A Sectoral Analysis of Labour's Share of Income in Canada

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First Version: November 2005
Latest Version: May 2006
Preliminary Version — Do not quote
Comments are welcome

Abstract

From 1998 to 2004, Canadian aggregate labour's share of income, *i.e.* the ratio of total labour compensation to GDP, has declined considerably, reaching levels even below previous troughs. This study is an attempt to better understand the fluctuations observed in labour's share of income over time. By analyzing its evolution across 18 broad sectors of the Canadian economy, we find that the increase in commodity prices observed over the recent years has contributed substantially to declining aggregate labour's share of income, operating through a sectoral bias. Moreover, results coming from the estimation of a panel data error-correction model of labour's share of income for 19 Canadian manufacturing sectors reveal that movements in labour's share are affected by fluctuations in labour productivity, openness to trade and union density. Finally, deviations of labour's share of income from its long-run equilibrium are not very persistent and are strongly counter-cyclical.

*The author would like to acknowledge Richard Dion, Bob Fay, Frédérick Demers, Russel Barnett and Sylvain Martel for their precious input on this document. The views expressed in this study are those of the author. No responsibility for them should be attributed to the Bank of Canada.

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1 Introduction

In a well-known exercise, Kaldor (1961) presents some stylized facts about the United States economy. One of them argues that the shares of labour and capital in the national income are roughly constant over time. This statement is generally seen as a good approximation of the United States economic process. However, in many other countries, labour's share of income, *i.e.* the ratio of total labour compensation to aggregate value added, has fluctuated greatly over the last four decades, which contradicts Kaldor's stylized fact. In particular, in Canada, labour's share of income has dropped as much as 6 percentage points from 1990 to 2004.

The goal of this study is to improve our understanding of labour's share of income in Canada. In particular, it proposes answers to the following questions:

- How should labour's share of income be measured correctly?
- How did aggregate labour's share of income fluctuate in Canada over the last 45 years?
- Was the drop observed in aggregate labour's share of income from 1998 to 2004 in Canada caused or amplified by sectoral composition biases?
- What are the long-run determinants of labour's share of income in the Canadian manufacturing sector and its subsectors?
- How does labour's share of income behave over the business cycle?

To answer these questions, this study reviews different measures of labour's share of income and discusses their relative merits. Mismeasured labour's share of income can exhibit a completely different dynamic than the actual labour's share, making any analysis thereof necessarily flawed.

This study also computes labour's share of income for 18 broad sectors of the Canadian economy from 1961 to 2004. This exercise allows us to analyze the impact of sectoral composition on fluctuations in aggregate labour's share of income. In particular, it decomposes the decline observed in aggregate labour's share from 1998 to 2004 to understand whether or not sectoral composition biases has contributed to the decline.

Moreover, this study develops an error-correction model (ECM) of labour's share of income using a Canadian panel data set of 26 years and 19 manufacturing subsectors. An ECM captures both the long-run dynamics of labour's share of income as well as short-run deviations from its equilibrium path.

The main results of this study are the following:

- From 1998 to 2004, the strong increase in commodity prices created a sectoral bias which contributed substantially to the decline of aggregate labour's share of income. After controlling for this bias, labour's share of income exhibits a relatively constant profile over that period.
- In the long-run, labour's share of income is affected negatively by labour productivity and openness to trade and positively by union density. These results are consistent with the existing literature.
- Deviations of labour's share of income from its long-run equilibrium path are not very persistent and are strongly counter-cyclical.

This study is organized as follows. Section 2 discusses different issues in the measurement of labour's share of income. Section 3 describes the evolution of aggregate labour's share of income. Section 4 presents labour's share of income for 18 sectors of the Canadian economy. Section 5 deals with the possibility of sectoral composition bias in aggregate labour's share of income. Section 6 presents an empirical investigation of the long-run and short-run determinants of labour's share of income in the Canadian manufacturing sector. Section 7 discusses the cyclical behaviour of labour's share of income. Finally, section 8 concludes.

2 How is Labour's Share of Income Measured?

Despite the great deal of research about the way labour's share of income should properly be measured[1], there is no clear consensus in the literature. However, a widely-accepted, but somewhat broad definition of labour's share of income consists in the ratio of total labour compensation of workers to aggregate value added, both measured in nominal terms:

$$\text{Labour's share of income} = \frac{\text{total labour compensation}}{\text{aggregate value added}} \tag{1}$$

Although equation (1) looks rather simple to compute, the debate surrounding the measurement of labour's share concerns what should – or should not – be included in the definition of both the numerator and the denominator.

2.1 The System of National Accounts

Within the system of national accounts, the measurement of a country's total production could be achieved by either summing up factor (capital and labour) incomes or final expenditures ($C + I + G + X - M$). This study focuses on the income approach of national accounts, *i.e.* value added being the sum of these six sources of income[2]:

A. *Labour income* (wages and salaries + supplementary labour income):
All earnings from employment paid for work performed, before any deductions (including income taxes), plus employer's contributions to pension funds, social insurance and other benefits. This aggregate also includes military pay, commissions, tips and bonuses.

B. *Profits before taxes*:
Net earnings from either corporations or government business enterprises, measured net of depreciation.

C. *Net interest income*:
Interest and miscellaneous investment income received by persons, excluding dividends.

[1] In particular, see Krueger (1999), Gollin (2002), Daudey (2003) and Gomme and Rupert (2004).
[2] See Statistics Canada (1990), pp. 38-39.

D. *Net income from unincorporated business* (farm and non-farm – including rent): Net earnings of unincorporated proprietors from their own business. Adjustments are made in order to include a measure of imputed rents and to remove depreciation from net earnings. This category comprises independent workers such as lawyers, dentists, engineers, doctors and also farmers.

E. *Indirect taxes less subsidies*:
All taxes which represent a business cost and are usually reflected in market prices (sales and excise taxes, import duties and property taxes) less all government subsidies to firms.

F. *Depreciation*:
Also known as *Capital consumption allowances*, it represents all allowances for the wear and tear of physical capital in the productive process.

Measuring labour's share of income consists primarily in determining which of these sources of income should be attributed (partly or totally) to labour and/or capital. In this context, labour income should unambiguously be attributed to the factor of production "Labour"; profits, net interest income and depreciation to "Capital". As for the unincorporated business income, since self-employed workers use both capital and labour in their production process, their income should be allocated between the two factors of production (see next section). Taxes and subsidies are discussed in more depth in section 2.4.

2.2 The Treatment of Unincorporated Business Income

As shown in Figure 1, the proportion of Canadian workers who are self-employed fluctuates greatly over time, increasing from about 12 per cent in 1976 to about 17 per cent in 1998, before coming back to lower levels recently. According to Kamhi and Leung (2005), the cyclicality of the self-employment rate cannot explain the upward trend observed in this series since the mid-1970s. Instead, they argue that industry-specific factors played an important role in these fluctuations.

Table 1 points out the wide dispersion of self-employment rates across industries. Sectors like agriculture and construction traditionally exhibit high self-employment rates while manufacturing and most public sectors (education, health care and public administration) traditionally exhibit low rates. It is noteworthy that the number of self-employed workers in the financial sector doubled over the last 15 years. Moreover, despite the fact that only 6 per cent of all self-employed in Canada were working in that sector in 2004, they were responsible for about 43 per cent of all unincorporated business income earned in Canada.

Given the quantitative importance of self-employment in Canada (around 14 to 17 per cent of the workforce), proprietors' income must absolutely be included in the calculation of labour's share of income; if not, the calculated measure will be underestimated. Also, as shown in Table 1, it is even more crucial to include unincorporated business income in the case of some industries, in which the rate of self-employment is high.

Figure 1: Self-Employment Rate – Canada – 1976-2004

Source: Labour Force Survey, Statistics Canada

In order to allocate proprietors' income between labour and capital, Gollin (2002) develops three adjusted measures of labour's share of income. These measures build on a measure of raw labour's share (sometimes called *Compensation share*), which omits the labour income of the self-employed:[3]

$$\text{Raw labour's share of income} = \frac{\text{labour income}}{\text{aggregate value added}} \tag{2}$$

As mentioned above, equation (2) systematically understates labour's share of income. However, some studies, such as Daudey (2003) and Daudey and García Peñalosa (2004), use this raw measure of labour's share of income to analyze the factor income distribution within the manufacturing sector, a sector for which the number of self-employed is generally low (and therefore, the underestimation is a minor concern).

Gollin's first proposed measure attributes the totality of the self-employed workers' income to labour:

$$\text{Labour's share of income} = \frac{\text{labour income} + \text{uninc. bus. income}}{\text{aggregate value added}} \tag{3}$$

Although equation (3) has the benefit to be straightforward to compute, it overstates labour's share of income by assuming that the output of unincorporated firms is being produced using only pure labour services (*i.e.* produced without any capital).

Gollin then proposes a measure that allows the proprietors' income to be allocated between labour and capital. Gollin's second adjusted measure assumes the same mix

[3]For now, the denominator is labelled *aggregate value added*, but will be discussed more deeply in sections 2.3 and 2.4.

of labour and capital income than the rest of the economy (or the specific industry):

$$\text{Labour's share of income} = \frac{\text{labour income}}{\text{aggregate value added} - \text{uninc. bus. income}} \tag{4}$$

In equation (4), the unincorporated business income is being subtracted from the value added, so that labour's share of income is calculated only for the incorporated part of the economy (private and public). Hidden in its simplicity is the problem that equation (4) "implicitly assumes that income shares are the same for establishments that differ significantly in size and structure".[4] This could particularly be a problem for some industries where the incorporated firms differ greatly from the unincorporated firms. A good example for Canada is the financial industry: on the one side, large private banks offer a wide range of financial services and on the other side, private unincorporated firms (sometimes with only one employee) compete for some market share.

Gollin finally proposes to measure labour's share of income by assuming that paid and self-employed workers earn the same average wage. The average wage for paid employees is obtained by dividing the labour income by the number of paid workers. Then, this average wage is scaled up by the total number of jobs in the economy (or the specific industry):

$$\text{Labour's share of income} = \frac{\left(\frac{\text{labour income}}{\text{paid employees}}\right) \times \text{total employment}}{\text{aggregate value added}} \tag{5}$$

Equation (5) has the advantage of using available information about wages to derive labour's share in the economy. However, in addition to the data availability, especially at the industry level, a problem occurs from the fact that equation (5) could generate labour's shares of income above unity, due to either measurement errors in the variables or to different definitions of self-employment in the national accounts compared to the employment survey. But even more problematic, this equation assumes that the average wage of self-employed workers is equal to that of paid employees.

