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TRENDS IN PAY RATIOS: MODELLING AMERICA'S PAST AND SPECULATING ON THE FUTURE

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ABSTRACT

Simon Kuznets' conjecture regarding inequality and economic growth has now been confirmed for America. What we now know about income and wealth inequality suggests an early rise and a later decline roughly matching the onset and maturity phases of modern economic growth. This paper advances and tests a three-sector general equilibrium model that fits the long-run (pre-fisc earnings) inequality trends very well. The model is in the spirit of Jan Tinbergen's "supply and demand" view of earnings inequality, but its key attribute is its ability to offer a quantitative decomposition of the sources of those inequality trends. In particular, it offers an evaluation of the impact on inequality of patterns of population growth, capital accumulation and technological change between 1839 and the present. It also offers some forecasts into the future.

Trends in Pay Ratios: Modelling America's Past and Speculating on the Future*

1. AMERICAN INEQUALITY TRENDS

Simon Kuznets' (1955) conjecture regarding inequality and economic development has now been confirmed for America. What we now know about income and wealth inequality suggests an early rise and a later decline roughly matching the onset and maturity phases of modern economic growth (Williamson and Lindert; Lindert; Lindert and Williamson; Williamson, 1976). We shall review these trends only briefly since the present paper will concentrate on explanations.

Starting from a very narrow dispersion around 1816, the nominal wage and salary advantage over common labor of such skilled groups as engineers, teachers, carpenters, and mechanics rose dramatically up to 1856. The advantages thus gained were maintained through 1916, with a slight decline in the late nineteenth century and a further rise between the 1890s and World War I. What we know about cost-of-living movements for different income classes confirms that the trends in real pay ratios matched those in nominal pay (Williamson, 1977). Movements in personal wealth inequality suggest that the overall income distribution widened along with occupational pay gaps. After a long period of colonial stability, wealth became much more concentrated between 1774 and 1860, with most of the rise probably taking place after 1820 (A.H. Jones, 1977; Soltow, 1975; Williamson and Lindert, forthcoming, ch. 3). The coincidence of rising antebellum earnings and property inequality suggests that a widening in the entire income structure, not just a widening of wage gaps, requires explanation. Furthermore, these trends do not appear to have been a spurious result of life-cycle forces. Changes in the adult age distribution did not play any significant role in accounting for the measured rise in wealth inequality between Independence and Civil War.

Twentieth-century inequality experience is better known, thanks to Kuznets' (1953) pioneering work with income tax returns and an abundance of postwar data. Pre-fisc income inequality dropped dramatically between 1929 and mid-century and has changed little since. This view, first suggested by Kuznets' results and postwar consumer surveys, can be sharpened in several ways. First, there is a striking conformity between income inequality and occupational rate-of-pay trends. Both show a brief levelling during World War I, a return to wide dispersion across the 1920s, a sharp levelling between 1929 and mid-century, and approximate stability in the postwar era. It appears that the income distribution was altered by true changes in the inequality of occupational rewards. Second, the 1929-1948 levelling and later stability remain in clear view even after adjusting for shifts in age structure and class-specific cost-of-living trends. Third, income and wealth inequality trends coincide in the twentieth century, as in the nineteenth.

2. MODELLING LONG-RUN TRENDS IN PAY GAPS

Before searching for explanations, some familiar but spurious arguments must first be laid to rest. For example, the observed inequality movements cannot be the result of mere shifts in population among occupational classes, since overall inequality trends parallel movements in wage and salary gaps between occupational groups and levels of skill. Furthermore, taxes and transfer payments cannot directly explain changes in pre-fisc inequality, the focus of the present paper. In addition, such short-run disruptions as depression, inflation, and war cannot tell us why shifts in earnings dispersion lasted so long.

In what follows we advance and test a model that fits the long-run history of pre-fisc earnings inequality very well. The model is in the spirit of Jan Tinbergen's "supply and demand" view of earnings inequality. It has several features that merit attention even though space does not permit us to test it against other competitors. First, the model is appropriate for explaining movements lasting longer than a decade. Second, the model not only fits past experience but allows some conditional forecasts. Third, the model focuses on forces that are usually ignored in discussions of income distribution, in particular twists in the patterns of population growth and technological change over the course of economic development.

We represent earnings inequality by a single statistic, the ratio of the real wage earned by skills (q) to the real wage earned by unskilled labor (w) in comparable sectors and regions.[1] To explain movements in this dependent variable, q/w, we shall use an extended version of the simple general-equilibrium model pioneered by Ronald Jones. Four factors of production are distinguished in our variant of Jones' model:

Factors: (i = J,K,L,S)

- farm land (J), excluding improvements other than initial clearing for cultivation or pasture;
- capital (K), consisting of all nonhuman asset services in the business and government sectors, other than farm land;
- unskilled labor (L), or total person-hours, compensated at the unskilled wage rate; and
- skills (S), or all attributes of labor input generating as much earnings as is received by an average skilled laborer in a base period.

The general-equilibrium framework permits us to focus on those sectors whose technological attributes may affect relative factor rewards. To conserve equations and fit data constraints, we shall consider only three:

Sectors: (j = A,M,C)

- agriculture (A), or all gross national product originating in agriculture, forestry and fisheries;
- industry, or the secondary or manufacturing sector (M), consisting of all gross national product originating in mining, manufacturing, transportation, communications and utilities;
- the tertiary sector (C), or all gross national product originating in construction, finance, trade, private services, and government.

Land is confined to the agricultural sector. We further assume that skilled labor is mobile only between the industrial and tertiary sectors, since the available data makes the measurement of agricultural skills extremely difficult. Unskilled labor and capital are assumed to be perfectly mobile among all sectors.

The model predicts rates of change in the following eight endogenous variables:

four factor prices	d = the real rental earned on an acre of cleared farm land, r = the real rental earned on manmade nonhuman capital, w = the real wage rate for unskilled labor, and q = the real wage premium for skilled labor;
two output prices	P_M = the price of industrial goods relative to agricultural goods (P_A = 1), P_C = the price of tertiary goods and services relative to agricultural goods;

and the three sectoral outputs introduced above (A,M,C).

Under (assumed) competition, the equality of price and average cost yields three <u>cost equations</u>:

$$1 = a_{JA}d + a_{KA}r + a_{LA}w \qquad (1)$$

$$P_M = a_{KM}r + a_{LM}w + a_{SM}q \qquad (2)$$

$$P_C = a_{KC}r + a_{LC}w + a_{SC}q \qquad (3)$$

where the a_{ij}'s are physical input-output ratios. These expressions take on an extremely convenient form when they are converted into rate-of-change equations involving sectoral factor cost shares, θ_{ij}, for the i^{th} factor in the j^{th} sector. These factor or cost shares add up to unity for each sector, since costs are assumed to exhaust the value of product. To explore linear approximations involving rates of change, we use the asterisk notation for rates of change per annum: $\overset{*}{X} = (dX/dt)/X$. Differentiating the cost equations and converting them into rates of change yields:

$$0 = \overset{*}{d}\theta_{JA} + \overset{*}{r}\theta_{KA} + \overset{*}{w}\theta_{LA} \qquad + \sum_i \overset{*}{a}_{iA}\theta_{iA} \tag{4}$$

$$\overset{*}{P}_M = \qquad \overset{*}{r}\theta_{KM} + \overset{*}{w}\theta_{LM} + \overset{*}{q}\theta_{SM} + \sum_i \overset{*}{a}_{iM}\theta_{iM} \tag{5}$$

$$\overset{*}{P}_C = \qquad \overset{*}{r}\theta_{KC} + \overset{*}{w}\theta_{LC} + \overset{*}{q}\theta_{SC} + \sum_i \overset{*}{a}_{iC}\theta_{iC} \tag{6}$$

