Purvis Prize
#002

Canadian Real Per Capita Income: Did We Take A Wrong Turn?

Economics 418B

Professor C. Beach

By: David Callum

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I. Introduction

Comparisons of Canadian and American economic performance are inevitable in evaluating the Canadian economy. The United States is Canada's single most important economic relationship and, as such, American incomes are a useful benchmark by which to gauge the economic well-being of the Canadian people. It is thus with decided anxiety that observers have noted a growing gap between Canadian and American real incomes that emerged in the 1980s and is widening in the 1990s. Indeed, there are few areas of economics that come as close to touching everyday lives as does the study of real per capita income.

Provided that an economy has a well-designed tax and transfer system, the optimization of real per capita income is, in effect, the optimization of living standards. The level of real per capita income and the rate at which it grows are important measures of society's welfare.

In recent months there has been a heightened interest in Canada's productivity performance, itself a component of real per capita income, by journalists, politicians, and economists. In March of this year, the government was quick to trumpet a Statistics Canada study showing that Canada's productivity performance may have outpaced that of the United States in 1997 (McCarthy, 1999). Editorialists and opposition M.P.'s downplayed that work, asserting that high tax rates and burdensome regulation were to blame for Canada's ongoing weak economic performance.

Despite this flurry of recent interest in productivity statistics, productivity remains a difficult concept to define and measure (Little, 1999). Lost in this debate has been the more fundamental question of what has happened to Canadian real per capita income. To tackle this problem, more needs to be understood about how real per capita income is determined and what has affected it in recent years.

This empirical study will endeavour to shed light upon the behaviour of real incomes in Canada between 1971 and 1996. By decomposing real per capita income (GDP per capita) into its components, labour productivity and the employment rate, it is proposed that we will acquire a more thorough understanding of what has influenced changes in real income over this period.

The paper proceeds as follows: Section II motivates the decomposition of real income into labour productivity and the employment rate, surveying the current state of research on the topic; Section III develops a fully specified system of reduced-form equations that will be used to study the determination of real per capita income; Section IV describes the data employed in the empirical study; Section V presents basic preliminary evidence on the dependent and independent variables that comprise the system of equations; Section VI describes and evaluates the results of the empirical portion of the study; Section VII concludes.

II. Real Income and Its Components: A Survey

Real income is an important measure of economic well being insofar as it is a widely accepted proxy for living standards. Sharpe (1999) notes the decline in Canadian real incomes both relative to the United States and to the OECD average. Drawing on data from Statistics Canada for Canada, the Bureau of Labor Statistics for the United States, and the OECD, the study documents Canada's lagging output per person. In 1997, GDP/capita in Canada was $48 583 in 1996 US$ amounting to 80.3% of the U.S. level. A decade ago, Canadian real incomes were as much as 81.8% of the U.S. level (Sharpe, 1999, p. 1).

To uncover the factors prompting this divergence, it is useful to define Canada's standard of living as real income per person. GDP per capita can then be reduced into its components,

$$[\textit{Real per capita income}] = [\textit{labour productivity}] \times [\textit{employment rate}]$$

$$[GDP / Population] = [GDP / Workers] \times [Workers / Population]$$

$$= [GDP / Workers] \times [1 - UR][PR],$$

where UR = unemployment rate
PR = participation rate

The appeal of this expansion is that it suggests two determinants of real per capita income: labour productivity and the employment rate. The employment rate can further be broken down into the unemployment and participation rates. It would thus seem plausible to construct three regression equations for each country for the analysis of real income differences.

II.1 Labour Productivity

As a determinant of real per capita income, labour productivity is interesting in two respects. Firstly, it embodies some of the determinants that may have factored in the fall in Canadian real incomes. Secondly, it is commonly acknowledged that without productivity gains, there can be no sustained long-term improvements to living standards (Krugman, 1994 p.14; Sharpe, 1998). Just as we use real incomes to measure the state of living standards, so should we employ productivity to chart changes in those standards.

Aggregate labour productivity is the summation of goods and services produced by an economy, using prices to aggregate over heterogeneous products, divided by the total labour input required to produce this output (Sharpe, 1995, p 223). In developing an understanding of labour's role in production and how its productivity is influenced, it is worthwhile to refer to the Solow growth model for context[1]. The determinants of growth can be derived from a standard Cobb-Douglas production function where output, Y, is a function of capital input, K, labour input, L, and a technological change factor, A.

$$Y = f(A, K, L)$$

The production function can be reconstructed in terms of the growth of output and inputs such that: y represents output growth, k is the growth of the capital input, l is the growth of the labour input, θ_K is the share of capital input used in production, θ_L is the share of the labour input used, and a represents productivity gains from improved technology or "total factor productivity".

$$y = \theta_K k + \theta_L l + a$$

The growth process can be recast in terms of a labour productivity measure, ϑ, where the difference between output growth and labour input growth, $y - l$, is growth owing to

[1] This exposition of the Solow growth model is adapted from Denny and Wilson (1992).

labour productivity improvements. This is especially useful in light of the limited data available on capital.

$$\vartheta = a + \theta_K(k - l)$$

Expressed this way, labour productivity growth is a function of Solow's residual and the growth of the capital to labour ratio.

The contribution of Sharpe to the literature on Canada's productivity performance is formidable. Sharpe (1999) raises, but does not analyze, two competing explanations that have emerged to explain the productivity slowdown. Firstly, is the view that there are structural impediments to productivity growth including low levels of research and development spending, a slower rate of innovation, poor basic literacy skills of the Canadian workforce, and high taxes. In the competing evaluation, it is suggested that the weak macroeconomic performance of the Canadian economy in the 1990s has held Canada back.

II.1.1 Cyclical Factors

The emergence of a productivity concern in Canada was noted in the mid 1980s and early 1990s by several Canadian observers[2]. Sharpe (1994) sounds the alarm of a potential crisis facing Canada. As Canada rose from the 1990-91 recession, casual empiricism led some to declare a productivity renaissance. Sharpe denied this resurrection arguing that the illusion of productivity gains during recovery masked an overall decline in trend growth. Short- to medium-term movement is influenced by two factors, the "underlying productivity trend" and a cyclical component. When the cyclical component was accounted for and filtered in the analysis, what appeared to be productivity improvement in the early 1990s was not an improvement in the overall trend of Canadian productivity growth, but standard business cycle effects.

Measured labour productivity is strongly influenced by the business cycle and must therefore be considered in this analysis. Failure to account for the short-run sensitivity of labour productivity to the business cycle threatens to render empirical results meaningless.

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[2] See Purvis (1985), Denny and Wilson (1992), and Sharpe (1994)

Output per worker tends to grow below trend or even to fall during recessions and grows well above trend in the early stages of recovery. Labour is a quasi-fixed factor of production (Denny and Wilson, 1992 p.34). As output falls, hours of work per person can be reduced as some employees are let go and workforces are reduced through attrition. As a result, there is not a one-for-one adjustment of the labour input to the fall in output since workers who are associated with fixed capital equipment cannot be laid off and the cost of temporarily dismissing skilled workers is high.

II.1.2 Structural Reform

Over the past two decades, Canada has undergone a series of structural reforms accompanied by the promise that they would release latent productivity gains. Deregulation of Canadian industry, privatization, and tax reform were all said to make the Canadian economy more "competitive" and "dynamic" in the sense that Canadian workers and industry would be able to produce more output with fewer inputs (increased productivity). While these represent an attractive set of factors to include in this study, they seem too difficult to quantify with the tools available and under the given time constraints of this study. As well, similar reforms took place in the United States and, in the case of deregulation, the changes were even more dramatic. Thus, it is not clear that the inclusion of these factors would lend much insight to the problem.

Two structural changes that stand out, however, are the Canada-U.S. Free Trade Agreement and the North American Free Trade Agreement. Freer trade, by capitalizing on a country's comparative advantage, is believed to unleash efficiency gains leading to greater productivity. Total factor productivity, it is claimed, is increased by free trade due to spillovers from abroad. Because free trade also stimulates capital formation, labour productivity necessarily increases. While NAFTA may have been introduced too recently, the FTA is now ten years old and may show an effect on labour productivity.

II.1.3 Human Capital and Innovation

Lee and Has (1996) suggest three measures of human capital: the ratio of workers with post-secondary education to total employment, the ratio of knowledge workers (defined in occupational terms) to total employment, and the ratio of the number of employed scientists and engineers to total employment (Lee and Has, 1996, p. 43). Of these three measures, the first is readily quantified while data on the latter two are more difficult to come by.

No less important than human capital is the level of research and development (R&D) in the economy. R&D directly contribute to innovations that equip the labour force with better and more productive capital. Lee and Has have arrived at three measures for describing the level of R&D in the economy: R&D expenditures as a percentage of GDP, the proportion of R&D personnel in total employment, and the proportion of professional (post-secondary) degree personnel in total employment (Lee and Has, 1996 p. 43). Again, while data on direct R&D expenditures are readily available, defining and measuring "R&D personnel" presents problems for collecting information.

The implications for public policy with respect to R&D and human capital are clear. In the 1999 federal budget, the Minister of Finance has made a significant investment in R&D programs arguing that Canada has for too long relied on imported innovation (Tuck, 1999). An inquiry into the effect of human capital and domestic innovation on Canada's standard of living may support or deny these claims.

As illustrated earlier in this Section, labour productivity is influenced both by capital and pure technological change. To capture this latter element, a time trend variable will be employed in the labour productivity model that is specified.

II.1.4 Sectoral Reform and the Computer Age

It is confounding in the age of computers and information technology that a fully industrialized nation is experiencing an apparent productivity slowdown. It is this inconsistency that has led many to label this puzzle "the productivity paradox". Sharpe (1997) surveys many of the efforts to explain the phenomenon ranging from the benefits having been realized but are invisible in productivity statistics, to the need for patience in the face of inevitable productivity lags, to the belief that the ebullience over information technology is misplaced. The conclusion of the paper is that the explanations are not mutually exclusive and that a definitive understanding of the "paradox" is a long way off in the face of a new research vacuum.

In discussing the possible causes of the productivity slowdown, Sharpe raises, but does not investigate, the issue that sectoral shifts from high-productivity goods industries to low-productivity service industries are offsetting the potential gains offered by the information technology sector. More rigorous analyses of this issue are provided by Prasad (1993), Gera, Gu and Lee (1997), and Gera and Mang (1998).

Prasad (1993) notes that there has been significant industrial restructuring in Canada over the last decade and that the effect of technological innovation is experienced differently by different sectors. Canada has been traditionally, and may still be to some extent, labeled an economy structured around commodities and primary resources. The rise of information technology has had little impact on these industries, but is very important in manufacturing. However, in employment terms, Canada has experienced a shift away from manufacturing and primary industries to the service industry. Within the service industry, computer innovation benefits some sectors like finance and telecommunications, but are of little use in hairdressing and landscaping. According to Prasad, much of the increase in employment in Canada has been in these low productivity sectors rather than high productivity sectors.

In a thorough examination of the productivity paradox, Gera, Gu, and Lee (1997) seek to address falling productivity in the type of environment that, in the context of endogenous growth theory, seems conducive to its growth. They seek to address, on an industry basis, the extent to which investments in information technology contribute to productivity growth and the effect of R&D spillovers from this sector (Gera, Gu, and Lee, 1997 p.3).

In a formal approach to the problem, they employ econometric analysis to come to grips with the productivity mystery. They proceed to construct a model by which to judge how investments in information technology contribute to productivity growth and whether R&D spillovers from this sector are important for productivity growth. The data used in their application are from across different industries, not nationally as is the subject of this study. Their evidence suggests that the information technology investment rate is significant and has a positive influence on labour productivity. As well, spillovers from R&D investment from outside a particular industry have a significantly positive effect (Gera, Gu, and Lee, 1997 p.12). Of particular interest is the evidence of international diffusion of R&D embodied in both information technology and non-information technology imports. These were determined to have a positive and statistically significant impact on productivity growth (Gera, Gu, and Lee, 1997 p. 13). Performing the same set of regressions for the United States, the study revealed that the effect of information technology investment on labour productivity growth is positive, but not as strong as in the Canadian experience. For both the United States and Canada, direct R&D spending within an industry is statistically insignificant suggesting little incentive for private sector R&D investment.