A priori, there are no reasons to believe that this assumption may hold. In fact, according to a study published by Human Resources Development Canada, the self-employed workers in Canada earn about two-thirds of what paid workers earn on an annual basis. The average wage ratio is obtained by dividing the average wage of self-employed (first part on the right hand side of equation (6)) by the average wage of paid workers (second part on the right hand side of equation (6)):

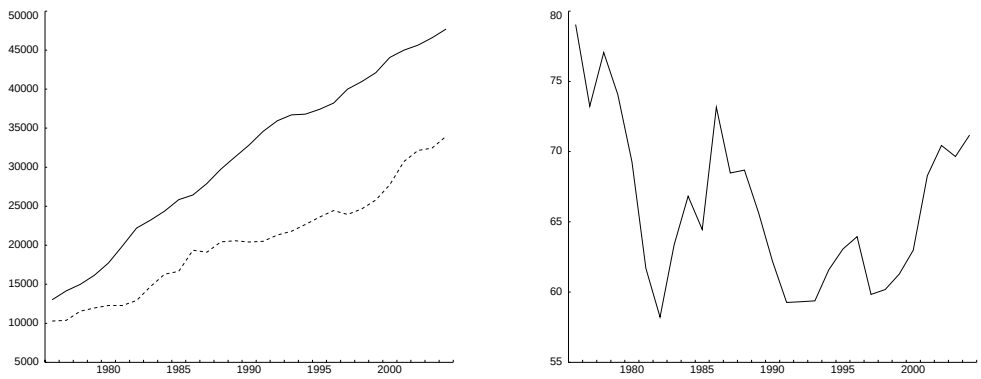
$$\text{average wage ratio} = \left(\frac{\text{net income from uninc. bus.}}{\text{self-employed workers}}\right) \div \left(\frac{\text{labour income}}{\text{paid employees}}\right) \tag{6}$$

Figure 2(a) presents the average wage for both self-employed (dotted line) and paid workers (solid line) in Canada. Although both series trend upward, the gap between the two lines fluctuates over time, leading to a time-varying average wage

[4] Gollin (2002), pp. 468.

ratio (see Figure 2(b)). This ratio oscillates between 58.2 (1982) and 79.0 per cent (1976) and averages 66.1 per cent over the 1976-2004 sample, consistent with the ratio of two-thirds reported by HRDC (2000) and the ratio assumed by Bentolila and Saint-Paul (2003).

Figure 2: Average Wage of Self-Employed versus Paid Employees



(a) Average wage (level) – paid (solid), self-employed (dotted)

(b) Average wage ratio (self-employed/paid)

Moreover, given the procyclical behaviour of the average wage ratio, by arbitrarily fixing this ratio to 0.5, Daudey (2003) overstates labour's share of income during recessions and understates it during expansions. Ideally, labour's share of income would incorporate the time-varying average wage ratio shown in Figure 2(b), but given the way this ratio is calculated, combining equations (5) and (6) — after simplification — is equivalent to attributing all of the income of the self-employed to labour, as it is the case in equation (3).

To sum up, there is no clear way to divide unincorporated business income between labour and capital. Although equation (5) is seen as the most common method of calculating labour's share of income, empirical evidence for Canada about relative wages of self-employed workers tends to suggest that this method overstates labour's share of income. Another common way of proceeding is to assume that about 2/3 of the unincorporated business income goes to labour and 1/3 to capital. This was first suggested by Johnson (1954) and was also discussed by Krueger (1999).

Some of the other issues with the derivation of labour's share of income concern the exact definition of its denominator, *i.e.* aggregate value added. The next two sections elaborate on these issues.

2.3 Gross or Net Value Added?

An important question related to the derivation of labour's share of income is whether to use gross or net value added. Conceptually speaking, the difference between gross and net value added is depreciation:

$$\text{gross value added} = \text{net value added} + \text{depreciation} \tag{7}$$

As explained earlier, depreciation represents allowances for the wearing out of capital assets. Typically, total production of a country or an industry is measured by including capital consumption allowances, since these business costs are reflected in the market price of final goods and services. Moreover, as Gomme and Rupert (2004, pp.3) mention, "using net value added because depreciation merely compensates owners of capital for the physical wear and tear of their capital is a weak justification: labour is likewise subject to wear and tear, both physical and intellectual". The literature thus favours gross value added to net value added.

2.4 Value Added at Market Prices or at Factor Cost?

Another issue to be considered in the calculation of the value added is the treatment of taxes and subsidies. In the national accounting framework, the value added at market prices is the sum of the value added at factor cost and indirect taxes less subsidies:

$$\begin{gathered}\text{value added at market prices} = \\ \text{value added at factor cost} + \text{indirect taxes less subsidies}\end{gathered} \tag{8}$$

Batini, Jackson and Nickell (2000) argue that, in the context of the derivation of labour's share of income, the value added should be measured at factor cost: workers and firms (labour and capital) could only share revenues resulting from the economic activity of firms. Because indirect taxes are paid to the government and therefore, not received by the firms, they should be removed from the value added. Similarly, subsidies are paid by the government to firms and are thus available for labour and capital to share.

The conclusion that emerges from subsections 2.3 and 2.4 is that the preferred measure of aggregate value added should be Gross Domestic Product (GDP) at factor cost.

2.5 The Public Sector

It has been argued in the literature that the public sector should be excluded from both the numerator and the denominator. The reason behind this argument is that there is no capital income in the public sector; the only sources of income are labour income and capital depreciation allowances. Therefore, including government in the analysis tends to bias upward labour's share of income.

Moreover, according to Giammarioli et al. (2002), another reason to limit the calculation of labour's share of income to the market sector of the economy is the fact that the output in the public sector is generally estimated using a measure of input (for instance, hours or employment). This is actually the case for the public administration sector, the education and health care sectors in Canada. Therefore, by construction, these sectors would tend to have a labour's share of income close to one, which contributes to an upward bias.

3 Evolution of Aggregate Labour's Share of Income in Canada

This section analyzes the evolution of aggregate labour's share of income in Canada over the period 1961-2004, according to the different measures introduced in section 2.2. The data used for the calculation of these measures are produced by the Income and expenditure accounts division at Statistics Canada.

The bottom dotted line in Figure 3 is the raw labour's share of income (equation (2)), *i.e.* the ratio of nominal labour income to nominal GDP at factor cost. Alternatively, the solid thin line is the first adjusted measure (equation (3)), in which all the unincorporated business income is attributed to labour. Because one attributes none the unincorporated business income to labour and the other attributes it all, these two measures should be seen as the lower and upper bounds of labour's share of income. The gap between the lower and upper bounds, which in fact represents the share of unincorporated business income in the aggregate value added, has narrowed significantly between 1960 and 1980 (from about 12 to 5 percentage points). This could partly be attributed to the diminishing importance of agriculture in the economic structure of Canada.[5]

Figure 3: Different Measures of Aggregate Labour's Share of Income – 1961-2004

Note: See section 2.2 for definitions.

The second adjusted measure (equation (4)), which assumes the same mix of labour and capital in the unincorporated sector than in the rest of the economy, is depicted by the dashed line in Figure 3. As expected, this measure lies between the raw and the first adjusted measure of labour's share of income. The third and final measure (equation (5)) assumes that the average income of self-employed workers is

[5] According to Kumar (1971), the share of agriculture in the total income in Canada decreased by 65 per cent between 1926-30 and 1961-65. The currently available data suggest that this share decreased by an additional 45 per cent from 1965 to 1980.

the same as that of the paid workers. This measure is the top bold line in Figure 3 and starts only in 1976, due to uncollected employment data prior to this date.[6] As mentioned previously, the assumption that the average wage of both self-employed and paid workers are equal might be too strong of an assumption. This seems confirmed by the fact that the line "*Adj 3*" in Figure 3 sits outside the bounds set by the lines "*Raw*" and "*Adj 1*".

The level of the four measures presented in Figure 3 differ noticeably, depending on the treatment done to the unincorporated business income. However, given that the unincorporated business income only represents about 7 per cent of nominal GDP, and that this component is as volatile as nominal GDP, the year-to-year movements in labour's share of income are driven mainly by fluctuations in the labour income. In fact, the correlation between the different measures are generally above 0.95, except for the third measure (assuming the same average wage for self-employed than that of paid employees) for which the correlation with the other measures fluctuates around 0.80.

The literature seems to favour the third adjustment of labour's share of income. However, Figure 3 tends to suggest that this would be equivalent to assuming that more than 100 per cent of the unincorporated business income could be attributed to labour. Since this is empirically impossible and theoretically invalid, labour's share of income as measured by the second adjustment is preferred. Therefore, from now on, when labour's share of income is mentioned, it always refers to the second adjusted measure, that is:

$$\text{Labour's share of income} = \frac{\text{labour income}}{\text{GDP at factor cost} - \text{uninc. bus. income}} \tag{9}$$

Figure 4 shows the evolution of labour's share of income in Canada, from 1961 to 2004. Despite the fact that it averages 0.616 over the period, labour's share of income clearly exhibits a downward trend: an historical low of 0.577 has been reached in 2004, and data for 2005 suggest an estimate around 0.571. The drop since 1992 may appear particularly stunning, with labour's share diminishing by more than six percentage points in twelve years, but it is really after 1998 that labour's share of income reached very low levels, even below the troughs of 1984 and 1996.

Some researchers found similar patterns in labour's share of income of European countries, although the decline was usually reported earlier.[7] In the United States, labour's share declined sharply since 2000, but sits well above historical lows. As recently discussed by Perrier (2005), one of Kaldor's stylized facts is the relative constancy of the labour and capital's shares of income. However, empirical evidence for other countries and for Canada, suggests that this might not be the case. In order to determine whether or not the Canadian labour's share of income is statistically

[6] Statistics Canada's Labour Force Survey only begins in 1976. There exists some employment data prior to this date, but their reliability compatibility with the Labour Force Survey is questionable.

[7] See Bentolila and Saint-Paul (2003), Giammarioli et al. (2002), Harrison (2002) and de Serres, Scarpetta and de la Maisonneuve (2001).

Figure 4: Labour's Share of Income in Canada – 1961-2004

Note: The exact definition of labour's share of income is described by equation (9).

stable over time, Perrier (2005) conducts a unit root test on labour's share of income and finds that it is non non-stationary, contradicting Kaldor's "fact".

By comparing labour's share of income presented in Figure to 4 with the Bank of Canada estimate of the output gap, it is possible to corroborate the well-documented counter-cyclical behaviour of this variable.[8] The coefficient of correlation between these two series, over the sample 1982-2004, is -0.54. Also, labour's share of income increased substantially during both recessions of the early 1980s and 1990s.

In section 2.5, the relevance of possibly removing the public sector from both the numerator and the denominator of labour's share of income was discussed. Figure 5 displays labour's share for the overall economy (solid line) and for the market portion of the economy (dotted line). As expected, the market sector's labour's share is lower than that of the overall economy. The average gap over the 1961-2004 period is 5.3 percentage points, but increases over time as the public sector expands as a share of nominal GDP. Despite this gap, the year-to-year fluctuations in both measures are characterized by a correlation of 0.98. Therefore, given that this study focuses primarily on understanding the recent behaviour of labour's share of income, the analysis continues to be centred on labour's share for the overall economy.

[8] According to Giammarioli et al. (2002), the counter-cyclical nature of labour's share of income is due to labour adjustment costs, such as firing and hiring restrictions. Young (2004) argues that it results from the presence of biased technical change (non-neutral technology shocks).

Figure 5: Labour's Share of Income –
Overall Economy (solid), Market Sector Only (dotted)

Note: Labour's shares of income are based on equation (9).
Removed sectors are: Public Administration, Educational Services and Health Care Services

4 Labour's Share of Income Across Industries in Canada

The focus of section 3 was on aggregate labour's share of income, *i.e.* labour's share calculated for the overall economy. However, the wide diversity that characterizes sectors of economic activity in Canada suggests that a disaggregated look at labour's share of income could reveal interesting information and strengthen our understanding of the behaviour of the aggregate measure.

