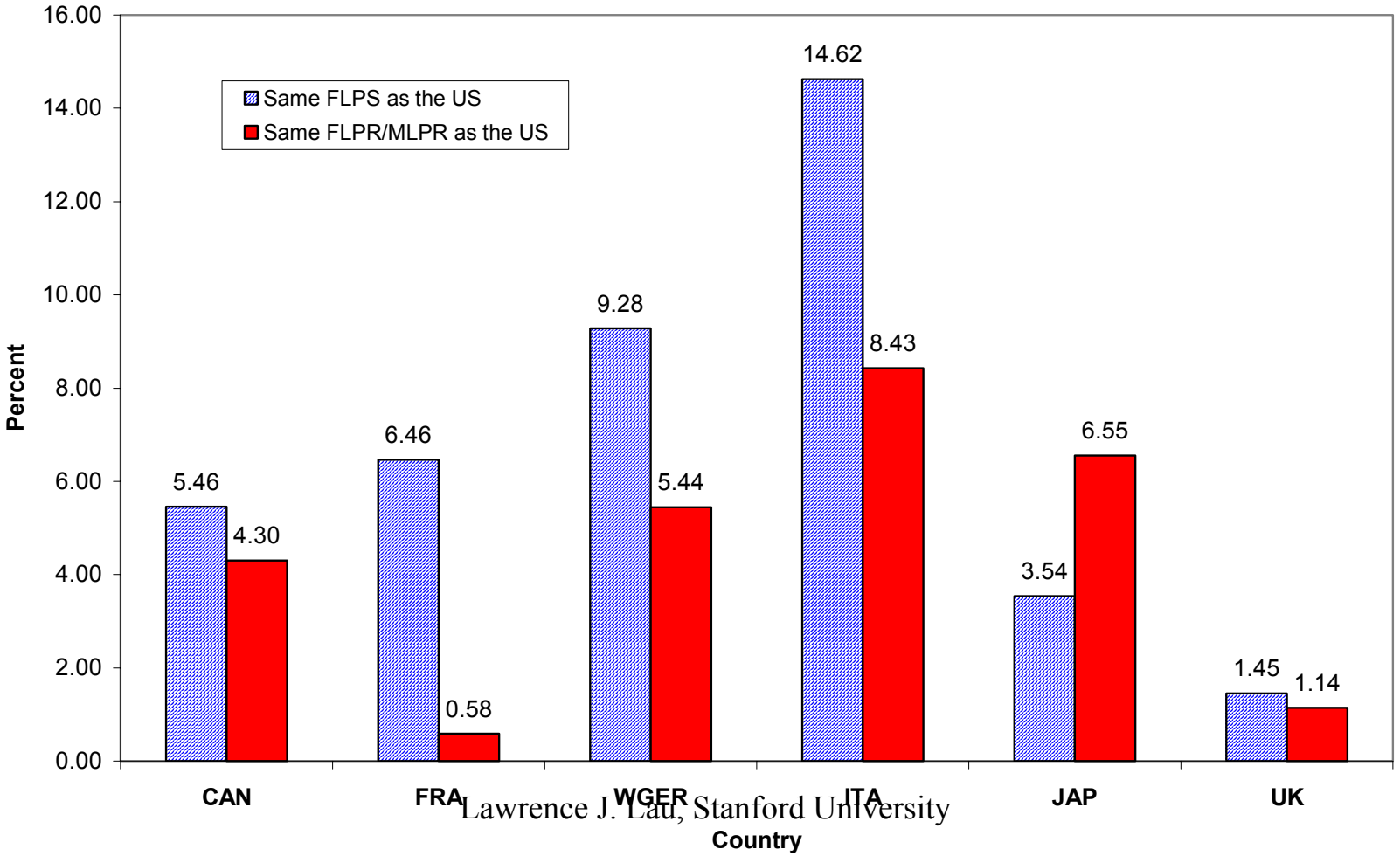
Chart 7.4: Hypothetical Output Gains (or Losses) in 1980 under the Assumption that U.S. Labor Market Conditions and Human Capital Prevail in the Other G-7 Countries (Percent)

Hypothetical Output Gains (or Losses), 1999 (CRS)