Gera and Mang (1998) discuss the evidence of large structural shifts in employment and ask whether the employment structure in Canada is shifting towards knowledge-based and technology-intensive industries. Like Prasad, they note the shift from traditional primary, manufacturing, and consumer industries to the service sector. They note, however, that the pace of structural change as captured by inter-industry employment shifts has not increased. The pace of sectoral change might have increased to some extent in the early 1980s, but has not accelerated, and may have even decelerated, in the late 1980s and 1990s (Gera and Mang, 1998 p. 153).

They further determine that Canada's industrial structure is indeed becoming more knowledge-based and technology intensive, "with its competitive advantage rooted in innovation and ideas - the foundations of the 'new economy' paradigm"(Gera and Mang, 1998 p. 178). Specifically, knowledge intensity is on the rise as "high knowledge" industries have outpaced medium and low-knowledge sectors gaining output share at their expense. Within manufacturing, technological intensity is increasing, representing a movement towards industries classified as "high technology". Finally, skill intensity of output in the manufacturing sector is on the rise where industries are using more skilled labour. These industries themselves have increased in their relative importance within the manufacturing sector.

II.1.5 Capital

A further implication of the Gera *et al* (1997) study is its insight into the role that capital plays in labour productivity growth. The better equipped a labour force with efficient capital, the more productive are their efforts. Gera *et al* survey the role of capital and capital embodiment in the new growth literature and analyze the effect of capital on labour productivity with respect to the embodiment and vintage effects. The former is where substantial capital accumulation is necessary to put new inventions into practice and facilitate their extensive use, whereas the latter refers to the greater productivity of new capital than older capital per dollar of expenditure. This is because new capital is more likely to be made with superior technology. The data used to represent these effects in their regression come from the Fixed Capital Flows and Stocks Data (Gera, *et al*, 1997 p. 21). The evidcncc supports the hypothesis that older capital has a negative influence on productivity to the extent that a one year reduction in the average age of the capital stock may be associated with an increase of labour productivity by 0.42 percent per year (Gera, *et al*, 1997 p. 25). Likewise, the embodiment effect as represented by the capital to labour ratio is shown to be positive and significant, a one percent increase resulting in 0.14 percent greater labour productivity (Gera, *et al*, 1997, p. 24).

II.2 Employment Rate

From the decomposition of real GDP per capita illustrated at the beginning of this section, the second half of the analysis mandates an examination of the behaviour of the Canadian employment rate defined by workers per capita. This measure of employment activity can be further broken down into the unemployment rate (or one minus the unemployment rate) and the participation rate. In exploring these measures of labour supply it is hoped that the effect of employment activity on real incomes in North America can be better understood.

II.2.1 Unemployment Rate

Aggregate data suggest that the Canadian and U.S. labour forces became more alike during the 1980s in terms of the amount of time spent in the labour force and the time spent employed. However, they became decidedly less similar in the duration and incidence of unemployment (Benjamin, *et al*, 1998 p. 603).

The amount of unemployment at any point in time is a function of its incidence and duration. The incidence of unemployment is the number of individuals that become unemployed in any period whereas the duration refers to the length of time spent in the unemployed state before obtaining employment or leaving the labour force.

In specifying a regression equation with the unemployment rate as the dependent variable, explanatory variables should be included to capture the incidence and duration of unemployment. Unemployment insurance generosity affects unemployment by making the unemployed more reluctant to take job opportunities early in the unemployment period, lengthening its duration. Additional factors that need to be considered are Canada's high rate of unionization and the price of raw materials. Given the importance of primary industries in Canada, one would expect that higher raw material prices lead to greater employment opportunities and a lower unemployment rate.

II.2.3 Participation Rate

Canadian and American labour supply do not differ significantly due in large part to the standard forty hour working week in the two countries. The participation rates themselves for Canada and the U.S. are virtually identical in both the aggregate and across males and females (Benjamin, *et al*, 1998 p. 102). Nonetheless, the determinants of the participation rate that can be considered are the wage rates, non-labour income, and the change in job opportunities.

III. Model Specification

A system is used to describe the determination of real per capita income and is composed of three reduced-form equations with the following dependent variables: GDP per worker representing labour productivity, the unemployment rate, and the participation rate. In all three equations, quarterly indicator variables are included to account for seasonality in the data with the fourth quarter set as the default quarter.

III.1 Labour Productivity

The first of the three equations in the system is designed to explore how GDP per worker is determined. The dependent variable is gross domestic product per employed person.

The right-hand side of the equation is composed of ten explanatory variables, including three quarterly indicator variables. Equation 1 is the fully-specified reduced-form regression equation for labour productivity.

$$GDP/Worker_t = \beta_1 + \beta_2 T_t + \beta_3 UPAM_t + \beta_4 DFTA_t + \beta_5 PSE_t + \beta_6 R\&D_t + \beta_7 MANSH_t + \beta_8 HOURS_t + \alpha_1 Q1_t + \alpha_2 Q2_t + \alpha_3 Q3_t + u_t \quad (1)$$

In equation 1, a time trend variable (T) is included to capture the effects of pure technological change on labour productivity and is expected to exert a positive effect on the dependent variable. The effects of the business cycle are represented by the unemployment rate of prime-aged males (UPAM). It is predicted that when the unemployment rate of prime-aged males is high and the economy is functioning below capacity, GDP per worker will be low. As a result, one expects that the coefficient on this variable will assume a negative sign. The implementation of the Canada-United States Free Trade Agreement is captured by an indicator variable (DFTA) that economic theory predicts will positively influence the dependent variable in the long run, if not the short run that will be examined in this study. Research and development spending as a percentage of GDP is included in the model (R&D) and will presumably have a positive impact on labour productivity. Manufacturing's share of aggregate employment (MANSH) is included to proxy the effects of structural change over the sample period. A priori, the effect of structural change on the dependent variable is ambiguous. On one hand, manufacturing makes better use of new technologies than do either primary sector or many service sector production activities. If this hypothesis were true, one would expect this variable's coefficient to be positive. On the other hand, it is also possible that, if manufacturing's share of employment remains high, Canada's economy is slow to adjust structurally. If this is the case, the expected sign on β_7 is negative. Finally, the influence of the number of hours that employees work each week is included as an explanatory variable (HOURS) and is predicted to have a positive influence on GDP per worker.

III.2 Unemployment Rate

The first of the two equations determining the employment rate is that with the unemployment rate as the dependent variable. The right-hand side of the equation has seven explanatory variables, including three seasonal dummies. Equation 2 is the fully-specified exposition.

$$UR_t = \gamma_1 + \gamma_2 UPAM_t + \gamma_3 EI_t + \gamma_4 UNION_t + \gamma_5 RAW_t + \alpha_1 Q1_t + \alpha_2 Q2_t + \alpha_3 Q3_t + v_t \quad (2)$$

In equation 2, the effects of the business cycle on the unemployment rate are captured by the unemployment rate of prime-aged males (UPAM). When the business cycle is on a downswing, the unemployment rate tends to be high. As a result, a positive sign is expected to accompany the coefficient of this explanatory variable. The generosity of the employment insurance system (EI) is likely to have a positive influence on the dependent variable. From a demand-side perspective, when employment insurance payments are high, it is largely because the incidence of unemployment itself is high. On the supply-side, the more generous the insurance scheme, the more reluctant are the unemployed to seize employment opportunities quickly, lengthening the duration of unemployment. The impact of unionization in Canada is captured by the union density rate (UNION) and its coefficient is expected to assume a positive sign. Finally, the price of raw materials (RAW) is included in the equation and expected to be positively related to the dependent variable.

It must be noted that equation 2 enters into the system of equations as (1 – unemployment rate). Therefore, variables that have a positive coefficient must, by construction, have a negative influence on real per capita income and vice versa.

III.3 Participation Rate

The second of the equations determining the employment rate, and the final equation in the system, is the regression equation for the participation rate, equation 3. This equation has six regressors, of which three are seasonal dummies.

$$PR_t = \delta_1 + \delta_2 WAGES_t + \delta_3 NLI_t + \delta_4 UPAM_t + \alpha_1 Q1_t + \alpha_2 Q2_t + \alpha_3 Q3_t + w_t \qquad (3)$$

The principle explanatory variables in equation 3 are wages (WAGE), non-labour income (NLI), and the unemployment rate of prime-aged males (UPAM). The wage rate will have a positive effect on the participation rate if higher wages induce entry to the labour market. However, if higher wages create an income effect that dominates this substitution effect, the participation rate may fall as fewer family members must work to support a household. In this case, the coefficient on wages will assume a negative sign. The effect of non-labour income is expected to be negative since higher levels of non-labour income make leisure more affordable and individuals substitute labour for leisure. Finally, the unemployment rate of prime-aged males is included to represent changes in job opportunities. When job opportunities are low, one expects fewer people to want to participate in the labour market and thus the discouraged worker effect will result in δ_4 assuming a negative sign.

III.4 Hypotheses

There are three items that empirical work on this system will hopefully shed light upon. Firstly, by testing the statistical significance of each coefficient estimate, we will determine how well this system describes the determination of real per capita income and its components. Secondly, it is hoped that regression analysis will indicate whether or not our expectations regarding the individual effects of the coefficients are correct in terms of either positive or negative influences. Finally, the magnitudes on each of the coefficients will indicate the relative size of each variable's influence, be it positive or negative.

IV. Data Set

The relevant sample period for this study's empirical portion is 1971 to 1996. All data are not seasonally adjusted and have a quarterly frequency.

IV.1 Data on Labour Productivity

The first of the three regression equations is for GDP per worker. The dependent variable, GDP/Worker has been calculated by dividing GDP by the number of employed persons.

The data on GDP came from the CANSIM database, Label D15721: "GDP, expenditure-based, 1992$ / GDP at market prices". The data were available quarterly from 1971 to 1996. The data were not seasonally adjusted.

Employed persons data from 1976 to 1996 were available quarterly from the CANSIM database, Label D980120: "CDA LF Characteristics, monthly unadj / Employment age 15+ unadj. CDA". From 1971 through 1975, the data were obtained from the *Bank of Canada Review* (February 1973 and March 1976), table 56: "Labour force status of the population: not seasonally adjusted, employed". Each observation is in thousands of persons.

All statistics, from both CANSIM and the *Bank of Canada Review* were available at a monthly frequency. They were converted from monthly to quarterly data by averaging over three-month quarters.

IV.1.1 Time Trend

The time trend variable, designed to capture pure technological change, is self-generated assuming a value of 0.25 in the first observation and increasing at increments of 0.25 for each observation thereafter.

IV.1.2 Unemployment Rate of Prime-Aged Males

Data on the unemployment rate of prime-aged males for 1976 to 1996 were available monthly, converted to quarterly data, in CANSIM, label D767404: "LFS Canada Characteristics monthly raw / Unemployment rate men 25-54 years". For the period 1971 to 1975, data were compiled from Statistics Canada's *Historical Labour Force Statistics* (serial 71-201): "Uemployment Rate Canada Males, 25-54 years". Again, the raw data were available monthly and are averaged to obtain quarterly figures.

IV.1.3 Free Trade Agreement

A self-generated indicator variable capturing the effect of the Canada-U.S. Free Trade Agreement has been included, assuming values of zero before 1989 and one in 1989 and the years following.

IV.1.4 Ratio of Workers with Post-Secondary Education

The number of people with a post-secondary education came from Statistics Canada's *Income Distributions by Size in Canada* (serial 13-207): "Percentage Distribution of Individuals by Income Groups, Education, and Sex". The data came from annual publications between 1971 and 1996. The number was estimated for the Canadian population from a sample based on the Survey of Consumer Finances. The figures used were the sum of individuals with a certificate or degree from a post-secondary institution and those with a university degree. Those with some post-secondary education but without a degree were excluded. Annual data has been interpolated to quarterly data.