Statistics Canada publishes disaggregated data in their annual input-output tables. More specifically, nominal GDP at factor cost, wages and salaries, supplementary labour income and mixed income (unincorporated business income) are all available for a subset of more than one hundred sectors, from 1961 to 2001. Although this 40 year span could already be very informative, the need to expand these series up to 2004 is justified by the fact that we are mostly interested in understanding the behaviour of labour's share of income over the recent years (since 1998).

This study computes labour's shares of income for 18 broad sectors, *i.e.* those represented by a two-digit code in the North American Industry Classification System (NAICS). The sectors are listed below. The first five sectors are good-producing, while the last 13 are service-producing sectors.

- Agriculture, forestry, fishing and hunting
- Mining and oil and gas extraction
- Utilities
- Construction
- Manufacturing

- Wholesale trade
- Retail trade
- Transportation and warehousing
- Information and cultural industries
- Arts, entertainment and recreation
- Finance and insurance, real estate and renting and leasing
- Professional, scientific and technical services
- Administrative and support, waste management and remediation services
- Educational services
- Health care and social assistance
- Accommodation and food services
- Other services (except public administration)
- Public administration

The Income and Expenditure Accounts Division of Statistics Canada provides data from 2001 to 2003 on wages and salaries and supplementary labour income per sector. Their annual growth rates were applied to the input-output table series. The values for 2004 were obtained by assuming, for each sector, the same share of total wages and salaries and supplementary labour income (available through the national accounts) than their average share over 2002 and 2003. The sectoral mixed income values for 2002, 2003 and 2004 were imputed by assuming the same share of total unincorporated business income than the average share that prevailed in 2000 and 2001.

The nominal GDP at factor cost were imputed using two different techniques. For a majority of the sectors, each sector's share of aggregate nominal GDP was very similar to its share of aggregate real GDP. Therefore, nominal GDP shares were regressed on real GDP shares (for which the data are available up to 2004), fitted values were obtained and, after adjusting the level of the fitted values to equal the level of the nominal share in 2001, nominal GDP were calculated using these estimated nominal GDP shares for 2002, 2003 and 2004.[9] For the other sectors, ARIMA models were employed on the nominal GDP shares.[10] Lags on the AR and MA terms were selected using Schwarz Information Criterion (SIC). The nominal WTI (world oil prices) was added to the ARIMA of the mining, oil and gas extraction sectors, as it was very statistically significant and was improving noticeably the fit of the regression.

Figure A1 shows labour's share of income for the 18 sectors of economic activity, calculated using equation (9). A few things are noteworthy about these graphs. First,

[9]The sectors for which the regression of GDP shares was used are: Agriculture, forestry, fishing and hunting, Utilities, Construction, Manufacturing, Retail trade, Arts, entertainment and recreation, Finance and insurance, real estate and renting and leasing, Professional, scientific and technical services, Administrative and support, waste management and remediation services, Health care and social assistance, Accommodation and food services, Other services (except public administration) and Public administration.

[10]The sectors for which an ARIMA model was used are: Mining and oil and gas extraction – ARIMAX(4,1,3) which also includes WTI as a regressor, Wholesale trade – ARIMA(4,1,2), Transportation and warehousing – ARIMA (4,1,4), Information and cultural industries – ARIMA(1,1,4), Educational services – ARIMA(2,1,2). According to ADF tests, nominal GDP shares for these sectors were all non-stationary.

as mentioned in section 2.5, labour's share of income in the public sectors (especially public administration and education) are very high (close to one). For sectors like mining, oil and gas extraction and utilities, which are very capital-intensive, labour's shares of income are low — around 0.25.

Secondly, in terms of cyclicality, as it is the case on the real side of the economy, labour's share in the good-producing sectors is more negatively correlated (-0.52) with the Bank of Canada's measure of the output gap than with labour's share in the service-producing sectors (-0.09). This suggests that the counter-cyclicality of aggregate labour's share of income discussed in section 3 originates from the more pronounced cyclical pattern of the good-producing sectors. Labour's share of the utilities and manufacturing sectors are the most negatively correlated with the cycle, with a correlation coefficient of respectively -0.68 and -0.65 over the period 1983-2004.

Finally, the variability of labour's share of income, measured as the standard deviation of the first difference (*sdfd*), differs greatly across sectors. High variability is observed for the mining, oil and gas extraction sectors (*sdfd*: 3.4 pp) and for the arts, entertainment and recreation sectors (*sdfd*: 2.9 pp). On the other side, the education and health sectors exhibit a very low variability, that is a *sdfd* of 0.3 and 0.7 percentage point respectively.

5 Sectoral Composition and Aggregate Labour's Share of Income

The economic environment in which Canadian firms evolve is constantly changing, forcing both firms and industries to adapt to new market conditions. This feature of today's business world sometimes implies hiring more qualified workers in order to increase productivity or closing obsolete production plants in order to stay competitive. All these changes affect the compositional structure of the economy and also, the sharing of the pie between labour and capital. This section looks at how the sectoral changes that took place in Canada over time have affected the factor distribution of income. More specifically, this section tries to understand whether or not sectoral changes have contributed to the decline observed in labour's share of income since 1998.

Table 2 presents the Canadian industry shares as of 1987, 1999 and 2004, measured in terms of both real production and employment. This table reveals the growing importance of the service sector in Canada. In particular, the finance, insurance, real estate and leasing sector and the professional, scientific and technical service sector have seen their production/employment growth outpacing that of the total-economy, increasing their respective shares. Due to remarkable productivity gains, both the agriculture and manufacturing sectors have seen their share of total employment decreasing by about 2 per cent since 1987, without noticeable production share movements.

As mentioned in section 3, labour's share of income has fallen considerably between 1998 and 2004, reaching levels even below previous troughs. It is possible that this decline was caused (or simply amplified) by the fact that production has moved from

sectors with traditionally high labour's share to sectors with lower labour's share of income. In order to measure the relative contribution of sectoral changes to this decline, two exercises often used in the literature are undertaken.[11] The first exercise is to create a fixed-weight measure of labour's share of income and the second is to decompose the variation of aggregate labour's share into the contribution of sectoral changes and into variations of sector-specific labour's shares of income.

The first step in creating a fixed-weight measure of labour's share of income (LSI) is to rewrite equation (9) as the product of each industry's labour's share ($\text{lsi}_{i,t}$) and its weight in the total nominal GDP — net of unincorporated business income ($\text{weight}_{i,t}$):

$$\text{Aggregate LSI}_t = \frac{\sum_{i=1}^{I} \text{labour income}_{i,t}}{\sum_{i=1}^{I} (\text{nominal GDP}_{i,t}) - \sum_{i=1}^{I} (\text{uninc bus inc}_{i,t})} \tag{10}$$

$$= \sum_{i=1}^{I} \left(\text{lsi}_{i,t} \times \text{weight}_{i,t}\right) \tag{11}$$

where:

$$\text{lsi}_{i,t} = \frac{\text{labour income}_{i,t}}{(\text{nominal GDP}_{i,t} - \text{uninc bus inc}_{i,t})}$$

and:

$$\text{weight}_{i,t} = \frac{(\text{nominal GDP}_{i,t} - \text{uninc bus inc}_{i,t})}{\sum_{i=1}^{I} (\text{nominal GDP}_{i,t}) - \sum_{i=1}^{I} (\text{uninc bus inc}_{i,t})}$$

In equations (10) and (11), i denotes industries (there are I of them), while t represents the current period (year).

According to equation (11), each period, aggregate labour's share of income is being calculated using the weight of each sector at time t. To create a fixed-weighted labour's share of income, weights are held constant at their average value over the whole sample (1961-2004), as suggested by de Serres, Scarpetta and de la Maisonneuve (2001):

$$\text{Fixed-weight aggregate LSI}_t = \sum_{i=1}^{I} \left(\text{lsi}_{i,t} \times \text{weight}_{i,AVE}\right) \tag{12}$$

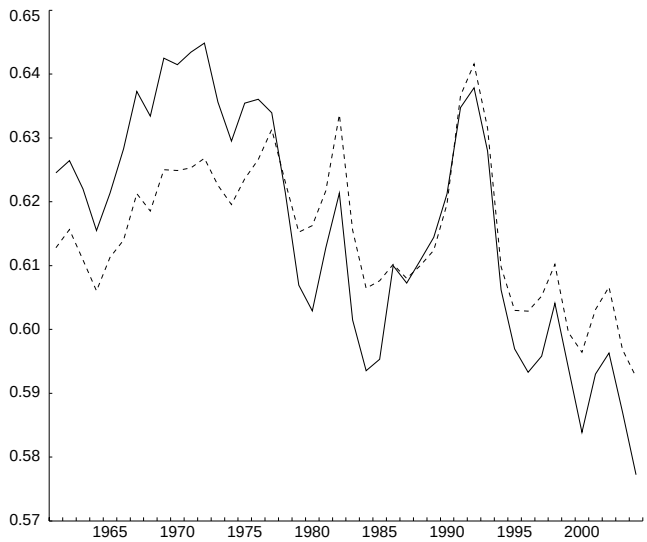
where:

$$\text{weight}_{i,AVE} = \frac{1}{T} \sum_{t=1}^{T} \text{weight}_{i,t}$$

Figure 6 displays the variable and the fixed-weight measures of labour's share of income. This graph suggests that over the period 1986 to 1994, sectoral shifts have not played a major role in driving either upward or downward labour's share of income. However, since 1994, sectoral shifts have contributed significantly to the decline in aggregate labour's share of income. In fact, if aggregate labour's share was measured using the fixed-weight measure, it would not show the same steep decline.

[11] The exercises undertaken in this section draw on Kumar (1971), de Serres, Scarpetta and de la Maisonneuve (2001), Shastri and Murthy (2005) and Kamhi and Leung (2005).

Figure 6: Labour's Share of Income –
Variable Sector Weights (solid), Fixed Sector Weights (dotted)



Note: Weights of the sectors for the fixed-weight measure are calculated as the average weight of the sector over the period 1961-2004.

The next exercise is designed to understand exactly in which way sectoral shifts contributed to the decline observed in aggregate labour's share starting in the late 1990s. The change in aggregate labour's share of income between period $(t-s)$ and period t could be decomposed into the following three parts:

$$\Delta \mathrm{LSI}_t = \sum_{i=1}^{I}(\mathrm{weight}_{i,t-s}\Delta \mathrm{lsi}_{i,t}) + \sum_{i=1}^{I}(\mathrm{lsi}_{i,t-s}\Delta \mathrm{weight}_{i,t}) + \sum_{i=1}^{I}(\Delta \mathrm{weight}_{i,t}\Delta \mathrm{lsi}_{i,t}) \quad (13)$$

The first term on the right-hand side of equation (13) represents the change in aggregate labour's share of income attributable to variations in labour's share of each sector. The second term is the change in aggregate labour's share of income due to changes in the weight of each sector. This middle term gives an idea of the relative importance of the sectoral composition bias in aggregate labour's share. Finally, the last term is usually considered as an unexplained residual.