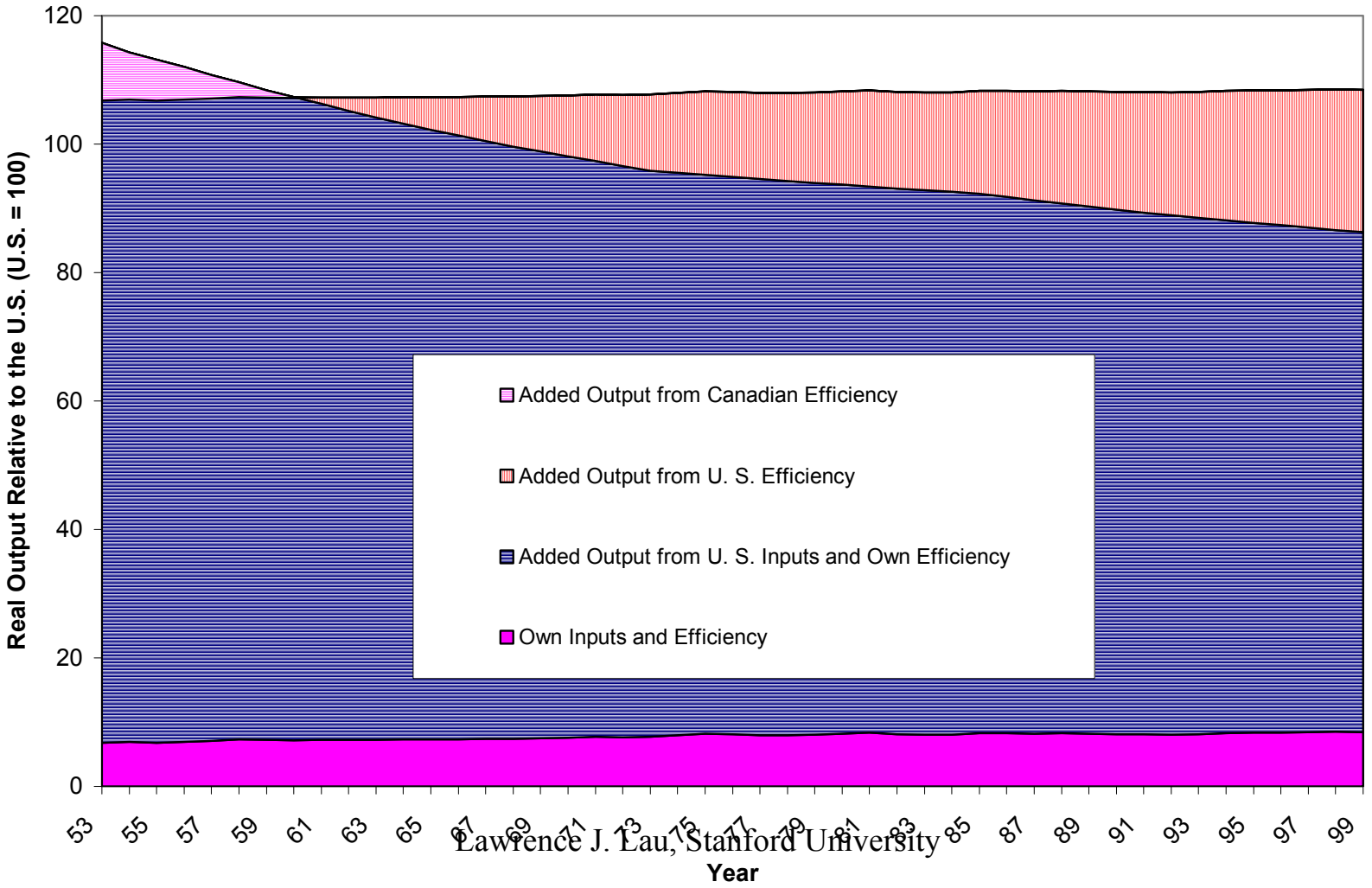
The Effects of Differences in the Female Labor Force Participation Rate (CRS)

Figure 7.6: The Effects of Differences in the Female Labor Force Participation Rates