It must be noted that these are not workers with a post-secondary education, but rather income-recipients with a post-secondary education. Thus, the ratio presented as PSE per worker is not really the ratio of workers with a post-secondary education. The number calculated is closer to the ratio of Canadians with a post-secondary education.

One figure was entered four times for each year because institutions grant degrees usually only once a year and usually in the second quarter.

IV.1.5 Research and Development as a Percentage of GDP

Data on this variable were available from the OECD in the publication *Main Science and Technology Indicators* between 1982 and 1994. The specific figure is "gross domestic expenditure on R&D as a percentage of GDP" or GERD. Again, annual data were interpolated to obtain quarterly data.

IV.1.6 Manufacturing Share of Employment

Monthly data on the number of persons employed in manufacturing were available in CANSIM from 1976 to 1996, label D980185: "CDA LF Characteristics monthly unadj. /

employment manufacturing unadj. CDA". For 1971 to 1975 monthly data were available in Statistics Canada's *The Labour Force*, "Employed by industry and sex, Canada: both sexes, manufacturing". The conversion to quarterly data was accomplished using an average.

IV.1.6 Hours Per Week

Monthly data on hours per week were available in CANSIM from 1976 to 1996, label D980233: "CDA LF Characteristics monthly unadj. / avg. usual hour jobs." From 1970-1975 data were available in Statistics Canada's *Employment, Earnings, and Hours* (serial 72-002): "Average weekly hours of hourly-rated wage earners, unadjusted". In both cases, data were averaged to obtain quarterly data.

IV.2 Unemployment

The data on the actual unemployment rate in Canada were obtained from the CANSIM database, label D980404: "CDA LF Characteristics monthly unadj. / UR age 15+ unadj. CDA". This covered 1976 through 1996 and monthly data were converted to quarterly data. From 1971 through 1975 data were obtained from the *Bank of Canada Review*. Again, data were not seasonally adjusted and converted from a monthly frequency.

IV.2.1 Unemployment Insurance Generosity

Annual data were available in CANSIM, label D14370: "Govt transfer payment to persons Canada / unemployment insurance benefits" for the period 1970 through 1995. It has been interpolated to obtain quarterly data. Each observation is in millions of constant Canadian dollars. To capture the program's generosity, this figure has been divided by the number of persons unemployed to provide unemployment insurance per unemployed person.

IV.2.3 Union Density Rate

The union density rate is the ratio of the number of workers who belong to a union to the number of paid workers. Data for union density in Canada were obtained from

Perspectives on Labour and Income, "Unionized Workers" (Spring 1996 8(1), pp. 43-52). These data were generated from the Labour Force Survey. Because this rate is slow to change, the same figure has been entered four times for each year.

IV.2.4 Raw Material Prices

Statistics Canada does have an index of monthly raw materials prices, but it is available only as far back as 1977. Thus as a proxy, this study uses indices available for wood-related industries. Data from 1971 through 1985 were taken from CANSIM, label D519100: "ISPI Wood (1971=100) / Wood Industries". From 1985 through 1996, data were taken from CANSIM, label D693407: "IPPI 1986=100 Lumber, Furniture, Paper, etc. / Lumber and other wood industries". In both cases monthly data were converted into quarterly data using an average conversion method.

IV.3 Participation Rate

The participation rate itself was obtained from CANSIM, label D980466: "CDA LF Characteristics Monthly Unadj. / Participation Age 15+ Unadjusted CDA." Monthly figures from 1976 through 1996 were converted from monthly to quarterly data. Similarly, data for 1971 through 1975 were obtained from the *Bank of Canada Review*

IV.3.1 Wages and Non-Labour Income

Wage data were difficult to obtain. However, Statistics Canada's *Income Distribution by Size in Canada* (serial 13-207) provides "Distribution of Individuals (number and percent) and of Aggregate Income of Individuals (amount and percent) and Percentage Composition of Income of Individuals by Income Groups". From these tables over the period 1971 to 1996, the number of income earners, aggregate income, and the percentage composition of aggregate income from wages and salaries were available annually. Using interpolation, these figures were converted from annual to quarterly data. Average income was calculated by dividing aggregate income (in millions) by the number of income earners (in thousands).

Weekly non-labour income was obtained by taking the percentage of income that was not earned from wages and salaries (1 - %W&S) and multiplying it by average income.

Wage data itself was taken from national accounts data, Statistics Canada publication 13-001: *National Economic and Financial Accounts*, "National Income and GNP, by quarters, unadjusted, millions of dollars".

A CPI deflator was necessary to make this data standard.

V. Basic Preliminary Evidence

Figures 1 through 4 illustrate the behaviour of the dependent variables in this system over the sample period 1971 through 1996.

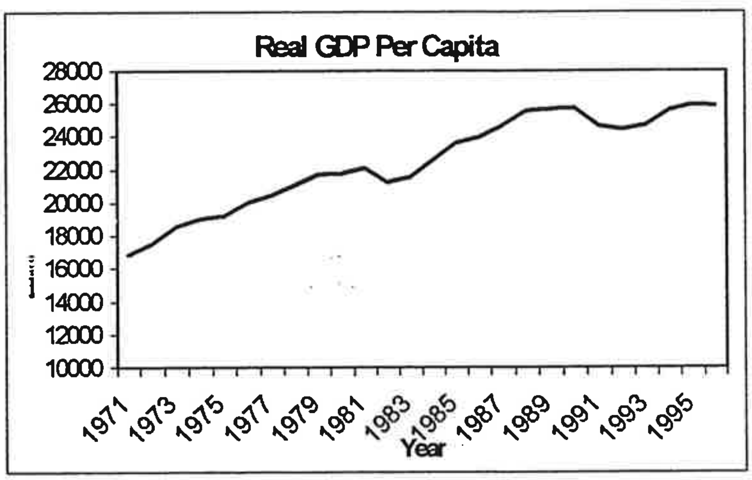

Figure 1.

Source: CANSIM Database, labels D14872, D31248

Figure 1 depicts the behaviour of real per capita income, reflecting its steady upward trend. GDP per capita accelerated most rapidly through the 1970s and in the inteval1983 through 1989. The graph illustrates the deep recession of 1981-82 and the longer, but less severe, recession of 1990-91. It is evident from this illustration that, since the late 1980s, real per capita income has not increased significantly and the rate of its growth appears to have slowed considerably.

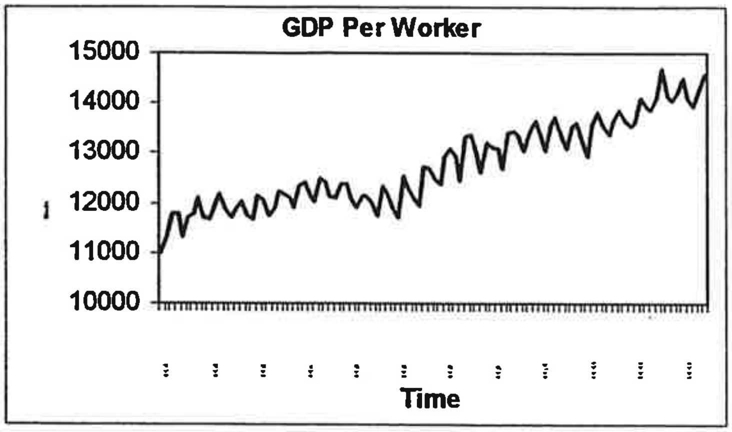

Figure 2.

Source: CANSIM Database, labels D15721, D980120

The movement of labour productivity is charted in figure 2. Its growth is reflective of GDP per worker, but appears to have grown more steadily and not to have slowed in its growth to the same degree. The negative growth of GDP in the sample's two recessions is apparent in figure 2. Most importantly, while real per capita income seems to have stalled since 1989, real per worker income appears to have not.

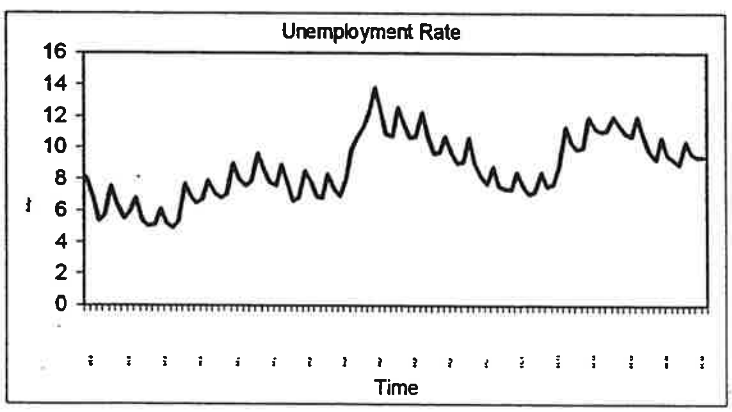

Figure 3.

Source: CANSIM Database, label D980404

The unemployment rate, as traced in figure 3, fluctuated substantially over the relevant twenty-five year interval. It was relatively low through the 1970s, hitting a high in the depths of the 1981-82 recession. When the economy returned to capacity production in the mid- and late-1980s the unemployment rate fell substantially, but returned again to double digit levels in the 1991-92 recession from which it has fallen only slightly since.

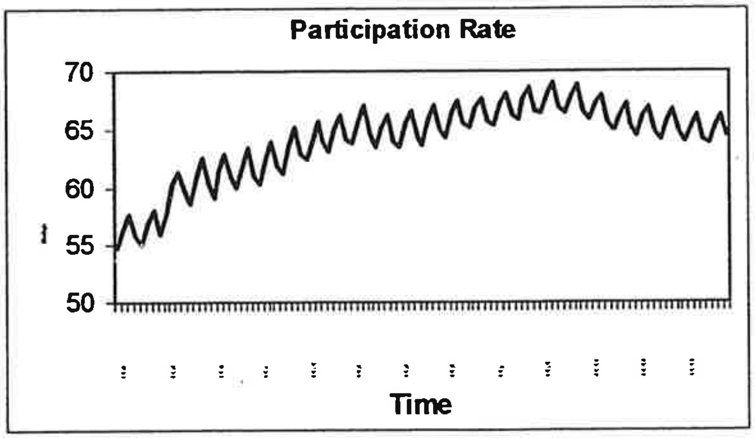

Figure 4.

Source: CANSIM Database, label D980466

The most consistent dependent variable in this system of equations is unquestionably the participation rate. This measure of labour supply jumped markedly in the early 1970s, but has since increased steadily over time. It appears to have reached a peak at the end of the 1990s from which it has slipped marginally. Apparent in figure 4 is the effect of the discouraged worker effect where the participation rate dips slightly in the two recessions. Indeed, this effect probably best explains the recent fall in this labour market indicator in light of the unimpressive job opportunities of the 1990s.

Variable	Mean	Std. Dev.	Minimum	Maximum
GDP/Worker	12756	862.79	10998	14673
TIME	13.125	7.5416	0.25	26
UPAM	6.801	2.5158	2.1	12
DFTA	0.30769	0.46377	0	1
PSE	37.577	15.1	16	71
R&D	1.324	0.19218	1.03	1.66
MANSH	18.228	2.5159	14.4	22.7
HOURS	37.551	1.081	36.1	40.3
UR	8.7058	2.0273	4.9	13.8
UPAM	6.801	2.5158	2.1	12

EI	6855.7	3009.2	335	12121
UNION	32.296	1.0104	30.5	33.6
RAW	268.59	99.341	93.5	483.9
PR	63.968	3.2568	54.7	68.9
WAGE	561.53	26.837	476.7	606.6
NLI	193.29	39.116	118.4	257.2
UPAM	6.801	2.5158	2.1	12

Table 1.

Source: SHAZAM output, see appendices A, B, C.

Table 1 provides a set of descriptive statistics for all variables that have been included in the system of equations and upon which empirical work has been performed. This chart provides the mean, standard deviation, minimum and maximum values for all dependent and independent variables in each of the three equations.