Table 3 shows the decomposition of the decline observed in aggregate labour's share of income between 1998 and 2004, as described by equation (13). Although it was mentioned previously in this section that the relative importance of the service sector in the real production — or in total employment — was constantly growing, this seems not to be the case in terms of nominal output. In fact, the first two columns of Table 3 reveal that the service sector's share of total nominal GDP (net of unincorporated business income) has declined from 66.8 to 64.7 per cent between 1998 and 2004. This observed pattern is mainly due to a 71 per cent increase in the GDP deflator for the mining, oil and gas extraction sectors in 2000, consistent with the significant rise in world commodity prices. The doubling of the weight of

the mining, oil and gas extraction sectors occurred at the expense of other sectors' weight, mainly in the service sector.

Table 3 also reveals that both the decrease in the share of the manufacturing sector within total nominal output and the decrease in the manufacturing sector's labour's share of income (and the residual term) contributed 45 per cent to the decline of aggregate labour's share of income between 1998 and 2004. The decrease in the share of nominal GDP held by the education sector (for which labour's share of income is very high — around 0.90) also contributed to some extent (18 per cent) to the decline observed in aggregate labour's share.

The last row of Table 3 exposes the contribution of sectoral shifts to the behaviour of aggregate labour's share of income between 1998 and 2004. Over the 2.68 percentage points decline observed over that period, 0.62 percentage point (or 23 per cent) could be attributable to sectoral shifts. However, this finding is greatly affected by the inclusion of the mining, oil and gas extraction sectors, which distorts the analysis: on the one hand, the rise in commodity prices in 2000 boosted the share of total nominal GDP held by the mining, oil and gas extraction sectors. It also induced labour's share of income in these sectors to drop significantly (the numerator did not fall as much as the denominator). These two effects tend to cancel each other out, so that the total contribution of the mining, oil and gas extraction sectors is very small. On the other hand, as mentioned earlier, this doubling of the nominal GDP share of the mining, oil and gas extraction sectors compelled the share of other sectors to fall, mainly the manufacturing, education and public administration sectors.

From 1998 to 2004, unexplained residuals ($\Delta W \Delta lsi$) contributed substantially (about 29 per cent) to further decreasing aggregate labour's share of income. Once again, this result is mainly driven by the mining, oil and gas extraction sectors, for which the unexplained factor is very large. Given the artificial biases created by this sector on the aggregate measure, the analysis now turns to an aggregate labour's share of income, excluding the mining, oil and gas extraction sectors. This measure is presented in Figure 7. By removing the spillover effects caused by the doubling of this sector's weight on other sectors, aggregate labour's share now exhibits a more constant behaviour since the mid-1990s.

Moreover, Table 4 shows the sectoral decomposition exercise described by equation (13) on labour's share of income, but excluding the mining, oil and gas extraction sectors. From 1998 to 2004, this measure of labour's share of income fell by only 0.34 percentage point. The exercise reveals that sectoral shifts contributed to increase this measure of labour's share by 0.38 percentage point. This now represents more the situation described previously: the production shifted from goods to services sectors, increasing aggregate labour's share of income (since labour's share is generally higher in service-producing sectors than in good-producing sectors). The increase in the weight of the professional, scientific and technical service sector particularly contributed to push this measure of labour's share of income up. On the other hand, the decline of labour's share in the manufacturing sector was still a major factor behind the drop of the aggregate measure. The next section then investigates which factors are behind the drop in the manufacturing sector's labour's share of income since the mid-1990s.

Figure 7: Labour's Share of Income –
Overall Economy (solid), Excluding Mining, Oil
and Gas Extraction Sectors (dotted)

6 An Empirical Investigation

This section takes advantage of 26 years of data for 20 industries within the manufacturing sector to empirically analyze the impact of some factors on labour's share of income, including the openness to trade. Other factors include labour productivity and union density.

6.1 The Determinants of Labour's Share in the Literature

6.1.1 Openness to Trade

Many studies have investigated whether openness to trade is an important factor explaining fluctuations of aggregate labour's share of income. The consensus is that, among industrialized countries, globalization has contributed to substantially diminish the share of national income attributed to labour.

Ortega and Rodríguez (2002) and Harrison (2002) argue that openness harms the bargaining power of labour relative to capital. Globalization tends to rise the level of competition faced by local producers. This increased competition translates into lower prices for imported goods, which, in turn, lowers the marginal value of an additional unit of labour. Also contributing to increasing labour demand elasticity is the higher international substitutability of factors associated with openness (see Slaughter, 2001). Harrison (2002) also points out the fact that protection usually focuses on labour-intensive sectors. Therefore, increasing openness via the diminution of protection measures (tariffs and quotas, for instance) hurts labour relative to capital.

Alternatively, according to the Heckscher-Ohlin trade model, as countries become more open to trade, they specialize in their areas of comparative advantage and factor prices equalize across countries. Also, in such a model, capital-abundant countries export capital-intensive goods while labour-abundant countries export labour-intensive goods. Another implication of the Heckscher-Ohlin model is that a movement towards free trade raises the real return of a country's relatively abundant factor, while the real return of the country's relatively scarce factor falls. Since industrialized countries are traditionally seen as capital-abundant, openness would be associated, in this framework, with a decrease in labour's share of income.

6.1.2 Technological Progress

In a perfectly competitive input market, labour should be paid its marginal product, that is $w = MPL$. However, this condition does not always hold. A wage gap could potentially arises due to imperfectly competitive input or output markets, labour shirking or simply due to labour market institutions, such as minimum wage. More generally, labour's share of income is affected by factor-biased technological progress, as mentioned by Bentolila and Saint-Paul (2003) and Young (2004). Under the assumption of complementarity between labour and capital, *i.e.* an elasticity of substitution lower than one in absolute value,[12] a capital-augmenting improvement in technology tends to increase the productivity of capital relative to labour and drags down labour's share of income. The converse is also true: productivity gains in a labour-augmenting technology framework should impact positively labour's share of income.

6.1.3 Union Bargaining Power

In the bargaining process between labour and capital, Bentolila and Saint-Paul (2003) distinguish between right-to-manage and efficient bargaining processes. The right-to-manage model assumes that firms and unions first bargain over wages and then firms decide on the number of jobs to keep given this wage rate. In this framework, labour's share of income could either increase or decrease following a rise in the bargaining power of unions, depending on the degree of complementarity between the two factors. In the efficient bargaining model, firms and unions bargain over both wages and employment. This framework implies that increasing the bargaining power of unions pushes labour's share of income up, as workers are being paid more than their marginal product.

Although Bentolila and Saint-Paul (2003) argue that the right-to-manage model is more representative of the way bargaining takes place in major industrialized countries in which case the sign of the effect of union bargaining power on labour's share is undetermined, empirical evidence tends to show that there usually exists a positive

[12] In a recent paper, Perrier (2005) estimates the elasticity of substitution between labour and capital in Canada to be somewhere between 0.4 and 0.6. Note that in the Cobb-Douglas case (elasticity of substitution of exactly one), any increase in technology is Hicks-neutral and leaves labour's share of income unchanged.

link between these two variables. As unions gain bargaining power, workers' real wages increase, leading to a higher labour's share of income.

6.1.4 Other Factors

Other factors were discussed in the literature as potentially affecting labour's share of income. Kessing (2003) shows that with a Cobb-Douglas production function and linear labour adjustment costs (hiring and firing costs), changes in labour's share are not linked to the size of the demand shocks affecting the economy, neither with the size of wage shocks, but rather depends on the size of adjustment costs. Bentolila and Saint-Paul (2003) find that adjustment costs (proxied by employment change) are negatively affecting labour's share. The reasoning behind this effect is that adjustment costs associated with workforce turnover create a wedge between the value of the marginal product of labour and wages, because labour costs now include wages as well as hiring and firing costs. According to Giammarioli et al. (2002), the counter-cyclicality of these adjustment costs implies that labour's share of income will also move counter-cyclically. Equivalently, labour's share of income is the counterpart of the capital's share of income and that profits are strongly procyclical.

International studies[13] have found that relative factor endowments of capital and labour tend to explain a significant portion of international differences in the level of labour's share. For instance, Harrison (2002) find that relative endowments, measured by the labour-to-capital ratio (L/K), are negatively associated with labour's share of income: increases in the labour force lead to a fall in labour's share. This is due to the low substitutability of labour and capital: when the labour force decreases, firms cannot easily substitute workers to more capital stock, and the relative returns to labour increase (labour is scarce relative to capital).

Diwan (1999) investigates the issue of financial crises, which he identifies as a year in which the nominal exchange rate of a country depreciates by more than 25 per cent. He founds that labour's share of income usually falls after a financial crisis, as labour bears the cost of a financial crisis more than proportionally.

Finally, commodity prices also affect labour's share of income, as pointed out at the end of section 5. Since commodities (also called raw materials) are used as another factor of production (just like capital or labour), an increase in the cost of this factor affects the other factors' share of nominal income. Prigent (1999) argues that when the price of energy increases, real wages drop and consequently, labour's share of income also decreases.

6.2 The Data

The last section just reviewed some of the factors that the literature identified as being important to explain either short-run or long-run fluctuations in labour's share of income. In the context of estimating an equation in which these factors enters, this subsection describes the data employed, both in terms of their source and their characteristics.

[13] See in particular Jayadev (2004), Harrison (2002) and Bentolila and Saint-Paul (2003).

The focus of this section is on the Canadian manufacturing subsectors (three-digit code). There are 20 in total in the North American Industry Classification System (NAICS):

- Food manufacturing
- Beverage and tobacco product manufacturing
- Textile and textile product mills
- Clothing manufacturing
- Leather and allied product manufacturing
- Wood product manufacturing
- Paper manufacturing
- Printing and related support activities
- Petroleum and coal products manufacturing
- Chemical manufacturing
- Plastics and rubber products manufacturing
- Non-metallic mineral product manufacturing
- Primary metal manufacturing
- Fabricated metal product manufacturing
- Machinery manufacturing
- Computer and electronic product manufacturing
- Electrical equipment, appliance and component manufacturing
- Transportation equipment manufacturing
- Furniture and related product manufacturing
- Miscellaneous manufacturing

As is the case in section 4, labour's shares of income within manufacturing sectors are derived using equation (9), that is subtracting the unincorporated business income from the aggregate value added in the denominator. Although there are few self-employed workers in the manufacturing sector, eliminating this additional piece of (easily available) information could bias the analysis in some way.

The data are published by Statistics Canada in their input-output tables and are available from 1961 to 2001. Unlike the calculation of labour's shares for the broader industries, no labour income data are available for the period 2002-2004, so the whole estimation sample ends in 2001. Figure A2 presents labour's share of income for the 20 manufacturing industries from 1961 to 2001.

The measures of openness to trade were taken from Dion (2000). They were calculated by adding exports and imports of a sector minus the imported input content of exports, expressed as a share of production in this sector. The data are also available from 1961 to 2001 from the input-output tables published by Statistics Canada. Figure A3, which presents the net trade exposures of the 20 manufacturing sectors, reveals that world trade liberalization has affected significantly the degree of openness to trade in each of these industries since the early 1960s.