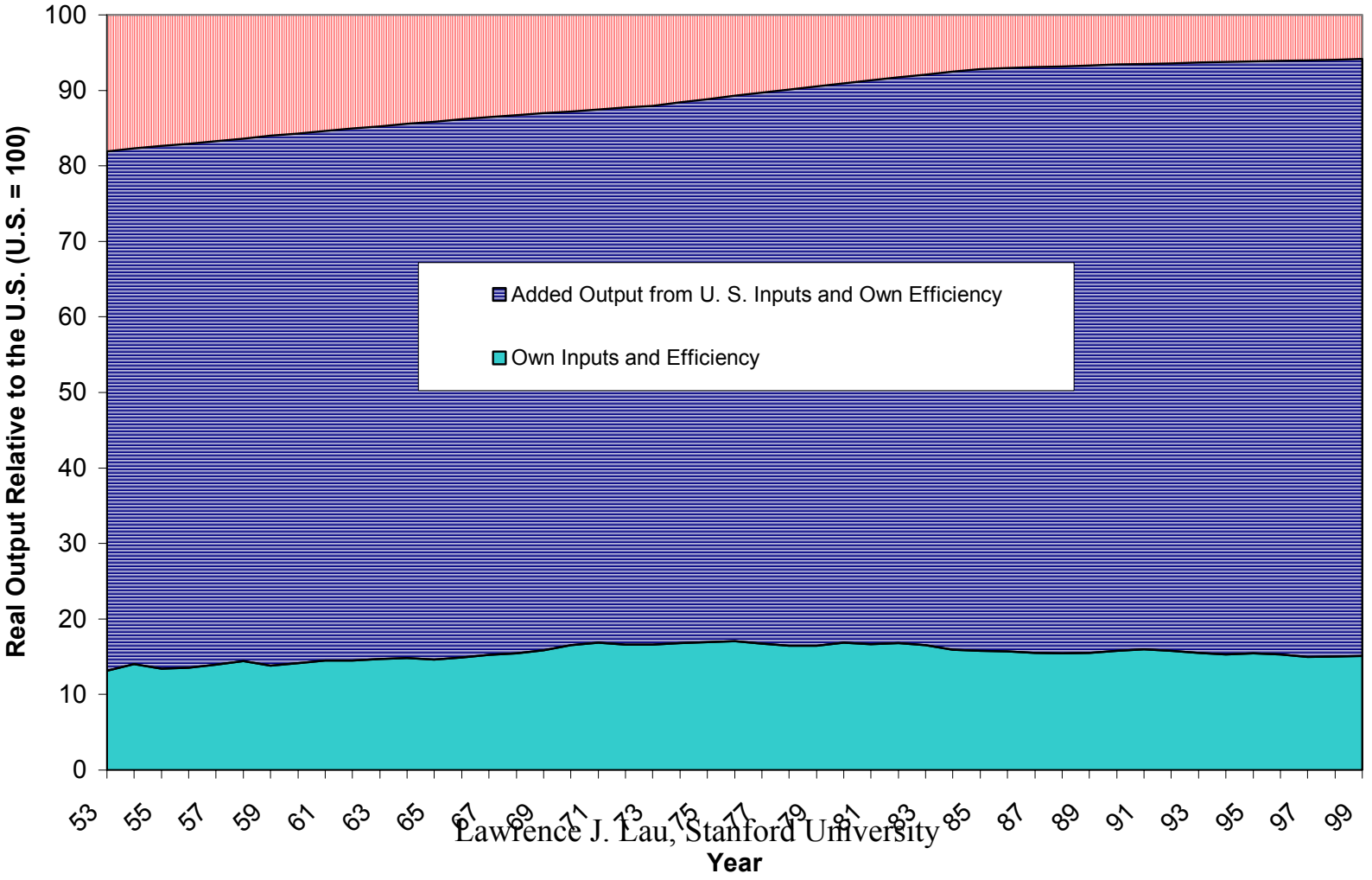
The Sources of Differences in Real Output Relative to the United States—Canada (CRS)