VI. Empirical Evidence

VI.1 Regression Results on Labour Productivity

VI.1.1 Basic Specification Results

Variable	(1)OLS Estimation		(2) ML Estimation	
Constant	4544.4	*1.851*	8186	*3.666*
Time	96.046	*4.926*	83.942	*3.444*
UPAM	-45.743	*-1.607*	-54.277	*-1.618*
DFTA	-352.67	*-2.834*	-242.84	*-1.528*
PSW	22.149	*3.12*	21.935	*2.203*
R&D	-96.124	*-0.291*	139.36	*0.3668*
MANSH	-71.545	*-1.286*	-49.422	*-0.7217*
HOURS	219.05	*3.388*	107.37	*1.95*
Q1	-234.23	*-3.385*	-243.08	*-3.48*
Q2	-522.61	*-9.508*	-496.65	*-11.55*
Q3	-267.43	*-3.9*	-185.18	*-3.221*
R-squared	0.9568		0.9659	
F	206.051			
SSE	3.31E+06		2.62E+06	
Log L.F.	-686.727		-674.65	
D-W	1.1323			

Table 2.

Source: SHAZAM output, see appendix A

Table 2 presents the regression results for the fully specified equation 1. The coefficients estimated by ordinary least squares are in the first column and the coefficient estimates from maximum likelihood estimation are in the second column. In both cases, t-statistics are in italics. With ordinary least squares estimation, the results yield a Durbin-Watson test statistic of 1.1323, failing the Durbin-Watson Test for autocorrelation. As a result, t-statisics are biased upwards and standard errors are biased downwards, rendering statistical inferences invalid. To remedy the problem, the fully specified equation (1) is re-estimated using maximum likelihood estimation.

The two estimation techniques yield similar results for the labour productivity regression equation. The model as a whole is a good fit with a high R^2 value and the ordinary least squares estimation gives a high F-statistic, indicating that the regression as a whole is significant.

Ordinary least squares coefficient estimates for the free trade indicator variable, the R&D variable and the manufacturing employment share variables are negative. The former two variables were explicitly expected to have a positive influence on GDP per worker, and the third was, at least tacitly, expected to have a similarly positive effect.

When the equation is re-estimated with maximum likelihood, the regression's fit increases slightly and the sign on the free trade indicator variable changes to the expected positive sign. However, the statistical significance of the free trade indicator variable falls when autocorrelation is adjusted for. Under both methods of estimation, the magnitudes of the individual coefficients are similar, but somewhat lower with maximum likelihood. In both sets of results, the fourth quarter is the dominant quarter.

The coefficient estimates that are least significant at the five percent level are those for the R&D and manufacturing employment share variables.

VI.1.2 Results for Deletion of Non-significant Regressors.

To deal with the statistical insignificance of the variables for R&D and manufacturing employment share, equation 1 was re-estimated without these variables using maximum likelihood estimation (see appendix A for full results). This procedure yielded a slightly lower R^2 than did the full specification and resulted in no significant change in the magnitudes or the statistical significance of the remaining variables. The one result of note is that the negative effect of the business cycle (represented by the unemployment rate of prime-aged males) is lower and more statistically significant with a lower standard error.

VI.2.3 Results Using Double-logarithmic Specification

The robustness of the fully specified regression was tested using maximum likelihood to estimate equation (1) in double-logarithmic form (see appendix A for full results). This procedure revealed that the previously reported results were wholly robust. The R^2 does not change, nor do the signs of the estimated coefficients. Using this specification, the significance of the individual coefficient estimates falls.

VI.1.4 Evaluation of Empirical Results for Labour Productivity

The reduced form equation specified for labour productivity has been largely successful in instructing us on its determination. Under linear and double-logarithmic specification, both ordinary least squares and maximum likelihood estimation indicate that the equation fit the data set well.

The time trend variable estimate had the positive sign that was expected a priori. The estimate suggests that for each quarter that passes, or for the technological change that transpires in each three-month period, GDP per worker increases by almost eighty-four dollars. The variable capturing the degree of post-secondary education in the Canadian workforce was also estimated to have the expected positive sign, but its estimate seems lower than what one would expect. It implies that for a one percent increase in the number of workers with a post-secondary education, GDP per worker rises only twenty-two dollars. While R&D was estimated to have a strong positive effect on GDP per worker, its coefficient estimate was not statistically significant at the five percent level. The insignificance of the estimate is likely due to the poor quality of the data available on R&D and other science and technology indicators. One would expect, however, that R&D indeed exerts a large positive effect on labour productivity because it creates a labour force that is both better skilled and better equipped. The most important determinant of labour productivity that emerges from the estimates is the strong positive effect of hours on GDP per worker. It suggests that for each additional hour spent on the job, the dependent variable increases by over one hundred dollars. American workers tend to work more hours per week on average than do Canadian workers and, as such, this may in part explain some of the difference between Canadian and American productivity.

The negative effect of business cycle downturns on GDP per capita is as expected in both sign and magnitude which indicates that for each percent increment in the unemployment rate of prime-aged males, GDP per worker falls by fifty-four dollars. Contrary to expectation, the Free Trade Agreement appears to have a negative effect on output per worker to the extent that the agreement has reduced the real incomes of workers by over two hundred dollars. However, this result must be qualified by noting that by the end of the sample period, 1996, the Free Trade Agreement had only been implemented for seven years, during which time the Canadian economy had gone through a particularly lengthy recession. The argument of free trade proponents has always been that free trade leads to greater productivity by capitalizing on comparative advantage in the long-run and, as such, one must be wary of interpreting the free trade estimate in this study as a failure of the Free Trade Agreement itself.

A priori, it was unclear what sign the coefficient on the manufacturing share of unemployment should assume. At one level, manufacturing industries like telecommunications make better use of technology than do some service and primary industries, and thus one expects that a labour force that is more manufacturing-oriented is more productive. As Prasad (1993) has noted, Canada's shift to service sector employment has been largely in the low-technology, low-wage areas. At another level, however, one can see that an economy that maintains a high-degree of manufacturing might be slow to adjust structurally and thus may experience poor productivity performance. While both the sign and the magnitude of the coefficient for manufacturing employment share in this study's empirical work appear to support the latter hypothesis, the estimate is not statistically significant at the five percent level.

VI.2 Regression Results for the Unemployment Rate

VI.2.1 Basic Specification Results

Variable	(1) OLS Estimation		(2) ML Estimation	
Constant	13.021	*8.869*	3.1539	*1.221*
UPAM	1.0257	*43.92*	0.82018	*17.47*
EI	-1.43E-04	*-6.266*	-9.40E-05	*-1.766*
UNION	-0.31536	*-6.51*	2.12E-02	*0.2528*
RAW	-5.82E-04	*-0.8772*	-7.43E-04	*-0.4853*
Q1	-0.44176	*-4.162*	-4.64E-02	*-0.4125*
Q2	-1.44E-02	*-0.1521*	8.63E-02	*1.363*
Q3	0.58685	*6.181*	0.44534	*7.615*
R-squared	0.9743		0.9851	
F-stat	520.832			
SEE	0.33635		0.24656	
Log L.F.	-30.0886		-2.56642	

Table 3.

Source: SHAZAM output, see appendix B.

Table 3 presents the regression results for the fully specified equation 2. The coefficients estimated by ordinary least squares are in the first column and the coefficient estimates from maximum likelihood estimation are in the second column. In both cases, t-statistics are in italics. This estimation yielded a Durbin-Watson test statistic of 0.9063, failing the Durbin-Watson test for autocorrelatation. This problem with the error term was remedied by re-estimating equation 2 with maximum likelihood.

Using ordinary least squares and maximum likelihood estimation, regression results indicate that the equation fits the data quite well with very high R^2s. However, it is disingenuous to interpret this as a truly good fit since there is likely a high degree of simultaneity from the dependent variable to the unemployment rate of prime-aged males regressor.

With respect to the individual coefficient estimates, only the unemployment rate of prime-aged males, again to proxy business cycle effects, and the raw materials price index assume the expected signs in both ordinary least squares and maximum likelihood estimation. The latter, while exerting a negative influence on the unemployment rate as expected, is not statistically significant.

A priori, it was postulated that both the generosity of unemployment insurance and the unionization rate in Canada would have a positive effect on the unemployment rate. With ordinary least squares, both coefficient estimates have negative signs and with maximum likelihood, the unemployment insurance generosity coefficient has a negative sign. Furthermore, with maximum likelihood, the statistical significance of the unionization rate coefficient falls.

The seasonal indicator coefficients indicate that unemployment is highest in the second and third quarters.

VI.2.2 Results of Re-estimation Without the Unemployment Rate of Prime-Aged Males

Variable	ML Estimation	
Constant	11.792	*2.227*
EI	-4.01E-04	*-3.667*
UNION	-9.68E-03	*-7.13E-02*
RAW	-4.89E-03	*-1.251*
Q1	1.0934	*8.067*
Q2	0.30121	*3.115*
Q3	-0.1676	*-2.328*
R-squared	0.9614	
SEE	0.39661	
Log L.F.	-53.5737	

Table 3a.

Source: Shazam output, see appendix B.

Attempting to remove the simultaneity problem, equation 2 was re-estimated omitting the unemployment rate of prime-aged males variable using maximum likelihood estimation. These results are presented in table 3a. Despite this effort, the goodness of fit measure remained high, suggesting the presence of mulitcollinearity. Furthermore, the sign on the coefficient for the unionization rate was estimated as negative and its statistical significance fell further.

These results still provide a negative sign on the generosity of unemployment insurance, contrary to economic intuition. In this set of results, the dominant quarters for unemployment appear to be the first and second quarters, with unemployment lowest in the third quarter.

VI.2.3 Results Using Double-Logarithmic Specification

Again to test the robustness of the preceding empirical work, maximum likelihood specification was employed to test the fully specified regression equation for unemployment insurance in double-logarithmic form (see appendix B for full results). The signs changed on every estimated coefficient except for unemployment insurance generosity and the statistical significance fell for each estimate. These results indicate that the above results are not robust.

VI.2.4 Evaluation of Empirical Work for the Unemployment Rate

While the results of the empirical work on the unemployment rate are disappointing, several insights should be noted. Firstly, the dependent variable is relatively stable in the face of changes to the independent variables. The magnitudes on all coefficient estimates were very small, regardless of the coefficient's sign.

The price of the raw materials variable did assume a negative sign, indicating that increases in the price of raw materials place downward pressure on the unemployment rate. In the context of our system of equations, this result suggests that as the price of raw materials increases, so does real per capita income. For an economy where commodities play an important role, this result is not surprising.

The generosity of unemployment insurance was expected to exert a positive influence on the unemployment rate. From a demand-side perspective, more benefits paid out to the unemployed indicates widespread unemployment and a low demand for workers. From a supply-side perspective, a more generous unemployment insurance scheme may provide insufficient incentives for the unemployed to take employment opportunities quickly, thus inflating the unemployment numbers. In either case, we would expect a positive sign, instead of the negative sign that was found. Clearly, the best solution to this is to find a better proxy for the generosity of the unemployment insurance system. Ideally, a statistic representing the national average eligibility for unemployment insurance would yield more insightful results. Unfortunately, such information does not yet exist.

When the initial specification was re-estimated having adjusted for autocorrelation, the coefficient for the unionization rate met expectations with a positive sign. It indicated that for a one percent increase in the unionization density of the Canadian labour force, the unemployment rate would rise only by one-fiftieth of a percent. This implies that the effect of Canada's high unionization rate on unemployment is minimal.

VI.3 Regression Results for the Participation Rate

VI.3.1 Basic Specification Results

Variable	(1) OLS Estimation		(2) ML Estimation	
Constant	25.287	*4.816*	69.339	*12.32*
WAGE	5.37E-02	*4.73*	-1.96E-02	*-2.808*
NLI	4.20E-02	*3.533*	1.60E-02	*1.52*
UPAM	-4.65E-02	*-0.3158*	-0.2413	*-2.783*
Q1	-1.6641	*-3.062*	-4.16E-02	*-0.2159*
Q2	1.4115	*3.115*	1.0251	*11.83*
Q3	3.778	*6.985*	1.671	*11.02*
R-squared	0.771		0.9875	
F-stat	54.419			
SEE	1.6061		0.36302	
Log L.F.	-193.224		-44.7844	

Table 4.

Source: SHAZAM output, see appendix C.