The $\sum_i \overset{*}{a}_{ij}\theta_{ij}$ terms are weighted sums of increases in physical input-output ratios. These become more familiar when each is expressed as minus the rate of increase in output-input ratios, weighting all ratios by input cost shares and holding prices constant. In other words, each of these expressions is simply the negative value of the rate of exogenous total factor productivity growth, $\overset{*}{T}_j$. Regrouping so as to put all terms involving endogenous variables on the left and all exogenous terms on the right, the cost equations simply become "price dual" expressions for sectoral total factor productivity growth:

$$\overset{*}{d}\theta_{JA} + \overset{*}{r}\theta_{KA} + \overset{*}{w}\theta_{LA} \qquad = \overset{*}{T}_A \tag{7}$$

$$\overset{*}{r}\theta_{KM} + \overset{*}{w}\theta_{LM} + \overset{*}{q}\theta_{SM} - \overset{*}{P}_M = \overset{*}{T}_M \tag{8}$$

$$\overset{*}{r}\theta_{KC} + \overset{*}{w}\theta_{LC} + \overset{*}{q}\theta_{SC} - \overset{*}{P}_C = \overset{*}{T}_C \tag{9}$$

The next four equations are full-employment statements giving the division of the total supply of each factor into its employment in the various sectors:

$$J = a_{JA}A \tag{10}$$

$$K = a_{KA}A + a_{KM}M + a_{KC}C \tag{11}$$

$$L = a_{LA}A + a_{LM}M + a_{LC}C \tag{12}$$

$$S = \qquad a_{SM}M + a_{SC}C. \tag{13}$$

Elsewhere the endogenous reponses of K (Williamson and Lindert, forthcoming, ch. 12; Williamson, 1978) and L (Lindert, 1978; Williamson, 1974, forthcoming, ch. 11) to inequality, real wages and pay gaps have been explored. The nineteenth century evidence suggests that the assumption of exogeneity on factor stock growth has much to recommend it. In any case, equations (10)-(13) can also be converted into more convenient expressions by introducing shares (λ_{ij}) and taking rates of change. In this case, the λ_{ij} are the shares of each j^{th} factor used in the i^{th} sector. Taking derivatives of equations (10) through (13) and dividing through the total factor supplies yields:

$$\overset{*}{J} = \overset{*}{A} + \overset{*}{a}_{JA} \tag{14}$$

$$\overset{*}{K} = \lambda_{KA}\overset{*}{A} + \lambda_{KA}\overset{*}{a}_{KA} + \lambda_{KM}\overset{*}{M} + \lambda_{KM}\overset{*}{a}_{KM} + \lambda_{KC}\overset{*}{C} + \lambda_{KC}\overset{*}{a}_{KC} \tag{15}$$

$$\overset{*}{L} = \lambda_{LA}\overset{*}{A} + \lambda_{LA}\overset{*}{a}_{LA} + \lambda_{LM}\overset{*}{M} + \lambda_{LM}\overset{*}{a}_{LM} + \lambda_{LC}\overset{*}{C} + \lambda_{LC}\overset{*}{a}_{LC} \tag{16}$$

$$\overset{*}{S} = \lambda_{SM}\overset{*}{M} + \lambda_{SM}\overset{*}{a}_{SM} + \lambda_{SC}\overset{*}{C} + \lambda_{SC}\overset{*}{a}_{SC} \tag{17}$$

Each of the rates of change in input-output ratios ($\overset{*}{a}_{ij}$) consists of two parts, one exogenous ($\overset{*}{b}_{ij}$) and the other an endogenous response to changes in relative factor prices ($\overset{*}{c}_{ij}$): $\overset{*}{a}_{ij} = \overset{*}{b}_{ij} + \overset{*}{c}_{ij}$. In what follows we shall pull the $\overset{*}{b}_{ij}$ terms together into summary measures of the factor-saving resulting from exogenous productivity change. These factor-saving measures, Π_i, quantify the economy-wide savings on the use of each i^{th} factor:[2]

$$\Pi_i = - \sum_j \lambda_{ij}\overset{*}{b}_{ij}.$$

The induced part of each change in an input-output ratio is defined in terms of elasticities of factor substitution and factor price movements ($\overset{*}{v}_i$): $\overset{*}{c}_{ij} = \sum_k \theta_{kj}\, \sigma^j_{ik}(\overset{*}{v}_k - \overset{*}{v}_i)$. Key parameters in any such model are the elasticities of factor substitution, σ^{j}_{ik}. A large empirical literature tends to place these elasticities between zero and unity, closer to unity for long-run analysis. There is also some evidence that capital and skills tend to be less substitutable, and closer to being complements, than either of them is with unskilled labor (Griliches, 1969; Fallon and Layard, 1975; Kesselman, Williamson and Berndt, 1977). We assume this to be the case for both the nineteenth and twentieth centuries.[3]

Product demands are endogenous. Each sectoral demand equation takes the form

$$Q_j = D_j (Y/Pop)^{\eta_j} \; P_j^{\varepsilon_j} \; P_k^{\varepsilon_{jk}} \; (Pop)^{\varepsilon_{jpop}} \qquad (18)$$

where all prices are again relative to those of agriculture, and D_j = an exogenous demand shift term, Y = gross national product[4], Pop = total population, η_j = income elasticity of demand for j, ε_j and ε_{jk} are the own-price and cross-price elasticities of demand for j, and ε_{jpop} = the elasticity of demand for j with respect to population size for given prices and income per capita.[5]

Converting the demand equations into rate-of-change form, setting ε_{jpop} = 1 and rearranging to put exogenous terms on the right-hand side yields:

$$(19) \qquad (1 - \eta_M\phi_M)\overset{*}{M} - \eta_M\phi_A\overset{*}{A} - \varepsilon_M \overset{*}{P}_M - \varepsilon_{MC} \overset{*}{P}_C - \eta_M\phi_C\overset{*}{C} = \overset{*}{D}_M + (1 - \eta_M)\overset{*}{Pop},$$

$$(20) \qquad (1 - \eta_C\phi_C)\overset{*}{C} - \eta_C\phi_A\overset{*}{A} - \varepsilon_{CM}\overset{*}{P}_M - \eta_C\phi_M\overset{*}{M} - \varepsilon_C \overset{*}{P}_C = \overset{*}{D}_C + (1 - \eta_C)\overset{*}{Pop},$$

where the ϕ_j are initial final demand or sectoral output shares in GNP. These two demand equations and the national budget constraint make the demand equation for agricultural products redundant. It should be noted, however, that the budget constraint implicitly assumes that the nation's foreign trade is balanced, with no net international capital flows. The responsiveness of international trade to price and domestic income is implicit in the assumed (relatively high) demand elasticities, and the assumption is important to our conclusions below regarding the impact of unbalanced total factor productivity growth on earnings inequality. The own-price and cross-price elasticities are $\varepsilon_M = -1.3$, $\varepsilon_C = 1.0$, and $\varepsilon_{MC} = \varepsilon_{CM} = 0.5$. For the period 1839-1909, we shall set η_C at unity. We shall also assume that η_M equalled 1.60 around 1850 and 1.35 around 1900. These income elasticities have been chosen as to be consistent with an income elasticity of demand for the agricultural product of 0.50 for 1850 and 0.40 for 1900, values broadly consistent with a number of empirical studies.