Figure 7.7: Canada



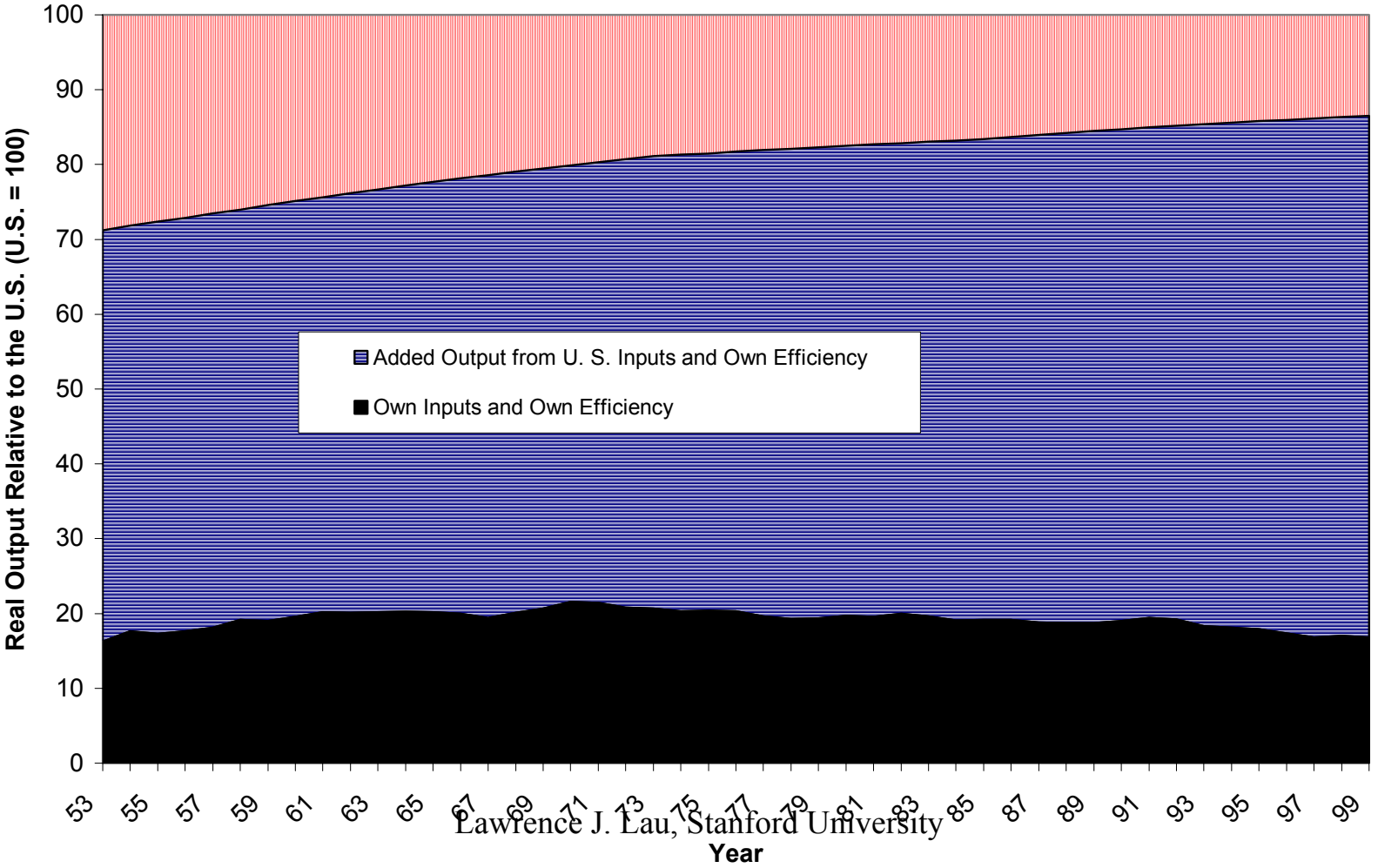
The Sources of Differences in Real Output Relative to the United States--France (CRS)