Table 4 presents the regression results for the fully specified equation 3. The coefficients estimated by ordinary least squares are in the first column and the coefficient estimates from maximum likelihood estimation are in the second column. In both cases, t-statistics are in italics. This estimation yielded a Durbin-Watson test statistic of 0.1594, failing the Durbin-Watson test for autocorrelatation. This problem with the error term was remedied by re-estimating equation 2 with maximum likelihood, the results of which are presented in the second column of table 3.

Ordinary least squares estimation provides a moderate fit for the regression as a whole with an R^2 value of 0.7710. Also provided by the OLS estimation are coefficient estimates for the wage variable and the unemployment rate of prime-aged males variable (to capture changes in job opportunities) that meet a priori expectations. According to the OLS results, an increase in the wage rate leads directly to an increase in the participation rate and a fall in job opportunities or the onset of a downturn leads to a fall in the participation rate.

The results do suggest, however, that non-labour income has a positive effect on the participation rate which runs contrary to what economic theory predicts. This result does not change when the equation is re-estimated using maximum likelihood where the result indicates that a dollar increase in weekly non-labour income leads to a very slight increase in the participation rate.

Estimation with maximum likelihood changes the sign on the wage coefficient to a negative sign, the opposite of that which was predicted and that which was obtained using ordinary least squares estimation. All three regressors are statistically significant at the five percent confidence level.

As with the estimation of equation 2, the high R^2 value with maximum likelihood estimation suggests some degree of multicollinearity in the system.

The second and third quarters are the dominant quarters.

VI.3.2 Results Using Double-Logarithmic Specification

The fully specified participation rate equation was re-estimated using a double-logarithmic form to test the robustness of the preceding results. The results of this process are presented in Appendix C.

The results of the linear specification hold up well using the double log specification. The coefficient estimate signs do not change, nor do their individual significance.

VI.3.3 Evaluation of Empirical Work for the Participation Rate

These results of the empirical work on the participation rate do not correspond well to a priori expectations.

That weekly wages, salaries, and other supplementary labour income per worker has a negative sign attached to its coefficient estimate implies that the labour supply curve is backward-bending. It suggests that an increase in wages causes people to reduce their labour supply such that the income effect from the higher wage dominates the substitution effect of more expensive leisure. This result is feasible if one accepts the dominance of the additional worker effect where low wages require more family members to join the labour market to assist in supporting the household.

The positive sign on the coefficient for weekly non-labour income per worker is the opposite from that which economic theory predicts. It is widely accepted that an increase in income from investment and transfers will lead to a decrease in the supply of labour. The fact that these results imply that an increase in these income sources lead to an increase in income can only be explained by the poor quality of data chosen to proxy weekly non-labour income. Because much of this data was self-generated, the results are invalid for interpretation.

The negative sign attached to the coefficient estimate for the unemployment rate of prime-aged males supports the expectation that when job opportunities are low, people withhold their labour supply. This is known as the discouraged worker effect and is supported by these results.

Finally, the seasonal variables indicate that the dominant quarters for the participation rate are the second and third quarters. This is the result that one would expect given that recent graduates enter the workforce at this time, and seasonal workers re-enter the labour market.

VII. Summary and Conclusions

The need for a deeper understanding of real per capita income and its determinants remains formidable and will likely not be satisfied at any time in the immediate future. This study has explored this measure of economic well-being and how it has fluctuated in the Canadian context over the last quarter of the twentieth century. Its growth has been lackluster and the reasons for this remain largely elusive. Based on these empirical findings, it seems that technological growth and the quality of human capital are important determinants of real per capita income and that the sluggish performance of the 1990s is due in no small part to the particularly severe recession of 1990-91.

The results of this study are by no means conclusive and they would doubtless be enhanced by using a better set of data and including additional explanatory variables. For instance, in light of the present political discourse on the issue of productivity, the inclusion of variables that reflect Canada's tax rates and regulatory structure is attractive.

Real per capita income is indeed the most important measure we have to gauge the state and progress of living standards. In an effort to better grasp this concept, this study has provided a reasonable picture of the labour productivity component, while its findings on the employment rate component are less insightful. Nonetheless, the model employed remains a reasonable one that, with adjustment, offers a useful tool by which to study real per capita income.

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Appendix A

Full Regression Results for Empirical Work Performed on Equation 1

|_*YRS=years
|_*GDP=gross domestic product
|_*WOR=number of employed persons
|_*GDW=GDP per number of employed persons
|_*TIM=time trend variable
|_*UPM=unemployment rate of prime-aged males
|_*DFT=FTA indicator variable
|_*NPS=number of persons with post-secondary education
|_*PSW=ratio of persons with a post-secondary education to number of employed persons
|_*RAD=gross expenditure on research and development as a percentage of GDP
|_*MEM=number of persons employed in manufacturing
|_*MSH=manufacturing share of employment
|_*HRS=hours worked per week
|_*Q1=quarter 1 indicator variable
|_*Q2=quarter 2 indicator variable
|_*Q3=quarter 3 indicator variable

|_*LINEAR FORM
|_*DESCRIPTIVE STATISTICS
|_STAT GDW TIM UPM DFT PSW RAD MSH HRS Q1 Q2 Q3

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
GDW	104	12756.	862.79	0.74440E+06	10998.	14673.
TIM	104	13.125	7.5416	56.875	0.25000	26.000
UPM	104	6.8010	2.5158	6.3292	2.1000	12.000
DFT	104	0.30769	0.46377	0.21509	0.00000	1.0000
PSW	104	37.577	15.100	228.01	16.000	71.000
RAD	104	1.3240	0.19218	0.36933E-01	1.0300	1.6600
MSH	104	18.228	2.5159	6.3300	14.400	22.700
HRS	104	37.551	1.0810	1.1685	36.100	40.300
Q1	104	0.25000	0.43511	0.18932	0.00000	1.0000
Q2	104	0.25000	0.43511	0.18932	0.00000	1.0000
Q3	104	0.25000	0.43511	0.18932	0.00000	1.0000

***OLS REGRESSION**

|_OLS GDW TIM UPM DFT PSW RAD MSH HRS Q1 Q2 Q3/ANOVA RSTAT COEFF=BHAT PREDICT=YHAT RESID=UHAT

REQUIRED MEMORY IS PAR= 27 CURRENT PAR= 500
OLS ESTIMATION

104 OBSERVATIONS DEPENDENT VARIABLE = GDW
...NOTE..SAMPLE RANGE SET TO: 1, 104

R-SQUARE = 0.9568 R-SQUARE ADJUSTED = 0.9522
VARIANCE OF THE ESTIMATE-SIGMA**2 = 35604.
STANDARD ERROR OF THE ESTIMATE-SIGMA = 188.69
SUM OF SQUARED ERRORS-SSE= 0.33112E+07
MEAN OF DEPENDENT VARIABLE = 12756.
LOG OF THE LIKELIHOOD FUNCTION = -686.727

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
AKAIKE (1969) FINAL PREDICTION ERROR - FPE = 39370.
(FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
AKAIKE (1973) INFORMATION CRITERION - LOG AIC = 10.580
SCHWARZ (1978) CRITERION - LOG SC = 10.860
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 39815.
HANNAN AND QUINN (1979) CRITERION = 44058.
RICE (1984) CRITERION = 40380.
SHIBATA (1981) CRITERION = 38573.
SCHWARZ (1978) CRITERION - SC = 52034.
AKAIKE (1974) INFORMATION CRITERION - AIC = 39338.

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	0.73362E+08	10.	0.73362E+07	206.051
ERROR	0.33112E+07	93.	35604.	P-VALUE
TOTAL	0.76673E+08	103.	0.74440E+06	0.000

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	0.16995E+11	11.	0.15450E+10	43393.943
ERROR	0.33112E+07	93.	35604.	P-VALUE
TOTAL	0.16998E+11	104.	0.16344E+09	0.000

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 93 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
TIM	96.046	19.50	4.926	0.000	0.455	0.8395	0.0988
UPM	-45.743	28.47	-1.607	0.111	-0.164	-0.1334	-0.0244
DFT	-352.67	124.4	-2.834	0.006	-0.282	-0.1896	-0.0085
PSW	22.149	7.100	3.120	0.002	0.308	0.3876	0.0652
RAD	-96.124	330.3	-0.2910	0.772	-0.030	-0.0214	-0.0100

MSH	-71.545	55.61	-1.286	0.201	-0.132	-0.2086	-0.1022
HRS	219.05	64.66	3.388	0.001	0.331	0.2744	0.6448
Q1	-234.23	69.20	-3.385	0.001	-0.331	-0.1181	-0.0046
Q2	-522.61	54.96	-9.508	0.000	-0.702	-0.2636	-0.0102
Q3	-267.43	68.58	-3.900	0.000	-0.375	-0.1349	-0.0052
CONSTANT	4544.4	2455.	1.851	0.067	0.189	0.0000	0.3563

DURBIN-WATSON = 1.1323 VON NEUMANN RATIO = 1.1433 RHO = 0.41533
RESIDUAL SUM = -0.68638E-10 RESIDUAL VARIANCE = 35604.
SUM OF ABSOLUTE ERRORS= 14627.
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9568
RUNS TEST: 42 RUNS, 59 POS, 0 ZERO, 45 NEG NORMAL STATISTIC = -2.0191
COEFFICIENT OF SKEWNESS = -0.3916 WITH STANDARD DEVIATION OF 0.2368
COEFFICIENT OF EXCESS KURTOSIS = -0.1947 WITH STANDARD DEVIATION OF 0.4695

GOODNESS OF FIT TEST FOR NORMALITY OF RESIDUALS - 15 GROUPS

OBSERVED	0.0	1.0	5.0	5.0	6.0	7.0	14.0	17.0	25.0	9.0	9.0	3.0	3.0	0.0	0.0
EXPECTED	0.5	1.0	2.3	4.7	8.1	12.0	15.2	16.5	15.2	12.0	8.1	4.7	2.3	1.0	0.5

CHI-SQUARE = 15.8846 WITH 2 DEGREES OF FREEDOM

***Maximum Likelihood Estimation**

|_AUTO GDW TIM UPM DFT PSW RAD MSH HRS Q1 Q2 Q3/ML

REQUIRED MEMORY IS PAR= 35 CURRENT PAR= 500

DEPENDENT VARIABLE = GDW
..NOTE..R-SQUARE,ANOVA,RESIDUALS DONE ON ORIGINAL VARS
DN OPTION IN EFFECT - DIVISOR IS N

MAXIMUM LIKELIHOOD ESTIMATION 104 OBSERVATIONS
BY COCHRANE-ORCUTT TYPE PROCEDURE WITH CONVERGENCE = 0.00100

LOG L.F. = -674.650 AT RHO = 0.49576

	ASYMPTOTIC ESTIMATE	ASYMPTOTIC VARIANCE	ASYMPTOTIC ST.ERROR	T-RATIO
RHO	0.49576	0.00725	0.08516	5.82155

R-SQUARE = 0.9659 R-SQUARE ADJUSTED = 0.9622
VARIANCE OF THE ESTIMATE-SIGMA**2 = 25171.
STANDARD ERROR OF THE ESTIMATE-SIGMA = 158.65

SUM OF SQUARED ERRORS-SSE= 0.26178E+07
MEAN OF DEPENDENT VARIABLE = 12756.
LOG OF THE LIKELIHOOD FUNCTION = -674.650

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
AKAIKE (1969) FINAL PREDICTION ERROR - FPE = 27833.
(FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
AKAIKE (1973) INFORMATION CRITERION - LOG AIC = 10.345
SCHWARZ (1978) CRITERION - LOG SC = 10.625
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 31477.
HANNAN AND QUINN (1979) CRITERION = 34832.
RICE (1984) CRITERION = 31924.
SHIBATA (1981) CRITERION = 30495.
SCHWARZ (1978) CRITERION - SC = 41138.
AKAIKE (1974) INFORMATION CRITERION - AIC = 31101.