Like Guscina (2005), technological progress was proxied by using labour productivity in each of the sectors. Labour productivity was obtained by dividing real GDP at basic prices by the total number of jobs in each sector. The employment numbers from 2001 to 2004 were provided by Statistics Canada (based on the Labour Force

Survey), the data from 1983 to 2001 were taken from the Survey of Employment, Payroll and Hours (SEPH) and from 1961 to 1983, SEPH employment indexes were used. Figure A4 presents the labour productivity measures across manufacturing sectors. In all cases, labour productivity trends up over time, with some of the most productive sectors in 2001 being chemical manufacturing and primary metal manufacturing.

Since there exists virtually no proxy for union bargaining power, union density, as in Guscina (2005), was employed, *i.e.* the percentage of the workforce part of a union. As pointed out by Macpherson and Stewart (1990, pp 440), "the ability of unions to affect wages is a positive function of the percentage organized in the industry". From 1976 to 1995, union densities were easily available through the Labour Force Survey, while from 1997 to 2001, the data were provided to us by Statistics Canada's Labour Statistics Division. The data for 1996 are missing, but approximated by averaging the union density values for 1995 and for 1997 for all the 20 sectors. Figure A5 graphs the union density of each of the 20 different manufacturing sectors. As it is the case of the economy as a whole, unions have lost significant ground in the manufacturing sectors since the early 1960s.

Due to the short sample size for the union density measures (which are only available since 1997) in the computer and electronic product manufacturing sector, this sector is removed from the analysis, which leaves a total of 19 manufacturing sectors.

Before presenting the econometric model, it is important to analyze the stationarity of these variables.[14] As detailed in Breitung and Pesaran (2005), panel unit root tests assume that a variable $y_{i,t}$ is generated, for each $i = 1, \ldots, N$, by a AR(1) process:

$$y_{i,t} = (1 - \alpha_i)\mu_i + \alpha_i y_{i,t-1} + \epsilon_{i,t} \tag{14}$$

where the errors, $\epsilon_{i,t}$, are i.i.d. across i and t, with $E(\epsilon_{i,t}) = 0$ and $E(\epsilon_{i,t}^2) = \sigma_i^2 < \infty$. Equation (14) can also be expressed as a Dickey-Fuller (DF) equation:

$$\Delta y_{i,t} = -\phi_i \mu_i + \phi_i y_{i,t-1} + \epsilon_{i,t} \tag{15}$$

where $\phi_i = \alpha_i - 1$. The null hypothesis in panel data unit root tests is that all $y_{i,t}$ are independent random walks:

$$H_0 \quad : \quad \phi_1 = \ldots = \phi_N = 0 \tag{16}$$

There are two possible alternative hypothesis:

$$H_{1a} \quad : \quad \phi_1 = \ldots = \phi_N \equiv \phi \text{ and } \phi < 0 \tag{17}$$

$$H_{1b} \quad : \quad \phi_1 < 0, \ldots, \phi_{N_0} < 0, N_0 \leq N \tag{18}$$

The first alternative (H_{1a}) assumes that all ϕs are identical across i; it is the homogeneous alternative. The second alternative (H_{1b}) assumes that N_0 of the N panel units are stationary with sector-specific ϕs; it is the heterogeneous alternative.

[14] The unit root test results are not explicitly presented in this document, but are available upon request.

Panel data unit root tests performed on the set of labour's shares of income for the 19 manufacturing sectors suggest that this variable is I(0). Tests assuming both a common unit root process, like in equation (17), and individual unit root processes, like in equation (18), rejected the null of unit root at a significance level of 4 per cent or less.[15] However, unit root tests performed on labour's share of income for total manufacturing unambiguously failed to reject the null of unit root.[16] Moreover, all studies in the literature have concluded to a I(1) variable. Labour's share of income is therefore assumed to be a non-stationary variable. The same problem was found for union density measures: panel unit root tests concluded to a I(0) variable, while the test done on the total manufacturing union density suggests a I(1) process. For the purpose of the cointegration long-run equation, the union density measures are assumed to also be non-stationary. The net trade exposures and the labour productivity measures were both undoubtedly non-stationary, according to panel data unit root test results.

6.3 The Econometric Model

6.3.1 Panel Data ECM

This part of the section presents the empirical model that sheds light on the determinants of labour's share of income. Given the non-stationarity of most variables, the most appropriate model is an error-correction model (ECM). The ECM allows us to capture both the long-run dynamics of labour's share as well as short-run deviations from a long-run path. The general case of a panel data error-correction model can be represented by the following equations:[17]

$$\begin{aligned}\Delta y_{i,t} = \phi_i + \rho \Delta y_{i,t-1} + \gamma_1 \Delta x_{1i,t-1} + \gamma_2 \Delta x_{2i,t-1} + \ldots \\ + \gamma_M \Delta x_{Mi,t-1} - \lambda e_{i,t-1} + u_{i,t}\end{aligned} \tag{19}$$

where

$$e_{i,t} = y_{i,t} - [\alpha_i + \beta_1 x_{1i,t} + \beta_2 x_{2i,t} + \ldots + \beta_M x_{Mi,t}] \tag{20}$$

and where

$$x_{mi,t} = x_{mi,t-1} + \mathrm{v}_{mi,t} \tag{21}$$

for $t = 1, \ldots, T;\ i = 1, \ldots, N;\ m = 1, \ldots, M,$
or using a matrix notation:

$$\Delta \mathbf{y}_t = \phi + \Delta \mathbf{y}_{t-1} \rho + \Delta \mathbf{X}_{t-1} \mathbf{\Gamma} - \mathbf{e}_{t-1} \Lambda + \mathbf{u}_t \tag{22}$$

[15]The panel data unit root tests performed are: the Levin, Lin and Chu test and the Breitung test against a homogeneous alternative; the Im, Peseran and Shin test, the Fisher ADF test and the Fisher PP test against heterogeneous alternatives.

[16]These different results could originate from 3 factors: the power of single-variable unit root tests is generally low, the aggregation of stationary processes artificially generates non-stationary processes (see Granger, 1980) and finally, since labour's share in the overall manufacturing sector is a weighed sum of individual manufacturing sector's labour's share, weights are non-stationary.

[17]Breitung and Pesaran (2005) offer a very up to date review of the literature on panel data cointegration models.

$$\mathbf{e}_t = \mathbf{y}_t - [\alpha + \mathbf{X}_t\beta] \tag{23}$$

$$\mathbf{X}_t = \mathbf{X}_{t-1} + \mathbf{v}_t \tag{24}$$

for $t = 1, \ldots, T$. Equations (19) and (22) are the short-run dynamics' equations, in which the variables x (there are M of them) represent the long-run variables entering the cointegration equations (20) and (23). Equations (21) and (24) simply state that these x-variables follow a random walk, so that the error terms, $\mathrm{v}_{si,t}$, are strictly stationary with mean zero. ϕ_i is a sector-specific effect, just as α_i in the cointegration equation. We make the assumption that

$$E[\mathbf{u}_{i,t}\mathbf{u}'_{j,t}] = \sigma_{ij}\mathbf{I}_T,$$

i.e. the errors of the short-run dynamics' equation are contemporaneously correlated across sector i and j. Note that the β in the cointegrating vector $(1, -\alpha_i, -\beta)$ is constrained to be the same across sectors, although a more general case could be one where the β coefficients would be allowed to differ across sectors. The same assumption holds for the coefficients θ and γ in the short-run equations. If $\mathbf{y}_t$ and $\mathbf{X}_t$ are cointegrated, then, $\mathbf{e}_t$ is I(0).

In this panel ECM, there are $T = 26$ time periods, *i.e.* a sample of annual data from 1976 to 2001, and $N = 19$ sectors of activity, those mentioned in section 6.2 minus the computer and electronic product manufacturing sector. The explained variable $\mathbf{y}_t$ is labour's share of income in each of the 19 sectors. The variables considered as part of the long-run determinants of labour's share are:

$$\mathbf{X}_t = \begin{bmatrix} \log(\text{Labour productivity}_{i,t}) \\ \text{Union density}_{i,t} \\ \text{Openness}_{i,t} \end{bmatrix}'$$

6.3.2 Panel Data Cointegration with Endogenous Variables

An important problem that could arises with the $\mathbf{X}_t$ matrix is that some or all of its components could be endogenous, that is there would exists a long-run correlation between $\mathbf{v}_t$ and $\mathbf{e}_t$. In this case, the ordinary least squares (OLS) estimator is consistent but inefficient. Breitung and Pesaran (2005) recommend to use either a "fully-modified ordinary least squares" (FM-OLS) approach or a "dynamic ordinary least squares" (DOLS) estimator. However, studying asymptotic distribution and finite sample properties of these two estimators, Kao and Chiang (2000) conclude that the DOLS outperforms the FM-OLS estimator. Moreover, Mark and Sul (2003) find that there is a large precision gain in terms of efficiency to use a panel DOLS estimator compared to a single-equation DOLS estimator.

Westerlund (2005) describes the panel DOLS estimator, an estimator originally developed by Saikkonen (1991) for cointegration among endogenous time series. The endogeneity of the regressors in the cointegration equation is eliminated by including an infinite number of lags and leads of the first difference of the endogenous regressors. In practice, the number of lags and leads included in the estimation is truncated to

p_i lags and q_i leads:

$$\mathbf{y}_t = \alpha + \mathbf{X}_t\beta + \sum_{k=-q_{i\tilde{m}}}^{p_{i\tilde{m}}} \Delta\widetilde{\mathbf{X}}_{t-k}\mathbf{\Omega}_{\tilde{m}} + \in_t \tag{25}$$

where $\widetilde{\mathbf{X}}_t$ is a subset of $\tilde{m}$ endogenous variables within $\mathbf{X}_t$:

$$\widetilde{\mathbf{X}}_t \subseteq \mathbf{X}_t$$

Three remarks on equation (25): the number of chosen lags and leads, p_i and q_i, is allowed to differ across sectors; since the number of lags and leads varies across industries and across variables, the estimated coefficients associated to these lags and leads, $\hat{\mathbf{\Omega}}_{\tilde{m}}$, also vary across sectors and variables; finally, the number of lags and leads for each sector/variable is selected by optimizing an information criterion.

Once the cointegrating vector $(1, -\alpha, -\beta)$ has been estimated using panel DOLS, the residuals from equation (23) are being computed:

$$\hat{\mathbf{e}}_t = \mathbf{y}_t - \left[\hat{\alpha}^{DOLS} + \mathbf{X}_t\hat{\beta}^{DOLS}\right]$$

Put differently, the residuals of the cointegration equation are obtained by excluding the lags and leads of the first difference of the endogenous regressors $\widetilde{\mathbf{X}}_t$ in equation (25) (note that $\in_t \neq \mathbf{e}_t$).

6.4 The Results

This section presents the estimation results of the panel ECM presented in equations (22) to (24), estimated using the DOLS technique in equation (25). The first step to accomplish before proceeding to any econometric estimation is to test the presence of cointegration between $\mathbf{y}_t$ and $\mathbf{X}_t$.