We have nine rate-of-change equations with nine endogenous variables: the three output growth rates, $\overset{*}{A}$, $\overset{*}{M}$, and $\overset{*}{C}$; the four factor price changes $\overset{*}{d}$, $\overset{*}{r}$, $\overset{*}{w}$, and $\overset{*}{q}$; and the two product price changes $\overset{*}{P}_M$ and $\overset{*}{P}_C$. The exogenous variables are the sectoral rates of total factor productivity growth ($\overset{*}{T}_j$), the rates of factor-saving produced by technological change (Π_i), the factor supply growth rates, the population growth rate and the demand shift terms.

The entire system is summarized in Table 1. Numerical values for elasticity parameters combined with observed initial conditions on factor and sector shares yield causal statements regarding the impact of each exogenous variable's measured historical growth rate on each endogenous

Table 1

The Nineteenth-Century General-Equilibrium Model in Rate-of-Change Form

	$\overset{*}{d}$	$\overset{*}{r}$	$\overset{*}{w}$	$\overset{*}{q}$	$\overset{*}{P}_M$	$\overset{*}{P}_C$	$\overset{*}{A}$	$\overset{*}{M}$	$\overset{*}{C}$	Endog. var's		Exog. shift terms
Eq. (7)	θ_{JA}	θ_{KA}	θ_{LA}	0	0	0	0	0	0	$\overset{*}{d}$		$\overset{*}{T}_A$
Eq. (8)	0	θ_{KM}	θ_{LM}	θ_{SM}	-1	0	0	0	0	$\overset{*}{r}$		$\overset{*}{T}_M$
Eq. (9)	0	θ_{KC}	θ_{LC}	θ_{SC}	0	-1	0	0	0	$\overset{*}{w}$		$\overset{*}{T}_C$
Eq. (14)'	g_{41}	g_{42}	g_{43}	0	0	0	1	0	0	$\overset{*}{q}$		$\overset{*}{J} + \Pi_J$
Eq. (15)'	g_{51}	g_{52}	g_{53}	g_{54}	0	0	λ_{KA}	λ_{KM}	λ_{KC}	$\overset{*}{P}_M$		$\overset{*}{K} + \Pi_K$
Eq. (16)'	g_{61}	g_{62}	g_{63}	g_{64}	0	0	λ_{LA}	λ_{LM}	λ_{LC}	$\overset{*}{P}_C$	=	$\overset{*}{L} + \Pi_L$
Eq. (17)'	0	g_{72}	g_{73}	g_{74}	0	0	0	λ_{SM}	λ_{SC}	$\overset{*}{A}$		$\overset{*}{S} + \Pi_S$
Eq. (19)	0	0	0	0	$-\varepsilon_M$	$-\varepsilon_{MC}$	$-\eta_M\phi_A$	$(1-\eta_M\phi_M)$	$-\eta_M\phi_C$	$\overset{*}{M}$		$\overset{*}{D}_M + (1-\eta_M)\overset{*}{Pop}$
Eq. (20)	0	0	0	0	$-\varepsilon_{CM}$	$-\varepsilon_C$	$-\eta_C\phi_A$	$-\eta_C\phi_M$	$(1-\eta_C\phi_C)$	$\overset{*}{C}$		$\overset{*}{D}_C + (1-\eta_C)\overset{*}{Pop}$

where

$$g_{41} = -(\underbrace{\theta_{KA}\sigma^A_{JK}}_{=g_{42}} + \underbrace{\theta_{LA}\sigma^A_{JL}}_{=g_{43}}) \qquad g_{52} = -(\lambda_{KA}\theta_{JA}\sigma^A_{JK} + \underbrace{\lambda_{KA}\theta_{LA}\sigma^A_{KL} + \lambda_{KM}\theta_{LM}\sigma^M_{KL} + \lambda_{KC}\theta_{LC}\sigma^C_{KL}}_{=g_{53}} + \underbrace{\lambda_{KM}\theta_{SM}\sigma^M_{KS} + \lambda_{KC}\theta_{SC}\sigma^C_{KS}}_{=g_{54}})$$

$$g_{63} = -(\underbrace{\lambda_{LA}\theta_{JA}\sigma^A_{JL}}_{=g_{61}} + \underbrace{\lambda_{LA}\theta_{KA}\sigma^A_{KL} + \lambda_{LM}\theta_{KM}\sigma^M_{KL} + \lambda_{LC}\theta_{KC}\sigma^C_{KL}}_{=g_{62}}) \text{ and } g_{74} = -(\underbrace{\lambda_{SM}\theta_{KM}\sigma^M_{KS} + \lambda_{SC}\theta_{KC}\sigma^C_{KS}}_{=g_{72}} + \underbrace{\lambda_{SM}\theta_{LM}\sigma^M_{LS} + \lambda_{SC}\theta_{LC}\sigma^C_{LS}}_{=g_{73}})$$

variable's temporal behavior. Aggregating these impacts over all exogenous variables yields predictions about the historical movements in factor prices, product prices, and output mix. Not all exogenous variables are easy to quantify, however.[6] In what follows, we first examine the predictions generated by the growth in those exogenous variables which are quantifiable, and then ask what other forces might account for any residual change in the endogenous variables of interest. Factor supply growth, sectoral total factor productivity growth, and a technical adjustment for a demand effect of population growth[7] are easy to quantify. We may also add conjectures about the possible magnitudes of government-induced product demand shifts ($\overset{*}{D}_M$, $\overset{*}{D}_C$), factor-saving biases within sectors, and the impact of inflation and institutional changes.

3. THE SOURCES OF PAY RATIO TRENDS BEFORE 1910

If the general-equilibrium model is to be used to advantage, it should be applied over long periods, where the assumptions of full employment, competition, and equilibrium are less objectionable. One must also pick periods for which data are abundant. The best practicable choices are the last two antebellum decades, 1839-1859; the late nineteenth century, 1869-1899; and the start of the twentieth century, 1899-1909. These were periods of increasing wage dispersion, with the rise being far faster in the first and the third period than in the late nineteenth century.