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS
REGRESSION	0.74055E+08	10.	0.74055E+07
ERROR	0.26178E+07	104.	25171.
TOTAL	0.76673E+08	103.	0.74440E+06

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS
REGRESSION	0.16996E+11	11.	0.15451E+10
ERROR	0.26178E+07	104.	25171.
TOTAL	0.16998E+11	104.	0.16344E+09

ASYMPTOTIC
VARIABLE ESTIMATED STANDARD T-RATIO PARTIAL
STANDARDIZED ELASTICITY
NAME COEFFICIENT ERROR ------- P-VALUE CORR. COEFFICIENT AT
MEANS

TIM	83.942	24.37	3.444	0.001 0.336	0.7337	0.0864
UPM	-54.277	33.54	-1.618	0.106-0.165	-0.1583	-0.0289
DFT	-242.84	158.9	-1.528	0.127-0.156	-0.1305	-0.0059
PSW	21.935	9.956	2.203	0.028 0.223	0.3839	0.0646
RAD	139.36	379.9	0.3668	0.714 0.038	0.0310	0.0145
MSH	-49.422	68.48	-0.7217	0.470-0.075	-0.1441	-0.0706
HRS	107.37	55.08	1.950	0.051 0.198	0.1345	0.3161
Q1	-243.08	69.84	-3.480	0.001-0.339	-0.1226	-0.0048
Q2	-496.65	43.00	-11.55	0.000-0.768	-0.2505	-0.0097
Q3	-185.18	57.49	-3.221	0.001-0.317	-0.0934	-0.0036

CONSTANT 8186.0 2233. 3.666 0.000 0.355 0.0000 0.6418

***MLE OMITTING INSIGNIFICANT VARIABLES**

|_AUTO GDW TIM UPM DFT PSW HRS Q1 Q2 Q3/ML

REQUIRED MEMORY IS PAR= 33 CURRENT PAR= 500

DEPENDENT VARIABLE = GDW
..NOTE..R-SQUARE,ANOVA,RESIDUALS DONE ON ORIGINAL VARS
DN OPTION IN EFFECT - DIVISOR IS N

MAXIMUM LIKELIHOOD ESTIMATION 104 OBSERVATIONS
BY COCHRANE-ORCUTT TYPE PROCEDURE WITH CONVERGENCE = 0.00100

LOG L.F. = -674.922 AT RHO = 0.50346

	ESTIMATE	ASYMPTOTIC VARIANCE	ASYMPTOTIC ST.ERROR	ASYMPTOTIC T-RATIO
RHO	0.50346	0.00718	0.08472	5.94235

R-SQUARE = 0.9657 R-SQUARE ADJUSTED = 0.9628
VARIANCE OF THE ESTIMATE-SIGMA**2 = 25301.
STANDARD ERROR OF THE ESTIMATE-SIGMA = 159.06
SUM OF SQUARED ERRORS-SSE= 0.26313E+07
MEAN OF DEPENDENT VARIABLE = 12756.
LOG OF THE LIKELIHOOD FUNCTION = -674.922

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
AKAIKE (1969) FINAL PREDICTION ERROR - FPE = 27490.
(FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
AKAIKE (1973) INFORMATION CRITERION - LOG AIC = 10.312
SCHWARZ (1978) CRITERION - LOG SC = 10.541
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 30322.
HANNAN AND QUINN (1979) CRITERION = 33004.
RICE (1984) CRITERION = 30596.
SHIBATA (1981) CRITERION = 29680.
SCHWARZ (1978) CRITERION - SC = 37817.
AKAIKE (1974) INFORMATION CRITERION - AIC = 30081.

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS
REGRESSION	0.74042E+08	8.	0.92552E+07
ERROR	0.26313E+07	104.	25301.

TOTAL	0.76673E+08	103.	0.74440E+06

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS
REGRESSION	0.16996E+11	9.	0.18884E+10
ERROR	0.26313E+07	104.	25301.
TOTAL	0.16998E+11	104.	0.16344E+09

ASYMPTOTIC
VARIABLE ESTIMATED STANDARD T-RATIO PARTIAL
STANDARDIZED ELASTICITY
NAME COEFFICIENT ERROR ------- P-VALUE CORR. COEFFICIENT AT
MEANS

TIM	96.529	17.35	5.563	0.000	0.496	0.8438	0.0993
UPM	-35.988	21.77	-1.653	0.098	-0.167	-0.1049	-0.0192
DFT	-220.33	156.6	-1.407	0.159	-0.143	-0.1184	-0.0053
PSW	22.009	9.952	2.212	0.027	0.221	0.3852	0.0648
HRS	103.29	45.43	2.274	0.023	0.227	0.1294	0.3041
Q1	-272.61	57.54	-4.738	0.000	-0.437	-0.1375	-0.0053
Q2	-495.47	41.70	-11.88	0.000	-0.773	-0.2499	-0.0097
Q3	-166.09	49.42	-3.361	0.001	-0.326	-0.0838	-0.0033
CONSTANT	7325.9	1793.	4.086	0.000	0.387	0.0000	0.5743

|

***MLE Using Double-Logarithmic Specification**

```
|_*DOUBLE-LOG FORM
|_GENR LGDW=LOG(GDW)
|_GENR LUPM=LOG(UPM)
|_GENR LPSW=LOG(PSW)
|_GENR LRAD=LOG(RAD)
|_GENR LMSH=LOG(MSH)
|_GENR LHRS=LOG(HRS)

|_AUTO LGDW TIM LUPM DFT LPSW LRAD LMSH LHRS Q1 Q2 Q3/ML

REQUIRED MEMORY IS PAR=   35 CURRENT PAR=   500

DEPENDENT VARIABLE = LGDW
..NOTE..R-SQUARE,ANOVA,RESIDUALS DONE ON ORIGINAL VARS
DN OPTION IN EFFECT - DIVISOR IS N

MAXIMUM LIKELIHOOD ESTIMATION          104 OBSERVATIONS
BY COCHRANE-ORCUTT TYPE PROCEDURE WITH CONVERGENCE = 0.00100
```

LOG L.F. = 307.163 AT RHO = 0.50296

	ESTIMATE	ASYMPTOTIC VARIANCE	ASYMPTOTIC ST.ERROR	ASYMPTOTIC T-RATIO
RHO	0.50296	0.00718	0.08475	5.93452

R-SQUARE = 0.9645 R-SQUARE ADJUSTED = 0.9607
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.15883E-03
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.12603E-01
SUM OF SQUARED ERRORS-SSE= 0.16518E-01
MEAN OF DEPENDENT VARIABLE = 9.4515
LOG OF THE LIKELIHOOD FUNCTION = 307.163

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
AKAIKE (1969) FINAL PREDICTION ERROR - FPE = 0.17563E-03
(FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
AKAIKE (1973) INFORMATION CRITERION - LOG AIC = -8.5361
SCHWARZ (1978) CRITERION - LOG SC = -8.2564
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 0.19863E-03
HANNAN AND QUINN (1979) CRITERION = 0.21979E-03
RICE (1984) CRITERION = 0.20144E-03
SHIBATA (1981) CRITERION = 0.19243E-03
SCHWARZ (1978) CRITERION - SC = 0.25958E-03
AKAIKE (1974) INFORMATION CRITERION - AIC = 0.19625E-03

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS
REGRESSION	0.44908	10.	0.44908E-01
ERROR	0.16518E-01	104.	0.15883E-03
TOTAL	0.46560	103.	0.45204E-02

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS
REGRESSION	9290.8	11.	844.62
ERROR	0.16518E-01	104.	0.15883E-03
TOTAL	9290.8	104.	89.335

ASYMPTOTIC
VARIABLE ESTIMATED STANDARD T-RATIO PARTIAL
STANDARDIZED ELASTICITY
NAME COEFFICIENT ERROR -------- P-VALUE CORR. COEFFICIENT AT
MEANS
TIM 0.90245E-02 0.2016E-02 4.476 0.000 0.421 1.0123 0.0125

LUPM	-0.30582E-01	0.1297E-01	-2.358	0.018	-0.238	-0.1837	-0.0060
DFT	-0.92410E-02	0.1140E-01	-0.8104	0.418	-0.084	-0.0637	-0.0003
LPSW	0.15666E-01	0.3256E-01	0.4811	0.630	0.050	0.0932	0.0059
LRAD	-0.15493E-02	0.3681E-01	-0.4209E-01	0.966	-0.004	-0.0034	0.0000
LMSH	-0.82964E-01	0.8486E-01	-0.9777	0.328	-0.101	-0.1709	-0.0254
LHRS	0.40112	0.1588	2.526	0.012	0.253	0.1696	0.1539
Q1	-0.14557E-01	0.4733E-02	-3.076	0.002	-0.304	-0.0942	-0.0004
Q2	-0.38074E-01	0.3356E-02	-11.34	0.000	-0.762	-0.2464	-0.0010
Q3	-0.17940E-01	0.4786E-02	-3.748	0.000	-0.362	-0.1161	-0.0005
CONSTANT	8.1403	0.5395	15.09	0.000	0.843	0.0000	0.8613

Appendix B.

Full Regression Results for Empirical Work Performed on Equation 2

```
|_*YRS = years
|_*UER = unemployment rate
|_*UPM = unemployment rate for prime-aged males
|_*UEM = unemployed persons
|_*UI  = UI benefits paid out
|_*UIU = UI benefits paid out per unemployed person
|_*UNR = Unionization rate
|_*RRW = unstandardized price indexes for wood
|_*RAW = standardized price index for wood industries
|_*Qi  = quarter i for all i = 1, 2, 3
|_SAMPLE 1 104
|_READ YRS UER UPM UEM UI UIU UNR RRW RAW Q1 Q2 Q3
  12 VARIABLES AND    104 OBSERVATIONS STARTING AT OBS     1

|_*LINEAR FORM
|_*DESCRIPTIVE STATISTICS
|_STAT UER UPM UIU UNR RAW
```

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
UER	104	8.7058	2.0273	4.1099	4.9000	13.800
UPM	104	6.8010	2.5158	6.3292	2.1000	12.000
UIU	104	6855.7	3009.2	0.90553E+07	335.00	12121.
UNR	104	32.296	1.0104	1.0210	30.500	33.600
RAW	104	268.59	99.341	9868.6	93.500	483.90

***OLS Estimation**

```
|_OLS UER UPM UIU UNR RAW Q1 Q2 Q3/ANOVA RSTAT COEFF=BHAT
PREDICT=YHAT RESID=UHAT

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  500
 OLS ESTIMATION
    104 OBSERVATIONS    DEPENDENT VARIABLE = UER
...NOTE..SAMPLE RANGE SET TO:     1,    104

 R-SQUARE =  0.9743    R-SQUARE ADJUSTED =  0.9725
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.11313
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.33635
SUM OF SQUARED ERRORS-SSE=   10.861
MEAN OF DEPENDENT VARIABLE =   8.7058
LOG OF THE LIKELIHOOD FUNCTION = -30.0886
```

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
AKAIKE (1969) FINAL PREDICTION ERROR - FPE = 0.12183
(FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
AKAIKE (1973) INFORMATION CRITERION - LOG AIC = -2.1054
SCHWARZ (1978) CRITERION - LOG SC = -1.9020
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 0.12256
HANNAN AND QUINN (1979) CRITERION = 0.13226
RICE (1984) CRITERION = 0.12342
SHIBATA (1981) CRITERION = 0.12049
SCHWARZ (1978) CRITERION - SC = 0.14927
AKAIKE (1974) INFORMATION CRITERION - AIC = 0.12180

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	412.46	7.	58.922	520.832
ERROR	10.861	96.	0.11313	P-VALUE
TOTAL	423.32	103.	4.1099	0.000

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	8294.7	8.	1036.8	9164.873
ERROR	10.861	96.	0.11313	P-VALUE
TOTAL	8305.5	104.	79.861	0.000