6.4.1 Cointegration Tests

Pedroni (2004) develops seven different panel data cointegration test statistics. These test statistics are testing the non-stationarity of the cointegration errors, $\mathbf{e}_{i,t}$, similar to an Engle and Granger (1987) two-step procedure developed for the case of cointegration of time series. The first four test statistics are "panel statistics" and the last three are "group statistics". "Panel statistics" are testing a unit root in the residuals ($\mathbf{e}_t$) of the cointegration equation against homogeneous alternatives (similar to assuming a common unit root process in a regular panel unit root test), while "group statistics" test a unit root in the residuals against heterogeneous alternatives (individual unit root processes in regular panel unit root tests). Testing the null of no cointegration, Pedroni (1999) shows that these tests statistics converge to a standard normal distribution as T and N get large. The procedure to calculate the test statistics also takes into consideration the potential endogeneity of the regressors.

Therefore, testing for the presence of cointegration between labour's share of income, the log of the labour productivity, union density and openness to trade leads to

the rejection of the null hypothesis of no cointegration for 4 of 7 Pedroni's test statistics at a significance level of 5 per cent.[18][19] These tests were performed by assuming sector-specific intercepts. Although it would have been ideal to reject the null in all cases, 4 out of 7 does suggest possible cointegration. It is therefore assumed that $\mathbf{y}_t$ and $\mathbf{X}_t$ are cointegrated.

6.4.2 Lags and Leads Selection

As noticed by Breitung and Pesaran (2005), with endogenous regressors, the DOLS estimator is more efficient than the OLS estimator. In this estimation exercise, we assume that both labour productivity and union density are endogenous, while the openness measure is considered as exogenous. On the endogeneity of union density, the literature has many times argued that globalization decreases union bargaining power.[20] The exogeneity of openness is justified by the fact that firms and workers of a specific sector take as given the level of openness when they bargain.

Therefore, the DOLS estimated cointegration equation is:

$$\begin{gathered}\text{lsi}_{i,t} = \alpha_i + \beta_1 \log \text{prod}_{i,t} + \beta_2 \text{union}_{i,t} + \beta_3 \text{open}_{i,t} + \\ \textstyle\sum_{k=-q_{i1}}^{p_{i1}} \theta_{i1} \Delta \log \text{prod}_{i,t-k} + \sum_{k=-q_{i2}}^{p_{i2}} \theta_{i2} \Delta \text{union}_{i,t-k} + \in_{i,t}\end{gathered} \tag{26}$$

The number of lags and leads of ($\Delta \log$ prod) and Δ(union) in equation (26) is determined by minimizing an information criterion. Westerlund (2005) evaluates five different information criteria and concluded that the best ones to use were the Schwarz Bayesian Information Criteria (SIC) and the Posterior Information Criteria (PIC):

$$SIC = \log\left(\frac{SSR_i}{M}\right) + K_i \frac{\log M}{M} \tag{27}$$

$$PIC = \log\left(\frac{SSR_i}{M}\right) + \frac{1}{M} \log\left(\left|\frac{M(X_i' X_i)}{\overline{SSR}_i}\right|\right) \tag{28}$$

where $M = T - \bar{p} - \bar{q}$, $\bar{p}$ and $\bar{q}$ are respectively the maximum lags and leads to be considered, SSR_i is the sum of squared residuals, K_i is the number of regressors, including all the lags and leads and finally, $\overline{SSR}_i$ is the sum of squared residuals obtained from having a model with $\bar{p}$ lags and $\bar{q}$ leads of the two first differenced variables. Minimizing these two information criteria with $\bar{p} = \bar{q} = 2$ generates a specification for equation (26) in which p_{i1}, q_{i1}, p_{i2} and q_{i2} are replaced by $\hat{p}_{i1}$, $\hat{q}_{i1}$, $\hat{p}_{i2}$ and $\hat{q}_{i2}$.

[18] Nominal and real commodity prices were also considered separately as a long-run determinant of labour's share of income. However, there inclusion was always leading to the non-rejection of the null of no cointegration. In fact, this is not surprising given that their effect on aggregate labour's share of income is through a sectoral bias in favor/defavor of the mining, oil and gas extraction sector. When only the manufacturing sector is considered, their effect is not as direct and therefore, their inclusion distorts the presence of cointegration between the dependant variable and the 3 mentioned regressors.

[19] Pedroni's test statistics lead to the following p-values: panel v-stat: 0.251; panel rho-stat: 0.644; panel pp-stat: 0.050; panel adf-stat: 0.024; group rho-stat: 0.826; group pp-stat: 0.034; group adf-stat: 0.021.

[20] See for example Macpherson and Stewart (1990) and Arbache (2004).

6.4.3 Estimation Results

Table 5 presents the estimation results of α_i and the βs from equation (26). The first column shows the DOLS estimated coefficients. The second column displays the coefficients estimated using Dynamic Seemingly Unrelated Regression (DSUR). This estimation technique assumes that there exists some cross-sector correlation in the residuals ($\in_{i,t}$) of equation (26). Said differently, the DSUR estimation corrects for the fact that the deviations of labour's share of income in each sector from their long-run path are correlated across industries, which is strongly likely in the present case. The last column presents the OLS estimation results, for the sole purpose of comparison.

Table 5 reveals a negative coefficient on the labour productivity measure, both using DOLS and DSUR. In both estimations, this result is statistically significant at a level of one per cent. This suggests that, from 1978 to 2001, the technological progress observed in the Canadian manufacturing sectors has been capital-augmenting. Also, as discussed by Guscina (2005), there might have been a structural change somewhere in the 1980s, which would be attributable to an IT-revolution. This structural change would have modified the sign of the estimated coefficient from positive (labour-augmenting technology progress) prior to the IT-revolution to negative (capital-augmenting technology progress) following the IT-revolution. The coefficient on labour productivity obtained from restraining the sample to 1978-1989 is -0.421 and is statistically significant at 1 per cent.[21] The same estimation performed on the sample 1990 to 2001 leads to a statistically significant coefficient of 0.420. This is exactly in line with Guscina's results.

Results presented in Table 5 also suggest that union density, which acts as a proxy for union bargaining power, is positively linked to labour's share of income, as the theory would suggest. Bentolila and Saint-Paul (2003) argue that this might be an indication that the bargaining process characterizing the manufacturing sector in Canada is closer to the efficient bargaining model, where wages and employment are set together. The effect of union density is statistically different from zero (at 10 per cent) only when the cointegration vector is being estimated using DSUR. For a given sector, if union density increases by 1 percentage point, in the long-run, labour's share will increase by 0.06 percentage point.

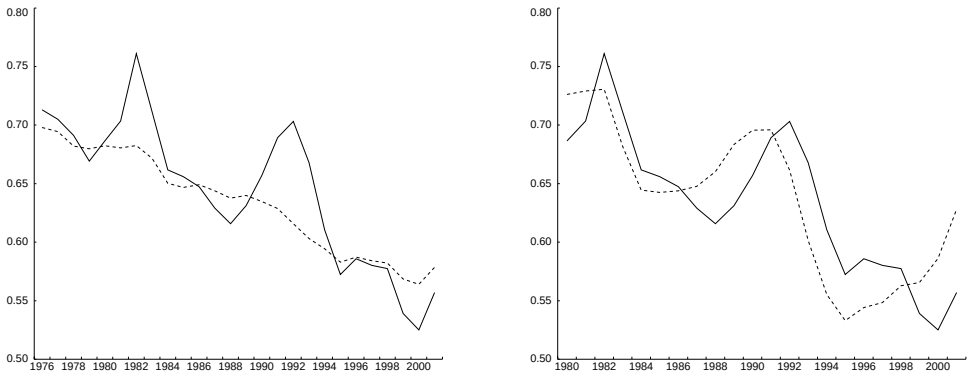
As expected, openness to trade seems to be negatively linked to labour's share of income, in line with what the theory would predict. This coefficient is strongly statistically significant in the DSUR estimation. The size of the coefficient is such that an increase of 1 percentage point of a sector's openness pushes the long-run labour's share down by 0.05 percentage point. Finally, the sector-specific intercepts are all strongly significant (individually and collectively).

Estimated coefficients in Table 5 generate a long-run equilibrium path for labour's share in each of the 19 manufacturing sectors. It is possible to get a long-run equilibrium path for the overall manufacturing sector by proceeding to a weighted sum of these sectoral paths, the weights being simply nominal shares of overall manufactur-

[21] The year 1989 was selected because it is the first year in the 1980s that allows us to reestimate equation (26), due to sample size limitations.

ing GDP. Figure 8a displays labour's share of income for the overall manufacturing sector (solid line) and the long-run estimated equilibrium path (dotted line).

Figure 8: Labour's Share of Income – Manufacturing
Actual (solid), Fitted Values from ... (dotted)



(a) ... the Cointegration Equation (b) ... a Dynamic Simulation

Given the estimated cointegration vector, the residuals were derived and included in an error-correction model. The estimation results are presented in Table 6. The short-run dynamics' equation was estimated using panel data cross-section SUR (sometimes referred to as the Parks estimator). The residuals from the cointegration equation included in the short-run dynamics' equation are those obtained from the DSUR estimation.

Up to three lags of the first difference of the long-run variables were included in the specification, in order to account for the long transmission mechanism of these variables. This long process could be due to wage contracts, or even economic uncertainty. Note that the first difference of labour productivity was also included at time t, since GDP appears in both labour's share's formula (W_t/Y_t) and labour productivity's formula (Y_t/L_t). A negative coefficient is therefore expected on this regressor.

Table 6 reveals that there exists some (low) persistence ($\hat{\rho} = 0.15$) in the first difference of labour's share of income. This persistence is strongly statistically significant. Also, the coefficient on the return to long-run path ($\hat{\lambda}$) is around -0.68 and is statistically different from zero, even at a significance level of one per cent. With annual data, such a coefficient implies that the half-life of duration of shocks to labour's share of income is about 9 months. Therefore, in the manufacturing sectors, deviations of labour's shares from their long-run path are not very persistent.

As expected, the coefficient on the contemporaneous first difference of labour productivity is negative and statistically significant. The sum of the three coefficients associated with short-run movements in labour productivity is negative (-0.104) and statistically different from zero. Again, this result suggests that, even in the short-run, technological progress favours capital at the expense of labour.

As expected, a change in the union density of a given sector has a positive cumulative impact (0.044) on the change of labour's share in this sector after 3 years. This result is statistically significant. Finally, changes in openness to trade have a negative cumulative impact (-0.117) on changes in labour's share of income after 3 years, and this impact is statistically significant.

The short-run dynamics' equation being estimated, it is possible to obtain $\widehat{\Delta y}_{i,t}$, *i.e.* an approximation of the change in labour's share of income for the 19 manufacturing sectors. Once again, $\widehat{\Delta y}_t$ for the overall manufacturing sector could be derived using a weighted sum of each sector's estimated change in labour's share. Applying $\widehat{\Delta y}_t$ to the level of the series in a base year (1979), a fitted value for the level of the series the year after (1980) could be obtained:

$$\hat{y}_{1980} = y_{1979} + \widehat{\Delta y}_{1980}$$

For the following years, last period's actual data is being replaced by last period's fitted value:

$$\hat{y}_t = \hat{y}_{t-1} + \widehat{\Delta y}_t$$

After adjusting the level of the fitted values $\hat{y}_t$ to make sure that the mean of the fitted values equals the mean of the series, we obtain a dynamic simulation of labour's share of income. Figure 8b graphs labour's share of income in the overall manufacturing (solid line) and the result of the dynamic simulation (dotted line).