Figure 7.8: France

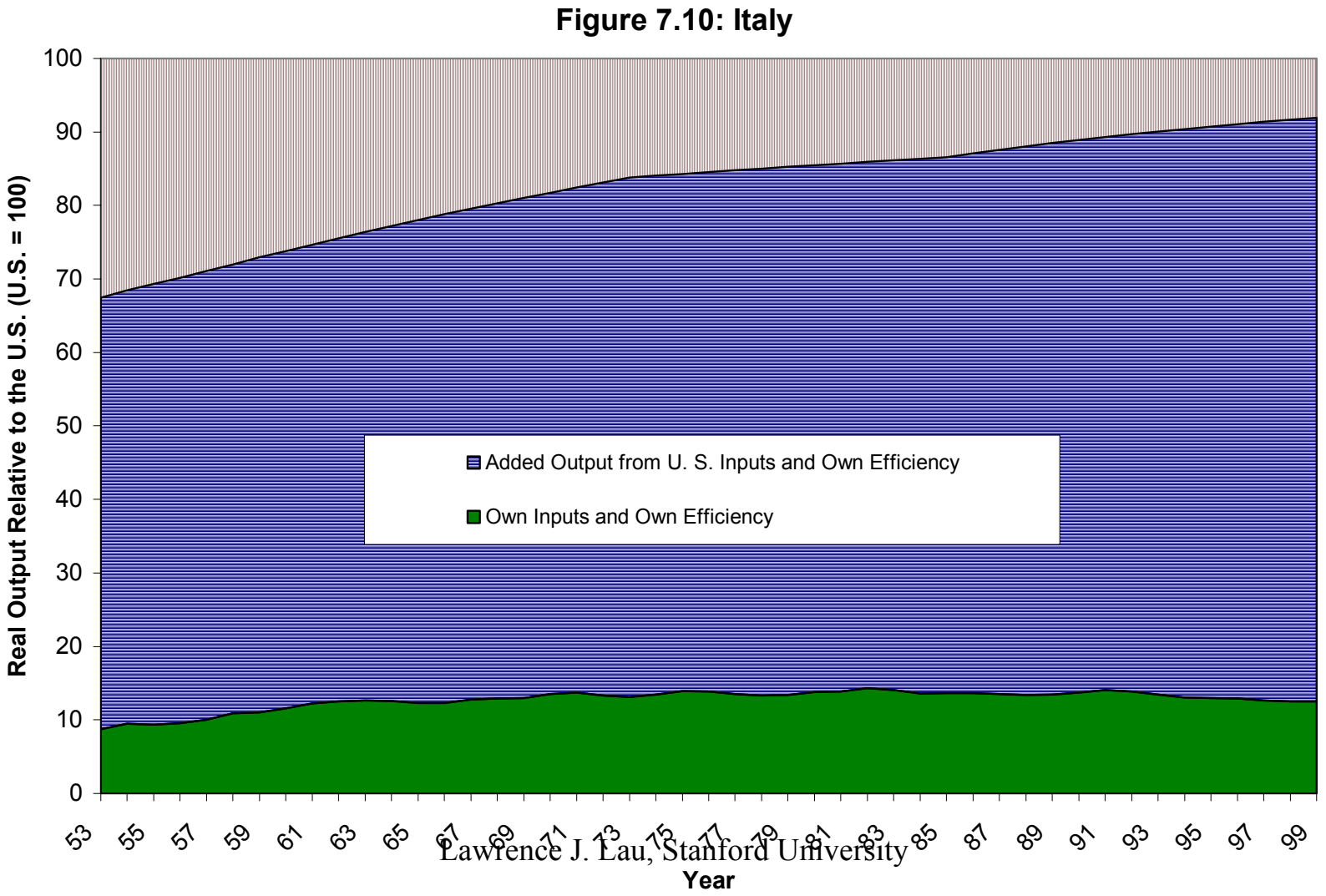


The Sources of Differences in Real Output Relative to the United States—W. Ger. (CRS)