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 96 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
UPM	1.0257	0.2335E-01	43.92	0.000	0.976	1.2728	0.8013
UIU	-0.14331E-03	0.2287E-04	-6.266	0.000	-0.539	-0.2127	-0.1129
UNR	-0.31536	0.4844E-01	-6.510	0.000	-0.553	-0.1572	-1.1699
RAW	-0.58234E-03	0.6639E-03	-0.8772	0.383	-0.089	-0.0285	-0.0180
Q1	-0.44176	0.1061	-4.162	0.000	-0.391	-0.0948	-0.0127
Q2	-0.14411E-01	0.9474E-01	-0.1521	0.879	-0.016	-0.0031	-0.0004
Q3	0.58685	0.9494E-01	6.181	0.000	0.534	0.1260	0.0169
CONSTANT	13.021	1.468	8.869	0.000	0.671	0.0000	1.4957

DURBIN-WATSON = 0.9063 VON NEUMANN RATIO = 0.9151 RHO = 0.54464
RESIDUAL SUM = -0.27067E-12 RESIDUAL VARIANCE = 0.11313
SUM OF ABSOLUTE ERRORS= 25.124
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9743
RUNS TEST: 38 RUNS, 57 POS, 0 ZERO, 47 NEG NORMAL STATISTIC = -2.8883

COEFFICIENT OF SKEWNESS = -0.8857 WITH STANDARD DEVIATION OF 0.2368
COEFFICIENT OF EXCESS KURTOSIS = 1.7145 WITH STANDARD DEVIATION OF 0.4695

GOODNESS OF FIT TEST FOR NORMALITY OF RESIDUALS - 12 GROUPS
OBSERVED 2.0 1.0 5.0 6.0 10.0 23.0 27.0 18.0 9.0 2.0 1.0 0.0
EXPECTED 0.6 1.7 4.6 9.6 15.6 19.9 19.9 15.6 9.6 4.6 1.7 0.6
CHI-SQUARE = 12.3220 WITH 2 DEGREES OF FREEDOM

***Maximum Likelihood Estimation**

|_AUTO UER UPM UIU UNR RAW Q1 Q2 Q3/ML

REQUIRED MEMORY IS PAR= 27 CURRENT PAR= 500

DEPENDENT VARIABLE = UER
..NOTE..R-SQUARE,ANOVA,RESIDUALS DONE ON ORIGINAL VARS
DN OPTION IN EFFECT - DIVISOR IS N

MAXIMUM LIKELIHOOD ESTIMATION 104 OBSERVATIONS
BY COCHRANE-ORCUTT TYPE PROCEDURE WITH CONVERGENCE = 0.00100

LOG L.F. = -2.56642 AT RHO = 0.84038

		ASYMPTOTIC	ASYMPTOTIC	ASYMPTOTIC
	ESTIMATE	VARIANCE	ST.ERROR	T-RATIO
RHO	0.84038	0.00282	0.05315	15.81200

R-SQUARE = 0.9851 R-SQUARE ADJUSTED = 0.9840
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.60792E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.24656
SUM OF SQUARED ERRORS-SSE= 6.3223
MEAN OF DEPENDENT VARIABLE = 8.7058
LOG OF THE LIKELIHOOD FUNCTION = -2.56642

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
AKAIKE (1969) FINAL PREDICTION ERROR - FPE = 0.65468E-01
(FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
AKAIKE (1973) INFORMATION CRITERION - LOG AIC = -2.6465
SCHWARZ (1978) CRITERION - LOG SC = -2.4430
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 0.71346E-01
HANNAN AND QUINN (1979) CRITERION = 0.76993E-01

RICE (1984) CRITERION = 0.71845E-01
SHIBATA (1981) CRITERION = 0.70144E-01
SCHWARZ (1978) CRITERION - SC = 0.86896E-01
AKAIKE (1974) INFORMATION CRITERION - AIC = 0.70902E-01

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS
REGRESSION	416.99	7.	59.571
ERROR	6.3223	104.	0.60792E-01
TOTAL	423.32	103.	4.1099

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS
REGRESSION	8299.2	8.	1037.4
ERROR	6.3223	104.	0.60792E-01
TOTAL	8305.5	104.	79.861

ASYMPTOTIC
VARIABLE ESTIMATED STANDARD T-RATIO PARTIAL
STANDARDIZED ELASTICITY
NAME COEFFICIENT ERROR ------- P-VALUE CORR. COEFFICIENT AT
MEANS

UPM	0.82018	0.4694E-01	17.47	0.000	0.872	1.0178	0.6407
UIU	-0.93906E-04	0.5317E-04	-1.766	0.077	-0.177	-0.1394	-0.0739
UNR	0.21185E-01	0.8379E-01	0.2528	0.800	0.026	0.0106	0.0786
RAW	-0.74337E-03	0.1532E-02	-0.4853	0.627	-0.049	-0.0364	-0.0229
Q1	-0.46359E-01	0.1124	-0.4125	0.680	-0.042	-0.0099	-0.0013
Q2	0.86348E-01	0.6333E-01	1.363	0.173	0.138	0.0185	0.0025
Q3	0.44534	0.5848E-01	7.615	0.000	0.614	0.0956	0.0128
CONSTANT	3.1539	2.583	1.221	0.222	0.124	0.0000	0.3623

MLE, Omitting UPM

|_AUTO UER UIU UNR RAW Q1 Q2 Q3/ML

REQUIRED MEMORY IS PAR= 26 CURRENT PAR= 500

DEPENDENT VARIABLE = UER
..NOTE..R-SQUARE,ANOVA,RESIDUALS DONE ON ORIGINAL VARS
DN OPTION IN EFFECT - DIVISOR IS N

MAXIMUM LIKELIHOOD ESTIMATION 104 OBSERVATIONS
BY COCHRANE-ORCUTT TYPE PROCEDURE WITH CONVERGENCE = 0.00100

LOG L.F. = -53.5737 AT RHO = 0.99364

	ESTIMATE	ASYMPTOTIC VARIANCE	ASYMPTOTIC ST.ERROR	ASYMPTOTIC T-RATIO
RHO	0.99364	0.00012	0.01104	90.02025

R-SQUARE = 0.9614 R-SQUARE ADJUSTED = 0.9590
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.15730
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.39661
SUM OF SQUARED ERRORS-SSE= 16.359
MEAN OF DEPENDENT VARIABLE = 8.7058
LOG OF THE LIKELIHOOD FUNCTION = -53.5737

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
AKAIKE (1969) FINAL PREDICTION ERROR - FPE = 0.16788
(FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
AKAIKE (1973) INFORMATION CRITERION - LOG AIC = -1.7150
SCHWARZ (1978) CRITERION - LOG SC = -1.5370
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 0.18082
HANNAN AND QUINN (1979) CRITERION = 0.19342
RICE (1984) CRITERION = 0.18177
SHIBATA (1981) CRITERION = 0.17847
SCHWARZ (1978) CRITERION - SC = 0.21502
AKAIKE (1974) INFORMATION CRITERION - AIC = 0.17996

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS
REGRESSION	406.96	6.	67.826
ERROR	16.359	104.	0.15730
TOTAL	423.32	103.	4.1099

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS
REGRESSION	8289.2	7.	1184.2
ERROR	16.359	104.	0.15730
TOTAL	8305.5	104.	79.861

ASYMPTOTIC
VARIABLE ESTIMATED STANDARD T-RATIO PARTIAL
STANDARDIZED ELASTICITY
NAME COEFFICIENT ERROR -------- P-VALUE CORR. COEFFICIENT AT
MEANS
UIU -0.40067E-03 0.1093E-03 -3.667 0.000-0.349 -0.5947 -0.3155
UNR -0.96796E-02 0.1358 -0.7130E-01 0.943-0.007 -0.0048 -0.0359

RAW	-0.40006E-02	0.3198E-02	-1.251	0.211	-0.126	-0.1960	-0.1234
Q1	1.0934	0.1355	8.067	0.000	0.634	0.2347	0.0314
Q2	0.30121	0.9671E-01	3.115	0.002	0.302	0.0646	0.0086
Q3	-0.16760	0.7199E-01	-2.328	0.020	-0.230	-0.0360	-0.0048
CONSTANT	11.792	5.296	2.227	0.026	0.221	0.0000	1.3545

***MLE Using Double Logarithmic Specification**

```
|_*DOUBLE-LOG FORM
|_GENR LUER=LOG(UER)
|_GENR LUPM=LOG(UPM)
|_GENR LUIU=LOG(UIU)
|_GENR LUNR=LOG(UNR)
|_GENR LRAW=LOG(RAW)


|_AUTO LUER LUPM LUIU LUNR LRAW Q1 Q2 Q3/ML

 REQUIRED MEMORY IS PAR=    27 CURRENT PAR=   500

 DEPENDENT VARIABLE =  LUER
 ..NOTE..R-SQUARE,ANOVA,RESIDUALS DONE ON ORIGINAL VARS
 DN OPTION IN EFFECT - DIVISOR IS N

 MAXIMUM LIKELIHOOD ESTIMATION          104 OBSERVATIONS
 BY COCHRANE-ORCUTT TYPE PROCEDURE WITH CONVERGENCE = 0.00100

LOG L.F. =   204.347      AT RHO =    0.91377

                 ASYMPTOTIC  ASYMPTOTIC  ASYMPTOTIC
        ESTIMATE   VARIANCE   ST.ERROR   T-RATIO
 RHO      0.91377    0.00159    0.03983   22.93993

  R-SQUARE =   0.9804    R-SQUARE ADJUSTED =   0.9789
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.11307E-02
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.33625E-01
 SUM OF SQUARED ERRORS-SSE=  0.11759
 MEAN OF DEPENDENT VARIABLE =   2.1360
 LOG OF THE LIKELIHOOD FUNCTION =  204.347

 MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
  AKAIKE (1969) FINAL PREDICTION ERROR - FPE =      0.12176E-02
    (FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
  AKAIKE (1973) INFORMATION CRITERION - LOG AIC =  -6.6311
  SCHWARZ (1978) CRITERION - LOG SC =          -6.4277
 MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
```

CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 0.13270E-02
HANNAN AND QUINN (1979) CRITERION = 0.14320E-02
RICE (1984) CRITERION = 0.13363E-02
SHIBATA (1981) CRITERION = 0.13046E-02
SCHWARZ (1978) CRITERION - SC = 0.16162E-02
AKAIKE (1974) INFORMATION CRITERION - AIC = 0.13187E-02

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS
REGRESSION	5.8684	7.	0.83834
ERROR	0.11759	104.	0.11307E-02
TOTAL	5.9860	103.	0.58116E-01

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS
REGRESSION	480.37	8.	60.046
ERROR	0.11759	104.	0.11307E-02
TOTAL	480.49	104.	4.6201

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	T-RATIO --------	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
LUPM	0.47063	0.3522E-01	13.36	0.000	0.806	0.7883	0.4058
LUIU	-0.80189E-01	0.3131E-01	-2.561	0.010	-0.253	-0.1950	-0.3267
LUNR	0.19867	0.3731	0.5325	0.594	0.054	0.0259	0.3232
LRAW	0.66054E-01	0.6979E-01	0.9465	0.344	0.096	0.1091	0.1707
Q1	0.35034E-01	0.1184E-01	2.959	0.003	0.289	0.0632	0.0041
Q2	0.19007E-01	0.7764E-02	2.448	0.014	0.242	0.0343	0.0022
Q3	0.46100E-01	0.8091E-02	5.698	0.000	0.503	0.0832	0.0054
CONSTANT	0.87205	1.258	0.6930	0.488	0.071	0.0000	0.4083

Appendix C.