7 Discussion: Counter-cyclical Behaviour of Labour's Share of Income

It was mentioned in section 6.1.4 that labour's share of income has a counter-cyclical behaviour, due to the presence of labour adjustment costs (Giammarioli et al., 2002). Also, labour's share could be seen as the ratio of total wages (W) to GDP (Y):

$$\text{Labour's share} = \frac{W}{Y} \tag{29}$$

and W could be seen as the wage rate (w) times employment (L):

$$W = wL \tag{30}$$

When a recession occurs and Y decreases substantially, total wages do not drop as much, because of 1) the downward nominal rigidity of the wage rate w and 2) labour hoarding on employment L. It follows that labour's share of income behaves in a counter-cyclical way, increasing in recessions and decreasing in expansions.

Figure 9 graphs the deviations of labour's share in overall manufacturing from its long-run equilibrium (solid line), *i.e.* $\hat{\mathbf{e}}_t = \mathbf{y}_t - \left[\hat{\alpha} + \mathbf{X}_t\hat{\beta}\right]$, with the capacity utilization rate in the overall manufacturing sector (dotted line). The capacity utilization rate is usually a good measure of capacity pressures in the manufacturing sector. The correlation between these two variables over the period 1976-2001 is -0.80. This clearly confirms the counter-cyclical behaviour of labour's share of income.

Figure 9: Overall Manufacturing – Deviations of Labour's Share from its Long-Run Equilibrium (solid, left), CAPU (dotted, right)

Figure 9 suggests that this strong relationship could help to get a better fit of labour's share of income over time. The appropriate procedure would be to regress the deviations of labour's share of income from its long-run equilibrium on a constant and on the capacity utilization rate:[22]

$$\hat{\mathbf{e}}_t = \pi_0 + \pi_1 \mathbf{CAPU}_t + \mathbf{r}_t \tag{31}$$

where $\mathbf{r}_t$ is an i.i.d. error term. As a second step, the fitted values of equation (31), $\widetilde{\hat{\mathbf{e}}}_t$, are computed:

$$\widetilde{\hat{\mathbf{e}}}_t = \hat{\pi}_0 + \hat{\pi}_1 \mathbf{CAPU}_t \tag{32}$$

Finally, in a final step, the fitted values $\widetilde{\hat{\mathbf{e}}}_t$ are added to the long-run equilibrium path in order to combine the long-run and the cyclical profiles of labour's share of income:

$$\widetilde{\mathbf{y}}_t = \hat{\alpha} + \mathbf{X}_t \hat{\beta} + \widetilde{\hat{\mathbf{e}}}_t \tag{33}$$

Figure 10 presents labour's share of income for the overall manufacturing sector and its approximation, $\widetilde{\mathbf{y}}_t$, obtained by exploiting the cyclical behaviour of this variable. The fit is much better than in the dynamic simulation exercise.

[22]The capacity utilization rate is assumed to be stationary, even though shocks to the level of this series tend to be persistent over time. This is justified by the fact that this variable is fluctuating around a certain mean in the cycle. As the measure of the output gap, this indicator of the cycle should in theory be stationary. Note that panel data unit root tests on the Canadian manufacturing capacity utilization rates reject the null of non-stationarity, while time series unit root tests on the overall manufacturing capacity utilization rate conclude to a non-stationary variable.

Figure 10: Overall Manufacturing – Labour's Share (solid), Fitted Values From using CAPU (dotted)

8 Conclusion

Between 1998 and 2004 in Canada, labour's share of income has fallen by almost three percentage points and has reached very low levels. The main goal of this study was to understand what factors were behind this drop in labour's share. The sectoral decomposition undertaken in this paper showed that the large increase observed in commodity prices over this period contributed to substantially decreasing labour's share of income. This comes from the fact that higher producer prices imply a larger contribution of the mining, oil and gas extraction sector — a sector facing a lower-than-average labour's share of income — to aggregate labour's share of income. In fact, when removing this sector from the derivation of aggregate labour's share of income, this variable exhibits a relatively constant profile over the period 1998-2004.

More structurally speaking, this paper found that the decrease observed in labour's share of income in the Canadian manufacturing sector over the most recent years could be linked to three main factors: increasing labour productivity, decreasing union density and increasing openness to trade. In the current context of globalization, it is possible to expect that labour productivity and firms' openness to trade will continue to expand in the near future, leading to even lower labour's share of income.

Finally, this paper investigated the behaviour of labour's share of income over the business cycle and found that, consistent with the literature, deviations of labour's share of income from its long-run equilibrium are strongly counter-cyclical. However, these deviations seems to be not very persistent, as the half-life of duration of shocks to labour's share is about 9 months.

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Appendix

A Tables

Table 1: Self-Employment Rates per Industry* (per cent)

	1987	1999	2004
All industries	13.9	17.0	15.4
Goods-producing sector	17.5	18.4	16.6
Agriculture	68.6	69.1	64.2
Forestry, fishing, mining, oil and gas extraction	14.8	17.4	17.3
Construction	26.9	35.2	32.7
Manufacturing	3.8	4.4	4.1
Utilities	N.A.	N.A.	N.A.
Services-producing sector	12.4	16.6	15.0
Trade	14.3	14.6	12.1
Transportation and warehousing	12.7	18.1	17.5
Finance, insurance, real estate and leasing	8.7	15.0	15.4
Professional, scientific and technical services	27.7	36.7	35.5
Business, building and other support services	19.4	27.5	23.1
Educational services	2.3	5.4	4.6
Health care and social assistance	10.5	13.9	12.4
Information, culture and recreation	12.5	15.0	16.2
Accommodation and food services	10.3	10.6	8.5
Other services	29.4	36.6	32.3
Public Administration	N.A.	N.A.	N.A.

*Number of self-employed in industry i over total number of employees in industry i. The selected years are all characterized by an output gap close to zero ($\approx +0.1\%$). The Labour Force Survey has a different industry classification than NAICS, which explains why forestry and fishing are grouped with mining and oil and gas extraction. Source: CANSIM Table 282-0011, Labour Force Survey, Statistics Canada.

Table 2: Industry Shares* (per cent)

	1987	1999	2004
Real GDP			
All industries	100.0	100.0	100.0
Good-producing sector	34.2	32.6	31.4
Agriculture	1.6	1.7	1.4
Forestry, fishing, mining, oil and gas extraction	5.3	4.7	4.5
Construction	6.7	5.2	5.6
Manufacturing	17.1	18.0	17.3
Utilities	3.5	2.9	2.5
Service-producing sector	65.8	67.7	68.8
Trade	10.5	10.9	12.0
Transportation and warehousing	4.7	4.9	4.8
Finance, insurance, real estate and leasing	17.7	19.4	20.0
Professional, scientific and technical services	2.8	4.2	4.4
Business, building and other support services	1.9	2.0	2.1
Educational services	6.2	4.9	4.3
Health care and social assistance	6.9	6.0	5.9
Information, culture and recreation	3.6	4.6	5.1
Accommodation and food services	2.7	2.4	2.2
Other services	2.1	2.3	2.3
Public Administration	6.7	5.8	5.5
Employment			
All industries	100.0	100.0	100.0
Good-producing sector	29.4	26.1	25.0
Agriculture	3.8	2.8	2.0
Forestry, fishing, mining, oil and gas extraction	2.3	1.8	1.8
Construction	5.9	5.3	6.0
Manufacturing	16.5	15.3	14.4
Utilities	0.9	0.8	0.8
Service-producing sector	70.6	73.9	75.0
Trade	16.1	15.5	15.7
Transportation and warehousing	5.1	5.1	5.1
Finance, insurance, real estate and leasing	6.2	6.0	6.0
Professional, scientific and technical services	3.9	6.3	6.3
Business, building and other support services	2.2	3.5	3.9
Educational services	6.3	6.7	6.5
Health care and social assistance	9.4	9.7	10.9
Information, culture and recreation	4.1	4.4	4.6
Accommodation and food services	5.8	6.4	6.3
Other services	5.1	5.0	4.4
Public Administration	6.2	5.3	5.2

*The selected years are all characterized by an output gap close to zero ($\approx +0.1\%$). The Labour Force Survey has a different industry classification than NAICS, which explains why forestry and fishing are grouped with mining and oil and gas extraction. Sources: Real GDP: GDP at basic prices, 1997 constant dollars, Statistics Canada. Employment: LFS, Statistics Canada.

Table 3: Sectoral Decomposition of the Variation of Aggregate Labour's Share of Income over the Period 1998-2004

Sectors*	$W_{i,98}$	$W_{i,04}$	$lsi_{i,98}$	$lsi_{i,04}$	ΔW	Δlsi	$W_{i,98}\,\Delta lsi$	$lsi_{i,98}\,\Delta W$	$\Delta W\,\Delta lsi$	Sum	Contribution (%)
Agriculture	2.4	2.1	0.348	0.366	-0.3	0.019	0.045	-0.106	-0.006	-0.066	-2.5
Mining	3.5	7.2	0.349	0.156	3.7	-0.194	-0.672	1.291	-0.717	-0.098	-3.6
Utilities	3.3	2.9	0.235	0.232	-0.5	-0.003	-0.010	-0.110	0.001	-0.119	-4.4
Construction	5.0	5.2	0.837	0.785	0.2	-0.052	-0.261	0.198	-0.012	-0.075	-2.8
Manufacturing	19.0	17.9	0.577	0.547	-1.2	-0.031	-0.583	-0.670	0.036	-1.217	-45.4
Wholesale trade	5.7	5.7	0.703	0.646	0.0	-0.057	-0.326	0.013	-0.001	-0.313	11.7
Retail trade	5.4	5.5	0.809	0.764	0.0	-0.045	-0.241	0.036	-0.002	-0.207	-7.7
Transportation	5.0	4.5	0.636	0.656	-0.5	0.020	0.101	-0.316	-0.010	-0.225	-8.4
Info/culture	3.8	3.7	0.456	0.465	-0.1	0.010	0.037	-0.063	-0.001	-0.027	-1.0
Arts/entert.	0.9	0.9	0.561	0.575	0.0	0.014	0.013	0.015	0.000	0.028	1.1
FIREL	18.0	17.3	0.295	0.303	-0.7	0.008	0.143	-0.218	-0.006	-0.081	-3.0
Profes. services	3.7	4.1	0.826	0.806	0.4	-0.020	-0.075	0.316	-0.008	0.233	8.7
Business services	1.9	2.2	0.813	0.827	0.2	0.013	0.026	0.178	0.003	0.207	7.7
Education	5.5	5.0	0.909	0.896	-0.5	-0.013	-0.072	-0.417	0.006	-0.483	-18.0
Health	5.6	5.5	0.743	0.752	0.0	0.009	0.052	-0.018	0.000	0.034	1.3
Accomm./food	2.5	2.2	0.786	0.866	-0.3	0.081	0.204	-0.274	-0.028	-0.098	-3.7
Other services	2.4	2.4	0.562	0.556	0.0	-0.005	-0.013	0.006	0.000	-0.007	-0.3
Publ. admin.	6.4	5.9	0.982	1.036	-0.5	0.054	0.342	-0.483	-0.026	-0.167	-6.2
Overall economy							-1.288	-0.622	-0.771	-2.682	100.0

*The exact nomenclature of these sectors is: Agriculture, forestry, fishing and hunting, Mining and oil and gas extraction, Utilities, Construction, Manufacturing, Wholesale trade, Retail trade, Transportation and warehousing, Information and cultural industries, Arts, entertainment and recreation, Finance and insurance, real estate and renting and leasing, Professional, scientific and technical services, Administrative and support, waste management and remediation services, Educational services, Health care and social assistance, Accommodation and food services, Other services (except public administration) and Public administration.