Figure 7.9: Germany

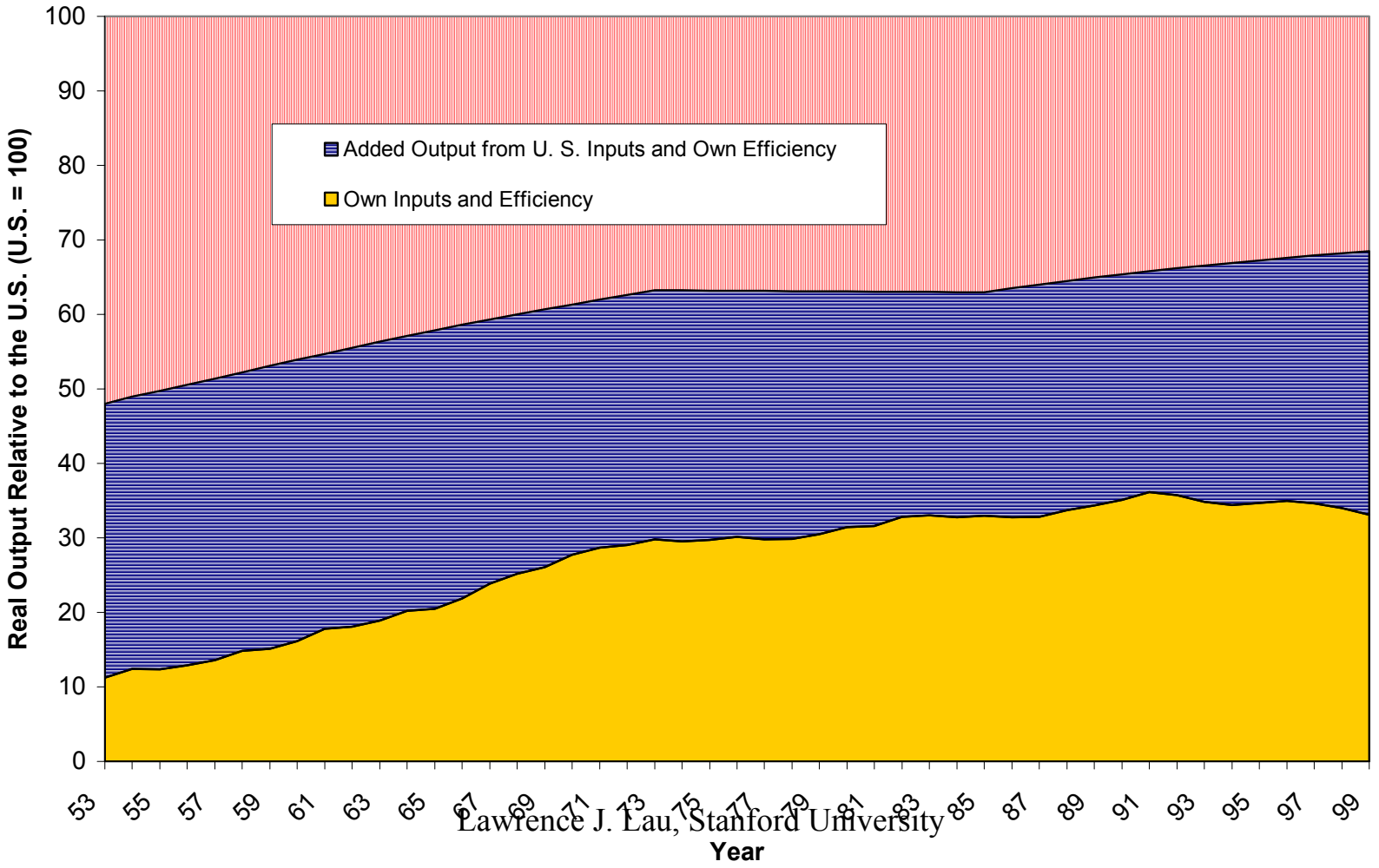


The Sources of Differences in Real Output Relative to the United States—Italy (CRS)



