
Appendix C: Estimating Labour Input

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C.1 Labour Input Methodology

WE AGAIN BEGIN WITH SOME NOTATION for measures of hours worked, labour inputs, and labour quality for worker categories:

$H_{j,t}$ = quantity of hours worked by worker category j at time t
 $w_{j,t}$ = price of an hour worked by worker category j at time t
 $L_{j,t}$ = quantity of labour services from worker category j at time t

and for economy-wide aggregates:

H_t = quantity of aggregate hours worked at time t
 W_t = average wage of hours worked at time t
 L_t = quantity index of labour input at time t
 $P_{L,t}$ = price index of labour input at time t
 $q_{L,t}$ = quality index of labour input at time t

In general, the methodology for estimating labour input parallels capital services, but the lack of an investment-type variable makes the labour input somewhat more straightforward. For each individual category of workers, we begin by assuming that the flow of labour services is proportional to hours worked:

$$(1) \quad L_{j,t} = q_{L,j} H_{j,t},$$

where $q_{L,j}$ is the constant of proportionality for worker category j , set equal to unity.

The growth rate of aggregate labour input is defined as the share-weighted aggregate of the components as:

$$(2) \quad \Delta \ln L_t = \sum_j \bar{v}_{j,t} \Delta \ln L_{j,t},$$

where weights are value shares of labour income:

$$(3) \quad \bar{v}_{j,t} = \frac{1}{2} \left(\frac{w_{j,t} L_{j,t}}{\sum_j w_{j,t} L_{j,t}} + \frac{w_{j,t-1} L_{j,t-1}}{\sum_j w_{j,t-1} L_{j,t-1}} \right),$$

and the price of aggregate labour input is defined as:

$$(4) \quad P_{L,t} = \frac{\sum_j w_{j,t} L_{j,t}}{L_t}.$$

We define the “aggregate index of labour quality”, $q_{L,t}$, by $q_{L,t} = L_t/H_t$, where H_t is the unweighted sum of labour hours:

$$(5) \quad H_t = \sum_j H_{j,t}.$$

The growth in labour quality is then defined as:

$$(6) \quad \Delta \ln q_{L,t} = \sum_j \bar{v}_{j,t} \Delta \ln H_{j,t} - \Delta \ln H_t.$$

Equation (6) defines growth in labour quality as the difference between weighted and unweighted growth in labour hours. As with capital, this reflects substitutions among heterogeneous types of labour with different characteristics and different marginal products. As described by Ho and Jorgenson (1999), one can further decompose labour quality into components associated with different characteristics of labour, such as age, sex, and education.

C.2 Labour Data

OUR PRIMARY DATA SOURCES are individual observations from the decennial Census of Population for 1970, 1980, and 1990, the NIPA, and the annual Current Population Survey (CPS). The NIPA provides totals for hours worked, and the Census and CPS allow us to estimate labour quality growth. Details on the construction of the labour data are presented in Ho and Jorgenson (1999). Table C.1 reports the primary labour input data used in this study, including the price, quantity, value, and quality of labour input,

as well as employment, weekly hours, hourly compensation, and hours worked.

Briefly, the Census of Population provide detailed data on employment, hours, and labour compensation across demographic groups in census years. The CPS data are used to interpolate similar data for intervening years, and the NIPA data provide control totals. The demographic groups include 168 different types of workers, cross-classified by sex (male, female), class (employee, self-employed or unpaid), age (16-17, 18-24, 25-34, 35-44, 45-54, 55-64, 65+), and education (0-8 years of grade school, 1-3 years of high school, 4 years of high school, 1-3 years of college, 4 years of college, 5+ years of college).¹ Adjustments to the data include allocations of multiple job-holders, an estimation procedure to recover “top-coded” income data, and bridging to maintain consistent definitions of demographic groups over time.

These detailed data cover the period 1959 to 1995 and are taken from Ho and Jorgenson (1999). They allow us to estimate the quality of the labour input for the private business sector, general government, and government enterprises, where only the private business sector index is used in the aggregate growth accounting results. For the years 1996-98, we estimate labour quality growth by holding relative wages across labour types constant, and by incorporating demographic projections for the labour force. Hours worked by employees are taken from the latest data in the NIPA; hours worked by the self-employed are estimated by Ho and Jorgenson (1999).

Note

- 1 There is also an industry dimension, which we do not exploit in this aggregate framework, but it is used in the industry productivity analysis discussed below.