To estimate the impact of exogenous variables, the model must be equipped with factor and sector share data from benchmark dates. We have chosen mid-century and turn-of-the-century benchmarks. Table 2 shows

Table 2

Factor Proportions in Three Sectors of the U.S. Economy, 1850 and 1900

1850

The share of factor i employed in sector j (λ_{ij})

j =	i = J	K	L	S	All factors (ϕ_j)
A	1.0000	.1656	.5951	0	.4022
M	0	.5241	.1871	.2095	.2710
C	0	.3103	.2178	.7905	.3268
	1.0000	1.0000	1.0000	1.0000	1.0000

The share of factor i's compensation in the income originating in sector j (θ_{ij})

j =	i = J	K	L	S	
A	.1430	.1110	.7460	0	1.0
M	0	.5216	.3479	.1305	1.0
C	0	.2560	.3360	.4080	1.0
	.0575	.2697	.5041	.1687	1.0

1900

The share of factor i employed in sector j (λ_{ij})

j =	i = J	K	L	S	All factors (ϕ_j)
A	1.0000	.0755	.3762	0	.2172
M	0	.5002	.2807	.3811	.3721
C	0	.4243	.3431	.6189	.4107
	1.0000	1.0000	1.0000	1.0000	1.0000

The share of factor i's compensation in the income originating in sector j (θ_{ij})

j =	i = J	K	L	S	
A	.1580	.1320	.7100	0	1.0
M	0	.5104	.3092	.1804	1.0
C	0	.3922	.3424	.2654	1.0
	.0343	.3797	.4099	.1761	1.0

Source: Williamson and Lindert, (forthcoming, Ch. 10, Table 10.2).

the sectoral patterns of factor use in 1850 and 1900. On both dates unskilled labor tended to be concentrated relatively intensively in agriculture, capital in industry, and skills in the tertiary sector.[8]

The Antebellum Widening

During the last two antebellum decades, the wage advantage of skilled workers rose at 1.48% per annum. The model's antebellum predictions are shown in Table 3 and Figure 1. The influences captured by the model account for over three quarters of the observed wage widening (1.15% out of 1.48%), a noteworthy performance in view of the amount of wage stretching to be explained and given that we have made no effort to measure the impact of factor-saving technological change within sectors, of exogenous shifts in demand, or of any institutional forces.

Technological and factor-supply changes both contributed to these antebellum wage inequality trends. The fact that technological progress was far slower in labor-intensive agriculture than elsewhere accounts for a widening of 0.26% per year. But the details of the nonagricultural pattern offer some surprises. The coefficient on productivity growth in the industrial sector ($\overset{*}{T}_M$) is close to zero and slightly negative, contrary to the intuition that productivity growth in manufacturing should have favored skills. The explanation seems to lie with the fact that skills were used no more intensively in the industrial sector than they were in the economy as a whole in 1850. (Conventional capital is another matter, and unbalanced technological progress was serving to raise the rate of return to capital and thus fostering <u>income</u> inequality. This paper, however, focuses on <u>earnings</u> inequality solely.) This prevents any large net effect of industrial productivity growth on the antebellum advantage of skilled

Table 3

Sources of Change in the Skilled-Wage Premium, 1839-1909,
Using 1850 and 1900 Parameters

Exogenous Shift Term	1839-1859		1869-1899			1899-1909	
	Shift	Impact, using 1850 parameters	Shift	Impact, using parameters from 1850	Impact, using parameters from 1900	Shift	Impact, using 1900 parameters
$\overset{*}{T}_A$	0%	0%	0.79%	-0.61%	-0.60%	-0.24%	0.18
$\overset{*}{T}_M$	2.00	-0.22	1.70	-0.18	0.35	0.98	0.20
$\overset{*}{T}_C$	0.80	0.70	0.80	0.70	0.44	1.70	0.93
Π_J	0	0	0.79	-0.02	-0.05	-0.24	0.02
Π_K	1.30	0.33	1.25	0.32	0.65	1.19	0.62
Π_L	0.55	0.55	1.05	1.05	0.92	0.77	0.68
Π_S	1.05	-1.10	1.14	-1.20	-1.33	1.43	-1.67
All "technology:"		0.26		0.06	0.38		0.96
$\overset{*}{J}$(land)	3.32	-0.07	2.44	-0.05	-0.17	0.47	-0.03
$\overset{*}{K}$ (capital stock)	6.57	1.69	5.20	1.34	2.70	3.84	1.99
$\overset{*}{L}$ (man-hours)	3.38	3.39	2.73	2.73	2.40	2.35	2.06
$\overset{*}{S}$ (skills)	3.38	-3.54	3.23	-3.39	-3.78	2.92	-3.41
All factor supply shifts		1.47		0.63	1.15		0.61
Demand effects of pop. growth	3.09	-0.58	2.19	-0.41	-0.35	1.92	-0.30
Predicted ($\overset{*}{q} - \overset{*}{w}$):		1.15		0.28	1.18		1.27
Actual ($\overset{*}{q} - \overset{*}{w}$):		1.48		0.30	0.30		1.06

Source: Williamson and Lindert (forthcoming, Tables 10.3 and 10.4).
Note: Totals may differ from column sums due to rounding.