Full Regression Results for Empirical Work Performed on Equation 3

```
|_*YRS=YEARS
|_*PAR=PARTICIPATION RATE
|_*EARNERS=NUMBER OF PEOPLE WITH INCOMES
|_*WORK=NUMBER OF WORKERS
|_*AGGINC=CANADIAN AGGREGATE PERSONAL INCOME FOR
INDIVIDUALS
|_*AVGINC=CANADIAN AGGREGATE PERSONAL INCOME FOR
INDIVIDUALS WITH INCOMES
|_*PWS=PROPORTION OF PERSONAL INCOME COMING FROM WAGES AND
SALARIES
|_*AGGWS=NATIONAL INCOME DUE TO WAGES, SALARIES, AND
SUPPLEMENTAL LABOUR INCOME
|_*WWS=PER CAPITA NATIONAL INCOME DUE TO WAGES SALARIES AND
SUPPLEMENTAL LABOUR INCOME
|_*WWS1=WEEKLY WAGES AND SALARIES DUE TO PERSONAL INCOME
|_*PNLI=PROPORTION OF PERSONAL INCOME COMING FROM NON-LABOUR
SOURCES
|_*WNLI=WEEKLY NON-LABOUR INCOME DUE TO PERSONAL INCOME
|_*NLI=NON-LABOUR INCOME
|_*UPM=UNEMPLOYMENT RATE OF PRIME-AGED MALES
|_SAMPLE 1 104
|_READ YRS PAR EARNERS WORK AGGINC AVGINC PWS AGGWS WWS
WWS1 PNLI WNLI NLI UPM Q1 Q2 Q3
  17 VARIABLES AND     104 OBSERVATIONS STARTING AT OBS      1


|_*DESCRIPTIVE STATISTICS
|_STAT PAR WWS NLI UPM
```

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
PAR	104	63.968	3.2568	10.607	54.700	68.900
WWS	104	561.53	26.837	720.24	476.70	606.60
NLI	104	193.29	39.116	1530.0	118.40	257.20
UPM	104	6.8010	2.5158	6.3292	2.1000	12.000

***OLS Estimation**

```
|_OLS PAR WWS NLI UPM Q1 Q2 Q3/ANOVA RSTAT COEFF=BHAT
PREDICT=YHAT RESID=UHAT

 REQUIRED MEMORY IS PAR=    24 CURRENT PAR=   500
  OLS ESTIMATION
```

104 OBSERVATIONS DEPENDENT VARIABLE = PAR
...NOTE..SAMPLE RANGE SET TO: 1, 104

R-SQUARE = 0.7710 R-SQUARE ADJUSTED = 0.7568
VARIANCE OF THE ESTIMATE-SIGMA**2 = 2.5797
STANDARD ERROR OF THE ESTIMATE-SIGMA = 1.6061
SUM OF SQUARED ERRORS-SSE= 250.23
MEAN OF DEPENDENT VARIABLE = 63.968
LOG OF THE LIKELIHOOD FUNCTION = -193.224

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
AKAIKE (1969) FINAL PREDICTION ERROR - FPE = 2.7533
(FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
AKAIKE (1973) INFORMATION CRITERION - LOG AIC = 1.0126
SCHWARZ (1978) CRITERION - LOG SC = 1.1906
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 2.7658
HANNAN AND QUINN (1979) CRITERION = 2.9586
RICE (1984) CRITERION = 2.7803
SHIBATA (1981) CRITERION = 2.7299
SCHWARZ (1978) CRITERION - SC = 3.2890
AKAIKE (1974) INFORMATION CRITERION - AIC = 2.7527

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	842.30	6.	140.38	54.419
ERROR	250.23	97.	2.5797	P-VALUE
TOTAL	1092.5	103.	10.607	0.000

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	0.42640E+06	7.	60915.	23613.562
ERROR	250.23	97.	2.5797	P-VALUE
TOTAL	0.42665E+06	104.	4102.4	0.000

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 97 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
WWS	0.53730E-01	0.1136E-01	4.730	0.000	0.433	0.4427	0.4717
NLI	0.41496E-01	0.1174E-01	3.533	0.001	0.338	0.4984	0.1254
UPM	-0.46530E-01	0.1473	-0.3158	0.753	-0.032	-0.0359	-0.0049
Q1	-1.6641	0.5435	-3.062	0.003	-0.297	-0.2223	-0.0065
Q2	1.4115	0.4531	3.115	0.002	0.302	0.1886	0.0055

Q3	3.4778	0.4979	6.985	0.000	0.578	0.4646	0.0136
CONSTANT	25.287	5.251	4.816	0.000	0.439	0.0000	0.3953

DURBIN-WATSON = 0.1594 VON NEUMANN RATIO = 0.1609 RHO = 0.92337
RESIDUAL SUM = -0.20428E-12 RESIDUAL VARIANCE = 2.5797
SUM OF ABSOLUTE ERRORS= 145.22
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.7710
RUNS TEST: 5 RUNS, 57 POS, 0 ZERO, 47 NEG NORMAL STATISTIC = -9.4531
COEFFICIENT OF SKEWNESS = -0.1742 WITH STANDARD DEVIATION OF 0.2368
COEFFICIENT OF EXCESS KURTOSIS = -1.2874 WITH STANDARD DEVIATION OF 0.4695

GOODNESS OF FIT TEST FOR NORMALITY OF RESIDUALS - 10 GROUPS
OBSERVED 0.0 2.0 9.0 27.0 9.0 20.0 28.0 9.0 0.0 0.0
EXPECTED 0.9 2.9 8.2 16.6 23.5 23.5 16.6 8.2 2.9 0.9
CHI-SQUARE = 28.9305 WITH 1 DEGREES OF FREEDOM

***Maximum Likelihood Estimation**

|_AUTO PAR WWS NLI UPM Q1 Q2 Q3/ML

REQUIRED MEMORY IS PAR= 26 CURRENT PAR= 500

DEPENDENT VARIABLE = PAR
..NOTE..R-SQUARE,ANOVA,RESIDUALS DONE ON ORIGINAL VARS
DN OPTION IN EFFECT - DIVISOR IS N

MAXIMUM LIKELIHOOD ESTIMATION 104 OBSERVATIONS
BY COCHRANE-ORCUTT TYPE PROCEDURE WITH CONVERGENCE = 0.00100

LOG L.F. = -44.7844 AT RHO = 0.99723

	ESTIMATE	ASYMPTOTIC VARIANCE	ASYMPTOTIC ST.ERROR	ASYMPTOTIC T-RATIO
RHO	0.99723	0.00005	0.00729	136.77438

R-SQUARE = 0.9875 R-SQUARE ADJUSTED = 0.9867
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.13178
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.36302
SUM OF SQUARED ERRORS-SSE= 13.705
MEAN OF DEPENDENT VARIABLE = 63.968
LOG OF THE LIKELIHOOD FUNCTION = -44.7844

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)

```
 AKAIKE (1969) FINAL PREDICTION ERROR - FPE =    0.14065
   (FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
 AKAIKE (1973) INFORMATION CRITERION - LOG AIC =  -1.8920
 SCHWARZ (1978) CRITERION - LOG SC =          -1.7140
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
 CRAVEN-WAHBA (1979)
   GENERALIZED CROSS VALIDATION - GCV =       0.15149
 HANNAN AND QUINN (1979) CRITERION =          0.16204
 RICE (1984) CRITERION =                 0.15228
 SHIBATA (1981) CRITERION =                0.14952
 SCHWARZ (1978) CRITERION - SC =              0.18014
 AKAIKE (1974) INFORMATION CRITERION - AIC =    0.15077

                ANALYSIS OF VARIANCE - FROM MEAN
                 SS          DF          MS
REGRESSION        1078.8        6.       179.80
ERROR          13.705      104.     0.13178
TOTAL          1092.5      103.      10.607

                ANALYSIS OF VARIANCE - FROM ZERO
                 SS          DF          MS
REGRESSION      0.42664E+06     7.       60949.
ERROR          13.705      104.     0.13178
TOTAL        0.42665E+06   104.      4102.4


                       ASYMPTOTIC
VARIABLE  ESTIMATED  STANDARD  T-RATIO      PARTIAL
STANDARDIZED ELASTICITY
 NAME   COEFFICIENT  ERROR   ------  P-VALUE CORR. COEFFICIENT  AT
MEANS
WWS     -0.19577E-01 0.6972E-02  -2.808    0.005-0.274   -0.1613    -0.1719
NLI     0.16038E-01 0.1055E-01   1.520    0.129 0.153    0.1926    0.0485
UPM     -0.24130    0.8671E-01  -2.783    0.005-0.272   -0.1864   -0.0257
Q1      -0.41616E-01 0.1928     -0.2159    0.829-0.022   -0.0056   -0.0002
Q2       1.0251    0.8664E-01   11.83    0.000 0.769    0.1369    0.0040
Q3       1.6710    0.1517       11.02    0.000 0.745    0.2232    0.0065
CONSTANT  69.339    5.627       12.32    0.000 0.781    0.0000    1.0840
```

***MLE Using Double-Logarithmic Specification**

```
|_*DOUBLE-LOG FORM
|_GENR LPAR=LOG(PAR)
|_GENR LWWS=LOG(WWS)
|_GENR LNLI=LOG(NLI)
|_GENR LUPM=LOG(UPM)
```

```
|_AUTO LPAR LWWS LNLI LUPM Q1 Q2 Q3/ML

REQUIRED MEMORY IS PAR=    30 CURRENT PAR=   500

DEPENDENT VARIABLE =  LPAR
..NOTE..R-SQUARE,ANOVA,RESIDUALS DONE ON ORIGINAL VARS
DN OPTION IN EFFECT - DIVISOR IS N

MAXIMUM LIKELIHOOD ESTIMATION          104 OBSERVATIONS
BY COCHRANE-ORCUTT TYPE PROCEDURE WITH CONVERGENCE = 0.00100

LOG L.F. =    384.437      AT RHO =     0.99746

               ASYMPTOTIC  ASYMPTOTIC  ASYMPTOTIC
        ESTIMATE    VARIANCE    ST.ERROR    T-RATIO
RHO       0.99746    0.00005     0.00699  142.68721

R-SQUARE =   0.9874     R-SQUARE ADJUSTED =   0.9866
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.34255E-04
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.58528E-02
SUM OF SQUARED ERRORS-SSE=  0.35625E-02
MEAN OF DEPENDENT VARIABLE =   4.1571
LOG OF THE LIKELIHOOD FUNCTION =  384.437

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
 AKAIKE (1969) FINAL PREDICTION ERROR - FPE =     0.36561E-04
   (FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
 AKAIKE (1973) INFORMATION CRITERION - LOG AIC =  -10.147
 SCHWARZ (1978) CRITERION - LOG SC =           -9.9691
MODEL SELECTION TESTS - SEE RAMANATHAN (1992,P.167)
 CRAVEN-WAHBA (1979)
   GENERALIZED CROSS VALIDATION - GCV =         0.39377E-04
 HANNAN AND QUINN (1979) CRITERION =           0.42121E-04
 RICE (1984) CRITERION =                      0.39583E-04
 SHIBATA (1981) CRITERION =                    0.38866E-04
 SCHWARZ (1978) CRITERION - SC =                0.46826E-04
 AKAIKE (1974) INFORMATION CRITERION - AIC =     0.39191E-04

                  ANALYSIS OF VARIANCE - FROM MEAN
                     SS          DF          MS
REGRESSION      0.27974         6.      0.46623E-01
ERROR         0.35625E-02     104.      0.34255E-04
TOTAL           0.28330       103.      0.27505E-02

                  ANALYSIS OF VARIANCE - FROM ZERO
```

```
                SS        DF          MS
REGRESSION       1797.5        7.       256.79
ERROR          0.35625E-02  104.     0.34255E-04
TOTAL            1797.5      104.     17.284


                   ASYMPTOTIC
VARIABLE  ESTIMATED STANDARD  T-RATIO      PARTIAL
STANDARDIZED ELASTICITY
 NAME   COEFFICIENT  ERROR  -------  P-VALUE CORR. COEFFICIENT  AT
MEANS
LWWS    -0.11413    0.6435E-01  -1.774    0.076-0.177   -0.1068   -0.1738
LNLI    0.33522E-01 0.2953E-01  1.135    0.256 0.114    0.1369    0.0423
LUPM    -0.29066E-01 0.6517E-02 -4.460    0.000-0.412   -0.2238   -0.0129
Q1     -0.12496E-02 0.2180E-02 -0.5732   0.567-0.058   -0.0104   -0.0001
Q2      0.16811E-01 0.1388E-02  12.11    0.000 0.776    0.1395    0.0010
Q3      0.26044E-01 0.2205E-02  11.81    0.000 0.768    0.2161    0.0016
CONSTANT  4.6917    0.3529     13.29    0.000 0.804    0.0000    1.1286
|_STOP
```