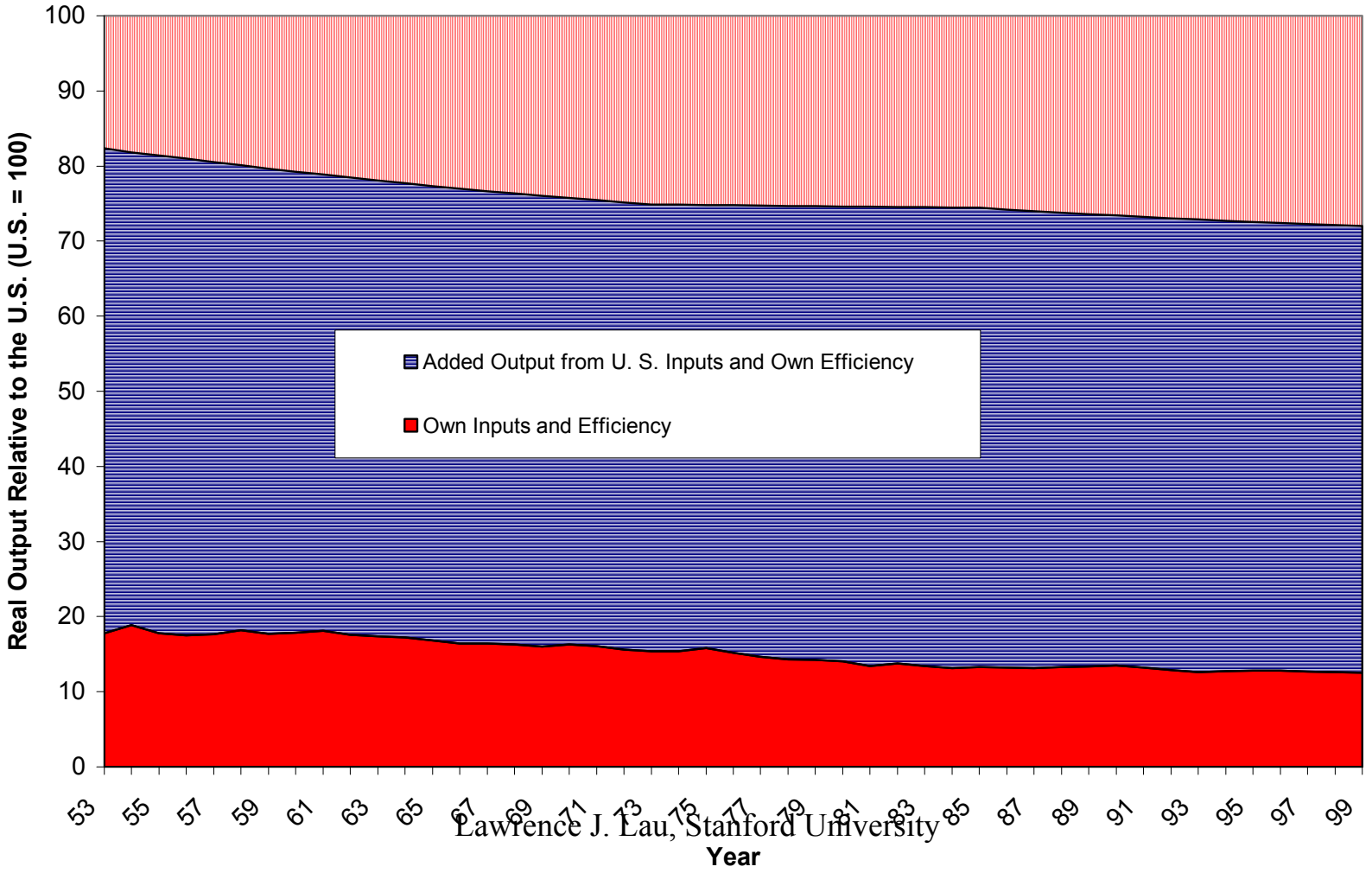
The Sources of Differences in Real Output Relative to the United States—Japan (CRS)

Figure 7.11: Japan



The Sources of Differences in Real Output Relative to the United States—U. K. (CRS)

Figure 7.12: U. K.



Conclusions

- The United States has been and continues to be vastly more efficient than the other G-7 countries. In 1999, we estimate that the other G-7 countries ranged from 60% to 80% as efficient as the United States in transforming given inputs into output (about 70-90% if constant returns are imposed).
- Over time, there has been substantial improvement in the relative productive efficiency of France, Italy and Germany, most of it accomplished by 1980; a modest deterioration in the relative productive efficiency of Canada and the United Kingdom; and large gains by Japan, most of them evident by 1990.
- The differences in labor market practices, institutions and outcomes--labor force participation rates, employment rates, average hours of work, human capital levels, and female labor force participation rates – have had major effects on the relative real outputs of the G-7 countries. The real output loss associated with these labor market differences are enormous in continental Europe, amounting to an entire decade or more of lost economic growth, and large in the U.K. and Canada as well, even more if constant returns to scale are assumed.

Conclusions

- Between 1960 and 1999, the importance of the efficiency effects (as opposed to the input differential effects) in accounting for the output gap with the U.S. has remained unchanged for Canada and the U.K., at 30% and 45% respectively. It has declined significantly for the other G-7 countries: France from 40% to 25%, West Germany from 50% to 30%, Italy from 50% to 25% and Japan from 63% to 55%. Correspondingly, the importance of input differentials in accounting for the differences in real outputs between these G-7 countries and the United States has risen.
- For the constant returns case, the importance of the efficiency effects (as opposed to the input differential effects) in accounting for the output gap with the U.S. is much reduced. In 1960, efficiency effects account for only 55% of the output gap for Japan, 30% for Germany and Italy, 25% for the U. K., less than 20% for France and -8% for Canada (compared to a range of 30-63% for the general case). As in the general case, the importance of the efficiency effects has also declined significantly in all of the other G-7 countries except Canada and the U.K. By 1999, efficiency effects account for less than 10% of the output gaps of France and Italy, 18% of the output gap of Germany, and 47% of the output gap of Japan.