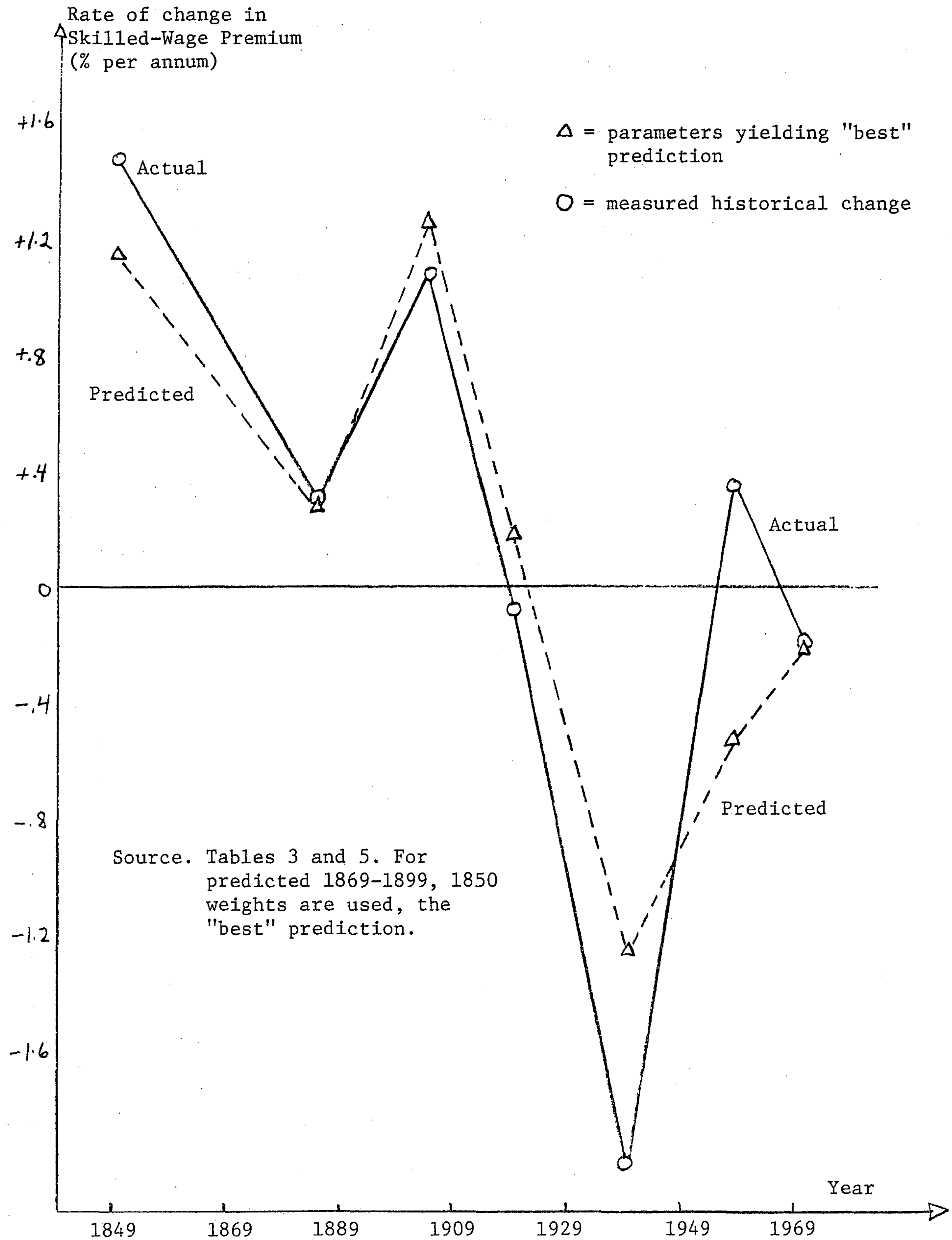

Figure 1. Predicted and Actual Changes in the Skilled-Wage Premium Since 1839

workers, though a role re-emerges when its effects on inequality are traced through capital goods production and the accumulation response. Yet as the estimates now stand, technological imbalance contributed to the antebellum rise in wage inequality primarily because the rate of total factor productivity growth was even lower in the agricultural sector than in the tertiary sector.

Factor supply growth played a slightly greater role in accounting for the antebellum wage widening than did the pattern of technological progress. An outstanding feature of these two decades before the Civil War was the extraordinarily high rate of capital accumulation. Taken as an exogenous force, this alone would explain the observed wage stretching. The story of why wage rates became more unequal before the Civil War must include the tendency of rapid mechanization to shift aggregate labor demand toward more skilled groups, despite the attempts of several authors to argue that industrial mechanization, especially in textiles, reduced the relative demand for skills within sectors. If capital accumulation thus emerges as a central proximate explanation for the rise of wage inequality, more attention should be paid to explanations of the high rate of accumulation itself. (See Williamson, 1978; Williamson and Lindert, forthcoming, ch. 12.) Other factor supplies had a less potent effect when the period 1839-1859 is compared with a no-growth (or pre-1830s growth) alternative. The model rejects the Turner "safety-valve" hypothesis since the rapid expansion of farm land played no significant role in levelling wage rates. The growth of skills and unskilled labor actually had a net levelling effect, since the inegalitarian consequences that would have followed from the labor supply growth with high immigration and high fertility were more than offset by the matching growth of skills and the tendency of the rapid population growth to shift demand back toward labor-intensive agriculture. It appears that elastic labor-supply and "labor surplus" paradigms are unlikely to be very relevant for American nineteenth-century growth.

The Late Nineteenth Century

Post-Civil-War parameters should be used to analyze the last three decades of the nineteenth century, but Table 3 offers both the 1900-based and 1850-based results for comparative purposes. While the 1850-based predictions neatly fit the late-nineteenth-century experience, the 1900-based predictions greatly overstate the extent of wage-gap widening. However, both models give similar explanations for the deceleration in the growth of the skilled worker's wage advantage.

All of the forces mentioned in connection with the antebellum episode played a part in keeping the wage inequality from deteriorating as fast after the Civil War as before. The pattern of technological progress became more balanced, erasing any clear bias toward the use of skills over common labor. Capital accumulation also slowed down much less than did labor and population growth, tipping the scales toward skills-abundance and helping check a continuation of the mid-century wage stretching. The contrast between the two nineteenth-century periods thus assigns important roles to three forces: a shift toward more balanced productivity growth, slower capital accumulation, and faster growth in skills per man-hour.

The Start of the Twentieth Century

Contrary to the conventional emphasis on immigration, factor supply growth cannot explain why the skilled once again pulled ahead of the unskilled in the first decade of this century. True, the high tide of immigration of low-skilled workers from southern and eastern Europe may have decelerated labor "quality" growth: Table 3 does document $\overset{*}{S}$ declining from 3.23% per annum between 1869 and 1899, to 2.92 between 1899 and 1909, and based on 1900 parameters, the impact did serve to accelerate the rate of increase in the skilled wage premium. The influence was not sufficiently potent, however, to suggest that factor supply forces were at the heart of this last major surge in wage-stretching. First, there was a deceleration in the rate of growth in population and in the labor force. Second, capital also grew much more slowly after the turn of the century, providing far less support for skills. Furthermore, the model assigns almost no role to the disappearing (farm land) frontier in explaining these wage inequality trends. Factor supply growth seems to account for little of the resurgence of wage inequality at the start of this century.

The model clearly points to changes in the pattern of technological progress as the explanation for the resurgence in wage stretching. Agricultural total factor productivity actually declined, a development that should have undercut the growth in demand for common labor. Meanwhile, productivity grew rapidly in such skill-intensive sectors as telephones, electricity supply, natural gas, and capital goods production.[9] Since the relatively faster productivity growth in the capital-goods sector tended to induce part of the observed capital formation, some of the skills-favoring effect of capital formation in this period (as in the antebellum period) should be chalked up to technological imbalance.

The model thus seems quite capable of explaining why earnings dispersion increased in America before World War I. The leading explanatory factors were capital accumulation and technological imbalance. These were the correlates of early modern growth that produced the inequality upswing featured in the Kuznets hypothesis. Labor supply played a minor role.

4. TWENTIETH-CENTURY PARAMETERS

The main distributional event in this century was, of course, the "incomes revolution" following 1929. We now know this revolutionary levelling to have been due in large part to compression in pay rates.[10] The central task here is to explain not only why the levelling took place, but also why it failed to continue after the late 1940s.

The nineteenth-century model also turns out to explain the more recent experience, after it is furnished with twentieth-century attributes. First, farm land is purged from the model, aggregating its returns and its growth into the capital category. While this saves an equation and one endogenous variable, the simplification is also justified by the fact that farm land growth had no great effect on wage inequality outside agriculture even in the nineteenth century. Second, our demand parameters must be revised. Agriculture's continued decline implies that lower income and price elasticities should be assumed for the industrial and tertiary sectors since they now make up almost the entire economy. At the same time many researchers have noted an apparent decline in the income elasticity of demand for agricultural product over time, a trend that our demand parameters should reflect. These considerations lead to the following assumed elasticities:

	income elasticities		own-price elasticities		cross-price elasticities
	η_M	η_C	ε_M	ε_C	$\varepsilon_{MC} = \varepsilon_{CM}$
with 1929 parameters	1.30	1.00	-1.30	-1.00	0.5
with 1963 parameters	1.03	1.03	-1.25	-0.30	0.5

We retain the three-sector division of the economy, but with a slight twist. Since the twentieth-century transportation sector has a much lower capital-intensity than other industrial sectors, it is now allocated to the tertiary (C) sector. There have been other more general trends in relative factor proportions deserving note. Indeed, Table 4 reveals an important evolution in factor proportions in our three sectors across this century. In 1929, the tertiary sector was still relatively skill-intensive, in contrast with the relatively heavier reliance on both capital and unskilled labor in agriculture and industry. After World War II the picture is different: the industrial sector now has the highest ratio of skilled to unskilled labor. As we shall see, this alters the impact of sectoral productivity growth or demand on the relative pay position of skilled and unskilled labor.