Year	Labour Input				Employment	Weekly Hours	Hourly Compensation	Hours Worked
	Price	Quantity	Value	Quality				
1959	0.15	1,866.7	269.8	0.82	58,209	38.0	2.3	115,167
1960	0.15	1,877.5	289.1	0.82	58,853	37.7	2.5	115,403
1961	0.16	1,882.0	297.7	0.83	58,551	37.4	2.6	113,996
1962	0.16	1,970.7	315.3	0.86	59,681	37.5	2.7	116,348
1963	0.16	2,000.2	320.4	0.86	60,166	37.5	2.7	117,413
1964	0.17	2,051.4	346.2	0.87	61,307	37.4	2.9	119,111
1965	0.18	2,134.8	375.1	0.88	63,124	37.4	3.0	122,794
1966	0.19	2,226.9	413.7	0.89	65,480	37.1	3.3	126,465
1967	0.19	2,261.8	429.3	0.90	66,476	36.8	3.4	127,021
1968	0.21	2,318.8	480.8	0.91	68,063	36.5	3.7	129,194
1969	0.22	2,385.1	528.6	0.91	70,076	36.4	4.0	132,553
1970	0.24	2,326.6	555.6	0.90	69,799	35.8	4.3	130,021
1971	0.26	2,318.3	600.2	0.90	69,671	35.8	4.6	129,574
1972	0.28	2,395.5	662.9	0.91	71,802	35.8	5.0	133,554
1973	0.29	2,519.1	736.4	0.91	75,255	35.7	5.3	139,655
1974	0.32	2,522.2	798.8	0.91	76,474	35.0	5.7	139,345
1975	0.35	2,441.8	852.9	0.92	74,575	34.6	6.3	134,324
1976	0.38	2,525.6	964.2	0.92	76,925	34.6	7.0	138,488
1977	0.41	2,627.2	1,084.9	0.92	80,033	34.6	7.5	143,918
1978	0.44	2,783.7	1,232.4	0.93	84,439	34.5	8.1	151,359
1979	0.48	2,899.6	1,377.7	0.93	87,561	34.5	8.8	157,077
1980	0.52	2,880.8	1,498.2	0.94	87,788	34.1	9.6	155,500
1981	0.55	2,913.8	1,603.9	0.94	88,902	33.9	10.2	156,558
1982	0.60	2,853.3	1,701.6	0.94	87,600	33.6	11.1	153,163

Table C.1 (cont'd)								
Year	Labour Input				Employment	Weekly Hours	Hourly Compensation	Hours Worked
	Price	Quantity	Value	Quality				
1983	0.66	3,095.5	2,040.2	0.95	93,176	34.0	12.4	164,870
1984	0.64	2,904.9	1,849.0	0.94	88,638	33.9	11.9	156,049
1985	0.69	3,174.6	2,183.5	0.95	95,410	33.9	13.0	168,175
1986	0.75	3,192.8	2,407.1	0.95	97,001	33.5	14.2	169,246
1987	0.74	3,317.1	2,464.0	0.96	99,924	33.7	14.1	174,894
1988	0.76	3,417.2	2,579.5	0.96	103,021	33.6	14.3	179,891
1989	0.80	3,524.2	2,827.0	0.96	105,471	33.7	15.3	184,974
1990	0.84	3,560.3	3,001.9	0.97	106,562	33.6	16.1	186,106
1991	0.88	3,500.3	3,081.4	0.97	105,278	33.2	16.9	181,951
1992	0.94	3,553.4	3,337.0	0.98	105,399	33.2	18.3	182,200
1993	0.95	3,697.5	3,524.4	0.99	107,917	33.5	18.8	187,898
1994	0.96	3,806.4	3,654.6	0.99	110,888	33.6	18.9	193,891
1995	0.98	3,937.5	3,841.2	1.00	113,707	33.7	19.3	199,341
1996	1.00	4,016.8	4,016.8	1.00	116,083	33.6	19.8	202,655
1997	1.02	4,167.6	4,235.7	1.01	119,127	33.8	20.3	209,108
1998	1.06	4,283.8	4,545.7	1.01	121,934	33.7	21.3	213,951

Note: The quantity of labour input is measured in billions of 1996 dollars; the value of the labour input is measured in billions of current dollars. Employment is in thousands of workers, hourly compensation is expressed in dollars, and hours worked are in millions. The price of the labour input and the index of labour quality are normalized to 1.0 in 1996.