5. THE SOURCES OF TWENTIETH CENTURY TRENDS IN PAY RATIOS

Within this century, there have been three long periods of about twenty years each in which pay ratios can be examined between initial and final years of nearly full employment. The first stretches from the

Table 4

Factor Proportions in Three Sectors of the U.S. Economy, 1929, 1963 and 1976

The share of factor i employed in sector j (λ_{ij}) | The share of factor i's compensation in the income originating in sector j (θ_{ij})

1929

j =	K	L	S	All factors (ϕ_j)		K	L	S	
A	.2684	.2260	0	.1202	A	.5977	.4023	0	1.0000
M	.3575	.3194	.3751	.3584	M	.2669	.1906	.5425	1.0000
C	.3741	.4546	.6249	.5214	C	.1920	.1866	.6214	1.0000
	1.0000	1.0000	1.0000	1.0000		.2676	.2140	.5184	1.0000

1963

j =	K	L	S	All (ϕ_j)		K	L	S	
A	.0932	.0807	0	.0388	A	.4980	.5020	0	1.000
M	.3978	.2806	.3718	.3551	M	.2324	.1909	.5767	1.000
C	.5090	.6387	.6282	.6061	C	.1742	.2546	.5712	1.000
	1.0000	1.0000	1.0000	1.0000		.2075	.2416	.5509	1.000

1976

j =	K	L	S	All (ϕ_j)		K	L	S	
A	.0667	.0476	0	.0294	A	.4258	.5742	0	1.000
M	.3838	.2532	.3425	.3186	M	.2266	.2823	.4911	1.000
C	.5495	.6992	.6575	.6520	C	.1585	.3808	.4607	1.000
	1.0000	1.0000	1.0000	1.0000		.1881	.3551	.4568	1.000

Source: Williamson and Lindert, (forthcoming, Table 11.2).

census of 1909 to 1929. The second extends across the abyss of depression and war to the first postwar peak in 1948. The third period extends to 1966, when the resumption of full employment was just beginning to yield to the Vietnam price acceleration. The years since 1966 have been complicated by inflation, rising unemployment, and a bout of wage-price controls under Nixon. For our purposes, the best terminal year is 1973, when unemployment was lower than it was about to become in the wake of the OPEC victory.

Before the Crash, 1909-1929

The two decades ending in the Wall Street crash were tumultuous enough to distress farmers and fool a large number of investors. Yet by 1929 prices had been stable and employment fairly full for some time--and the ratio of skilled to unskilled wage rates had pretty much returned to its prewar level.

This long-run stability in pay ratios is captured by the model, as shown by the conformity of predicted and actual pay ratio trends in Table 5 and Figure 1. In spite of the rapid growth in immigrant-augmented unskilled labor, the pay advantage of the skilled would have declined if only factor supplies had mattered. The relatively fast growth of skills compared with conventional capital and unskilled labor would have served to depress skill premia by 0.58% per year between 1909 and 1929. This levelling tendency also received strong reinforcement from the demand-effects of population growth. Why then did the "income revolution" fail to appear until after 1929? The answer seems to lie with imbalance in technological progress. Strong upward pressure on pay ratios resulted from the fact

Table 5

Sources of Change in the Skilled-Wage Premium $(\overset{*}{q} - \overset{*}{w})$, 1909-1973, Using 1929 and 1963 Parameters

Exogenous Shift Term	1909-1973 Shift	1909-1973 Impact, using parameters from 1929	1909-1973 Impact, using parameters from 1963	1909-1929 Shift	1909-1929 Impact, using 1929 parameters	1929-1966 Shift	1929-1966 Impact, using 1963 parameters	
$\overset{*}{T}_A$	1.13%	−0.84%	−0.40%	0.02%	−0.01%	1.78%	−1.33%	−0.63%
$\overset{*}{T}_M$	2.13	0.54	0.83	2.44	0.62	1.88	0.48	0.73
$\overset{*}{T}_C$	1.09	0.53	−0.04	0.84	0.41	1.19	0.58	−0.04
Π_K	1.52	−0.24	0.05	1.26	−0.20	1.70	−0.27	0.06
Π_L	1.47	1.33	1.39	1.06	0.96	1.69	1.52	1.60
Π_S	1.60	−0.96	−1.48	1.32	−0.80	1.75	−1.05	−1.62
All "technology:"		0.36	0.36		0.98		−0.04	0.12
$\overset{*}{K}$ (capital stock)	2.42	−0.38	0.09	3.16	−0.49	1.92	−0.30	0.07
$\overset{*}{L}$ (man-hours)	0.82	0.74	0.78	1.62	1.46	0.39	0.35	0.37
$\overset{*}{S}$ (skills)	1.94	−1.17	−1.79	2.58	−1.55	1.63	−0.98	−1.51
All factor supply shifts		−0.80	−0.92		−0.58		−0.94	−1.07
Demand effects of pop. growth	1.32	−0.18	−0.08	1.50	−0.21	1.28	−0.18	−0.08
Predicted $(\overset{*}{q} - \overset{*}{w})$:		−0.63	−0.64		0.19		−1.16	−1.03
Actual $(\overset{*}{q} - \overset{*}{w})$:		−0.54	−0.54		−0.09		−0.85	−0.85

Table 5--Continued.

Exogenous Shift Term	1929-1948 Shift	1929-1948 Impact, using 1929 parameters	1948-1966 Shift	1948-1966 Impact, using 1963 parameters	1966-1973 Shift	1966-1973 Impact, using 1963 parameters
$\overset{*}{T}_A$	2.06%	-1.53%	1.44%	-0.51%	1.02%	-0.36%
$\overset{*}{T}_M$	1.45	0.37	2.35	0.92	2.51	0.98
$\overset{*}{T}_C$	1.58	0.77	0.77	-0.03	1.29	-0.05
Π_K	2.25	-0.35	1.12	0.04	1.28	0.05
Π_L	2.01	1.81	1.36	1.29	1.48	1.40
Π_S	2.01	-1.21	1.47	-1.36	1.59	-1.47
All "technology:"		-0.14		0.35		0.55
$\overset{*}{K}$ (capital stock)	0.93	-0.15	2.98	0.11	2.92	0.11
$\overset{*}{L}$ (man-hours)	0.32	0.29	0.45	0.43	0.87	0.82
$\overset{*}{S}$ (skills)	1.82	-1.10	1.43	-1.32	1.75[a]	-1.62
All factor supply shifts		-0.96		-0.78		-0.69
Demand effects of pop. growth	0.96	-0.14	1.63	-0.10	0.98	-0.06
Predicted ($\overset{*}{q} - \overset{*}{w}$):		-1.24		-0.53		-0.20
Actual ($\overset{*}{q} - \overset{*}{w}$):		-1.99		0.35		-0.21

Source: Williamson and Lindert,(forthcoming, Tables 11.3-11.5).
Note: Figures for 1909-1973 and 1929-1966 are row averages, and total may not equal column sums due to rounding.
[a]1966-1969 nonresidential sector only.

that technological progress was comparatively rapid in the industrial sector, raising the relative demand for more skilled labor both through this sector's high skill intensity and through the tendency of concomitant income growth to favor demand for capital-cum-skill-intensive nonfarm products. Seen in this light, the pre-1929 stability in pay ratios, and in other measures of income inequality, does not seem puzzling at all.

The Levelling and Its End

The post-1929 pay levelling was not undone during the postwar era. Furthermore, the 1929-1966 decline in the skilled-wage premium of 0.85% per year is not far from the predicted decline of 1.03% per year (with 1963 parameters) or 1.16% per year (with 1929 parameters) as shown in Table 5. However, the model departs from the observed movements when the 1929-1966 levelling is bisected into the periods centered on 1948. The levelling before 1948 is somewhat underpredicted. The model makes the opposite error for 1948-1966, predicting a modest but continued decline in earnings dispersion when in fact the dispersion gently rose. This pattern of offsetting errors may have a straightforward explanation. Pay ratios were depressed more than predicted by short-run postwar inflation, to which the shorter-contract less skilled wage rates reacted more quickly than the more institutionalized wage and salary rates for the better-paid. It could also be argued that the sharp deceleration in capital stock growth after 1929 contracted the share of industrial demand going to skill-intensive capital goods, and that this extra factor demand shift needs to be added to the model predictions for 1929-1948. Thus, we interpret the observed plunge of occupational wage gaps to 1948 as the result of both longer-run forces and short-run inflationary disruption, the former more important than the latter. It follows that the predicted changes for 1929-1948 and 1948-1966 show how pay relationships would have evolved over the entire period had not postwar price acceleration made the levelling go further and stop sooner than it would have under price stability.

The model explains why the levelling started after 1929, and why it stopped around mid-century. The levelling era ushered in a pattern of technological change and factor supply growth that had not been experienced for at least a century. No longer was technological advance biased in favor of the more skill and capital-using industries. Total factor productivity improved as rapidly or more rapidly in agriculture as in the rest of the economy, and service activities underwent an acceleration as well. Table 5 makes it clear that this epochal change in the character of technological progress accounted for about half of the observed shift toward a more egalitarian earnings trend following 1929.

Demographic changes also accounted for something like 30% of the observed shift toward levelling, as one can confirm by examining the entries in Table 5 for labor supply, skills supply, and population growth for 1909-1929 and 1929-1948. The levelling took place when it did partly because Americans were having fewer babies per family, because they slammed the door on most would-be immigrants, and because their mode of accumulation shifted from physical capital to human capital.

It is also interesting to note that the significant swings in the rate of capital accumulation are given much less importance here than for the nineteenth century. The reason for this appears to lie in the evolution of factor proportions in different sectors. If our estimates are correct, the nineteenth-century association of capital with skills in the more modern sectors has been broken in this century. Table 4 documents that by 1929 capital had shifted away from its earlier degree of concentration in the skill-intensive tertiary sector, in part because the capital intensity of agriculture began to approach that of the economy as a whole. This tendency has continued, though the decline in agriculture's share of the national economy has reduced the importance of its factor proportions. The upshot is that since World War I capital accumulation no longer served to raise the supply of a cooperating factor concentrated in skill-intensive sectors. Capital accumulation no longer tends to favor the relative pay position of skilled workers.

Why did the levelling stop around mid-century? The growth of the labor force remained slow, but skills growth slowed down after mid-century. Denison's measure of skills grew more slowly between 1948 and 1966 than it had earlier, primarily because of changes in the age-sex composition of the labor force (Denison, 1974, pp. 32-35). While the slow and steady influx of wives into the labor force was no match for the earlier surges of immigrants from southern and eastern Europe, it did depress the growth of average skills, sustaining the pay advantage of the already higher-paid (male) groups. At the same time, an imbalance in productivity growth reappeared. The industrial sector re-emerged as the area of fastest productivity improvement, outpacing such unskilled-labor-intensive areas as agriculture and private services. The effect of this change depends on the parameters used but its role is best described as small but noticeable in Table 5.

Our accounting thus far had made little reference to exogenous shifts in product demand although endogenous shifts are, of course, implied by changes in technology and capital accumulation. This is a potentially important omission since the middle third of the twentieth-century witnessed a rise in government from a negligible share of national product to the dominant consumer. Could it be that the rise in government purchases generated a relative expansion in unskilled labor demands before 1949 while favoring the purchase of skill-intensive services thereafter?

The factor content of government purchases has been explored elsewhere (Williamson and Lindert, forthcoming, Ch. 8). It was found that government demand was not noticeably more skill-intensive in 1963 than the general economy. Nor was it more skill-intensive than earlier bundles of government purchases. If the rise of government had a net effect on relative factor demands, the main effect was a modest shift in demand toward all kinds of labor at the expense of capital, both before and after mid-century.

6. RECENT EXPERIENCE AND PROSPECTS

The model offers several good reasons for expecting a further levelling in pretax earnings over the remainder of this century. In fact, we are persuaded that the 1966-1973 experience replicated so well by the model in Table 5 is a indication of long-run trends over the next quarter century, rather than just a short-run peculiarity. This expectation emerges from themes already introduced: demographic trends, convergence in factor proportions, and convergence in sectoral productivity growth rates.

Demographic trends should favor the pay position of the less skilled. Between 1948 and 1966, the rise in the labor force participation of women aged 30-64 served to uphold the advantage of the higher-paid by adding more competition for lower-paid jobs. Since the mid-1960s, however, the continued rise of female labor force participation has had a different character. It is now most pronounced among higher-educated wives, with less downward pressure on rates of pay for the least skilled. The recent rise in work by women has also been tied to the "baby bust," and the latter will ultimately be a strong force tending to equalize rates of pay. The rate of growth of the labor force is already dropping off, and as the labor force stagnates and ages, the relative supply of unskilled labor will continue to taper off. This should depress skill premia. There will be some offset, of course, since decreases in the pay premia for skills will themselves cause fewer people to seek higher education and on-the-job training.[11]

There has been a low but noticeable tendency for sectoral factor proportions to converge over time perhaps as the result of "factor reversal" forces stressed by trade theorists and reinforced with the appearance of early CES elasticity of substitution estimates. Agriculture in particular has approached economy-wide factor proportions ever since 1899, the first date for which such calculations are possible. Indeed, there is good evidence that the capital share in agriculture has overtaken that for the national economy. The share of unskilled labor in agriculture also seems to have declined toward the national average. There is also some tentative evidence that factor proportions have become more similar among the nonagricultural sectors. This convergence implies that differences in sectoral productivity growth rates and shifts in product demand will have diminished impact on future pay ratios. In sharp contrast with nineteenth-century modelling, one-sector models should give late twentieth-century predictions that are almost as good as those of disaggregated general-equilibrium models. In such one-sector economies, the mere fact that skills per person-hour in the labor force continue to rise is almost sufficient to guarantee a further levelling in earnings dispersion.

There is another reason to expect more levelling in the late twentieth century than was true in the postwar period up to 1973. While it is extremely hazardous to forecast rates or patterns of productivity improvement, we do have one guide to productivity patterns in the near future. The OPEC victory affects the United States in a way that is similar to a decline in total factor productivity in the energy-intensive sectors of the economy. The energy-intensive sectors tend also to be more skill- and capital-intensive, and an inconclusive literature suggests that energy inputs may be more substitutable with unskilled labor than with capital (Berndt and Wood, 1975; Hillman and Bullard, 1978). If this is true, the shift to relative fuel scarcity should tend to depress the return to capital and skills relative to unskilled wage rates.

We find ourselves adopting a somewhat unconventional view of America's past and future inequality. The usual temptations are to debate "growth-equity-trade-off" lessons, to debate the "inevitable" trends of capitalism or to point out how social attitudes about class pay relations evolve. It seems to us that a more direct route to understanding the determinants of earnings and income inequality trends is to explore the demographic, technological, and capital formation forces that accompany economic development.

NOTES

[1]Skills are defined as attributes commanding pay above that of common labor. Thus, the return to skills is not the "skilled-labor" wage but rather its premium above the unskilled wage. If skilled workers earned \$6.00 an hour and unskilled labor earned \$4.00 an hour, the ratio q/w would be 0.50, not 1.50.

[2]Our measures of Π_i are derived from total factor productivity growth estimates in from three to twelve sub-sectors of the economy. We do not exploit factor-saving bias assumptions within sectors, though aggregate factor-saving appears in Π_i. In short, we assume that the rate of total factor productivity growth equals $-b^*_{ij}$ for all factors within any given sector.

[3]Specifically, we shall assume that the elasticities of substitution between capital and skills are one-half and that all other elasticities of factor substitution are unity. In other tests, we used elasticities of factor substitution that were all half of the respective values assumed here. These tests almost invariably yielded worse predictions than the assumptions favored from the outset of our calculations.

[4]The expression for gross national product (in terms of agricultural goods) is $Y_A = A + P_M M + P_C C$. The national product concept more relevant for demand patterns is gross national product divided by prices of all goods and services consumed (Y). We simplify by assuming that foreign trade is initially in balance for each of the three sectors, so that shares in domestic absorption equal shares in domestic production, defined as the ϕ_j's. It follows that $Y = (A + P_M M + P_C C)/\phi_A + \phi_M P_M + \phi_C P_C)$, and if

P_M and P_C are standardized to equal unity in the base period, then in growth rates we have:

$$\overset{*}{Y} = \phi_A\overset{*}{A} + \phi_M(\overset{*}{P}_M + \overset{*}{M}) + \phi_C(\overset{*}{P}_C + \overset{*}{C}) - \phi_M\overset{*}{P}_M - \phi_C\overset{*}{P}_C$$
$$= \phi_A\overset{*}{A} + \phi_M\overset{*}{M} + \phi_C\overset{*}{C}.$$

This rate-of-change expression is used to derive Equations (19) and (20).

[5]Demand patterns are taken to be independent of the income distribution. It may appear that this assumption serves to dampen movements in the skilled-wage premium since it does not allow increasing inequality to shift demand away from unskilled labor-intensive agriculture, thus further fostering inequality. Yet estimates reported elsewhere (Williamson and Lindert, forthcoming, ch. 8) suggest that the demand-independence-of-inequality assumption conforms to twentieth-century facts.

[6]Some of the endogenous variables are also hard to quantify. However, elsewhere (Williamson and Lindert, forthcoming, Appendix 11.1) we have shown that the model accounts quite well for observed movements in aggregate GNP, unbalanced sectoral output growth and the real wage of unskilled labor, though not so well for movements in sector prices. These side-results reinforce the credibility of the model's predictions on pay-ratio and inequality trends.

[7]This technical adjustment is the sum of two "effects" of population growth on demand. The first is of minor interest only. The model has already incorporated the growth of total income into the demand equations, but this leaves a demographic term on the right-hand sides of equations (19) and (20). To the extent that this demographic term reflects labor force growth, it could just as easily have been added to the factor-supply

effects of $\overset{*}{L}$. The second effect is tied to the rise in dependency rates, $\overset{*}{Pop} - \overset{*}{L}$, a rise that is equivalent to a reduction in income per person-hour.

The coefficient for the demand effects of population growth shown in the text tables had been calculated by the sum ($\overset{*}{D}_M$ coefficient)$(1 - \eta_M)$ + ($\overset{*}{D}_C$ coefficient)$(1 - \eta_C)$, an expression that can be derived from equations (19) and (20).

[8] That is, $\lambda_{LA} > \lambda_{KA} > \lambda_{SA}$, $\lambda_{KM} > \lambda_{SM} > \lambda_{LM}$, and $\lambda_{SC} > \lambda_{KC} > \lambda_{LC}$.

[9] The text agrees with Table 3 regarding the importance of technological imbalance in explaining the 1899-1909 widening, but to <u>source</u> of the imbalance is still open to debate. Total factor productivity in the tertiary sector may not have grown as fast as the figure of 1.7% per annum that we adapted from Kendrick (1961). On the other hand, within the industrial sector, total factor productivity grew faster in the relatively skill-intensive subsectors mentioned in the text, a disaggregation not reflected in Table 3.

[10] We have the following rates of change in the percentage pay premia over the wages of 2,000 hours of unskilled labor between 1929 and 1948:

Wage rate premia of skilled workers (1929-1950/51):	-1.99% per annum
Median 12-month salary, engineers (1929-1946):	-3.43%
Median 9-month salary, associate professors:	-3.28% " "
Average 9-month salary, college teachers:	-5.20% " "
Average annual net income, non-salaried lawyers:	-3.36% " "
Average annual net income, non-salaried dentists:	-2.65% " "
Average annual net income, non-salaried physicians:	-0.06% " "

In view of these ratios, the 1929-1950/51 drop in the skilled wage premium of 1.99 percent per annum seems a better reflection of the overall trend in pay differentials than the lesser drop implied by the 1929 and 1948 NICB figures (<u>Historical Statistics</u>, 1976, Pt. 1, pp. 175 and 176).

For the period 1966-1973, the skilled-wage premia estimated from BLS occupational wage survey data seem unreliable. This is partly because this series had a local peak around 1973, from which it had dropped considerably by 1975, but a more serious problem is that by the 1970s the skilled group consisting of mechanics, electricians and carpenters is, at best, a dim reflection of the large numbers of white collar professionals. A better measure is possible, thanks to the work of Sheldon Danziger and Robert Plotnick (1977), who used the 1965 and 1974 Current Population Surveys of consumer income. Danziger and Plotnick held constant the weights of a dozen demographic groups in order to keep shifts between these groups from affecting measures of income inequality. From the underlying distributions generously supplied by Sheldon Danziger, we have computed the percentage change in the pay advantage of the fourth quintile over the second, roughly the skilled and professionals over the working unskilled. This rate of change is the -0.21% shown in Table 5.

[11]The rate of labor force growth could rise should the age of retirement now start to increase. The extra elderly workers, however, are unlikely to be "low-wage" employees given their greater prior work experience and their self-employment potential with the help of personal savings. Later retirement should therefore have no clear effect on the ratio of skilled to unskilled wage rates.

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