W stands for weight (reported in per cent), while *lsi* stands for Labour's share of income. The column *Sum* equals to $(W_{i,98}\,\Delta lsi + lsi_{i,98}\,\Delta W + \Delta W\,\Delta lsi)$. The *contribution* for industry i is the ratio of the sum of industry i and the total economy's sum. A negative contribution implies that this sector has contributed to decreasing aggregate labour's share. The line *Overall Economy* is the sum of all industries.

Table 4: Sectoral Decomposition of the Variation of Aggregate Labour's Share of Income over the Period 1998-2004 — Excluding the Mining, Oil and Gas Extraction Sectors

Sectors*	$W_{i,98}$	$W_{i,04}$	$lsi_{i,98}$	$lsi_{i,04}$	ΔW	Δlsi	$W_{i,98}\,\Delta lsi$	$lsi_{i,98}\,\Delta W$	$\Delta W\,\Delta lsi$	Sum	Contribution (%)
Agriculture	2.5	2.3	0.348	0.366	-0.2	0.019	0.047	-0.079	-0.004	-0.036	-10.7
Utilities	3.5	3.1	0.235	0.232	-0.4	-0.003	-0.010	-0.086	0.001	-0.096	-28.0
Construction	5.2	5.6	0.837	0.785	0.5	-0.052	-0.270	0.386	-0.024	0.092	26.9
Manufacturing	19.7	19.2	0.577	0.547	-0.5	-0.031	-0.604	-0.269	0.014	-0.858	-250.6
Wholesale trade	5.9	6.1	0.703	0.646	0.3	-0.057	-0.337	0.178	-0.015	-0.173	-50.6
Retail trade	5.6	5.9	0.809	0.764	0.3	-0.045	-0.250	0.219	-0.012	-0.042	-12.4
Transportation	5.2	4.9	0.636	0.656	-0.3	0.020	0.104	-0.209	-0.007	-0.111	-32.4
Info/culture	3.9	4.0	0.456	0.465	0.0	0.010	0.039	0.003	0.000	0.042	12.3
Arts/entert.	0.9	1.0	0.561	0.575	0.1	0.014	0.013	0.037	0.001	0.051	15.0
FIREL	18.7	18.6	0.295	0.303	-0.1	0.008	0.149	-0.016	0.000	0.132	38.5
Profes. services	3.9	4.4	0.826	0.806	0.6	-0.020	-0.077	0.467	-0.011	0.378	110.4
Business services	2.0	2.3	0.813	0.827	0.3	0.013	0.027	0.256	0.004	0.288	83.9
Education	5.6	5.4	0.909	0.896	-0.3	-0.013	-0.074	-0.245	0.004	-0.316	-92.1
Health	5.8	6.0	0.743	0.752	0.2	0.009	0.054	0.150	0.002	0.206	60.2
Accomm./food	2.6	2.3	0.786	0.866	-0.3	0.081	0.211	-0.213	-0.022	-0.024	-7.0
Other services	2.5	2.6	0.562	0.556	0.1	-0.005	-0.013	0.062	-0.001	0.048	13.9
Publ. admin.	6.6	6.3	0.982	1.036	-0.3	0.054	0.355	-0.263	-0.014	0.077	22.5
Overall economy							-0.638	0.379	-0.084	-0.343	100.0

*The exact nomenclature of these sectors is: Agriculture, forestry, fishing and hunting, Utilities, Construction, Manufacturing, Wholesale trade, Retail trade, Transportation and warehousing, Information and cultural industries, Arts, entertainment and recreation, Finance and insurance, real estate and renting and leasing, Professional, scientific and technical services, Administrative and support, waste management and remediation services, Educational services, Health care and social assistance, Accommodation and food services, Other services (except public administration) and Public administration.

W stands for weight (reported in per cent), while *lsi* stands for Labour's share of income. The column *Sum* equals to $(W_{i,98}\,\Delta lsi + lsi_{i,98}\,\Delta W + \Delta W\,\Delta lsi)$. The *contribution* for industry i is the ratio of the sum of industry i and the total economy's sum. A negative contribution implies that this sector has contributed to decreasing aggregate labour's share. The line *Overall Economy* is the sum of all industries.

Table 5: Cointegration Estimation Results

Dep. Variable = $\text{lsi}_{i,t}$	Panel DOLS	Panel DSUR	Panel OLS
log productivity$_{i,t}$	-0.194	-0.192	-0.134
	(0.000)	(0.000)	(0.000)
union density$_{i,t}$	0.045	0.058	0.074
	(0.673)	(0.069)	(0.153)
openness$_{i,t}$	-0.059	-0.053	-0.052
	(0.196)	(0.000)	(0.073)
Manuf. Sectors	α_i	α_i	α_i
Food	1.11	1.20	16.60
Beverage & tobacco	-0.28	-0.37	10.94
Textiles	9.18	9.55	26.19
Clothing	4.20	3.40	24.89
Leather	9.74	11.13	28.81
Wood product	17.90	21.53	33.86
Paper	9.44	9.85	27.15
Printing	19.29	20.03	34.84
Petroleum & coal	14.23	10.81	24.49
Chemical	4.26	3.36	19.29
Plastics & rubber	11.55	11.59	28.02
Non-metallic min. prod.	8.85	9.35	23.17
Primary metal	17.42	18.22	33.06
Fabricated metal prod.	8.22	8.21	27.65
Machinery	17.69	18.19	34.31
Electric equipment	11.77	13.13	26.84
Transportation equip.	19.86	19.32	32.30
Furniture	9.50	9.19	29.18
Miscellaneous	7.02	8.80	25.12
T	24	24	26
N	19	19	19
Total number of obs.	442	442	494
R^2	0.727	0.737	0.558
Adjusted-R^2	0.675	0.684	0.539

p-values in parenthesis. The reported coefficients α_i are multiplied by 100. Lags and leads of the first differences of log productivity and union density were included in the DOLS and DSUR regressions. These estimated coefficients are not reported, but available upon request.

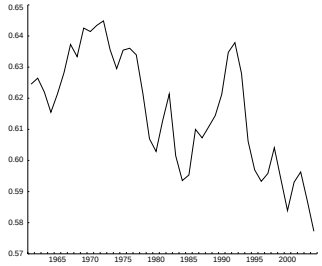
Table 6: Short-Run Dynamics — Estimation Results

Dep. Variable = $\Delta \text{lsi}_{i,t}$			Panel SUR
$\Delta \text{lsi}_{i,t-1}$			0.150
			(0.000)
$e_{i,t-1}^{DSUR}$			-0.676
			(0.000)
Δ log productivity$_{i,t}$			-0.139
			(0.000)
Δ log productivity$_{i,t-1}$			0.073
			(0.000)
Δ log productivity$_{i,t-2}$			-0.038
			(0.000)
Δunion density$_{i,t-1}$			0.034
			(0.000)
Δunion density$_{i,t-2}$			-0.036
			(0.000)
Δunion density$_{i,t-3}$			0.046
			(0.000)
Δopenness$_{i,t-1}$			0.042
			(0.000)
Δopenness$_{i,t-2}$			-0.094
			(0.000)
Δopenness$_{i,t-3}$			-0.065
			(0.000)
Manuf. Sectors	ϕ_i	Manuf. Sectors	ϕ_i
Food	-0.57	Plastics & rubber	0.11
Beverage & tobacco	-0.86	Non-metallic min. prod.	0.06
Textiles	-0.02	Primary metal	1.03
Clothing	0.66	Fabricated metal prod.	2.10
Leather	0.13	Machinery	0.95
Wood product	1.62	Electric equipment	0.31
Paper	3.39	Transportation equip.	-1.45
Printing	0.68	Furniture	0.35
Petroleum & coal	-4.70	Miscellaneous	0.53
Chemical	1.34		
T			22
N			19
T^*N			418
R^2			0.323
Adjusted R^2			0.271

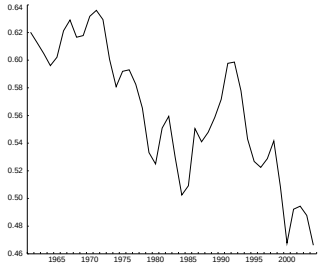
p-values in parenthesis. The reported coefficients ϕ_i are multiplied by 100. SUR allows for conditional correlation between the contemporaneous residuals for cross-section i and j.

B Additional Figures

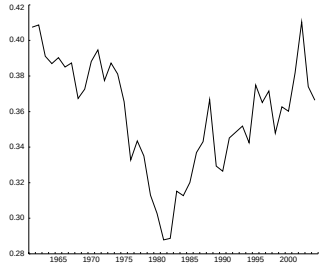
Figure A1: Labour's Share of Income Across Sectors



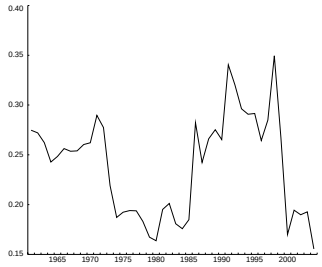
(a) All Industries



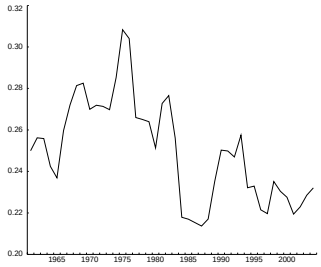
(b) Goods-producing Industries



(c) Agriculture, Forestry, Fishing and Hunting

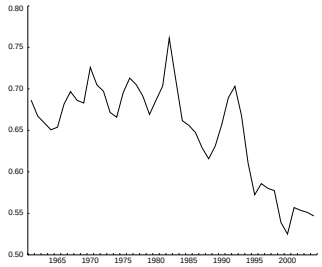


(d) Mining and Oil and Gas Extraction

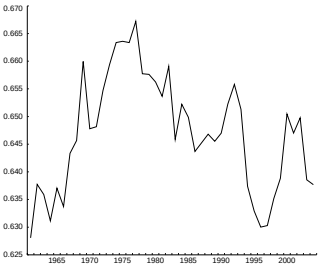


(e) Utilities

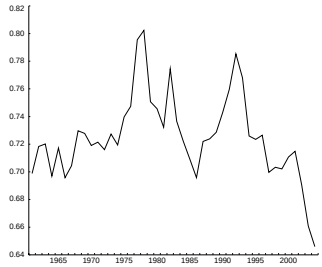
(f) Construction



(g) Manufacturing

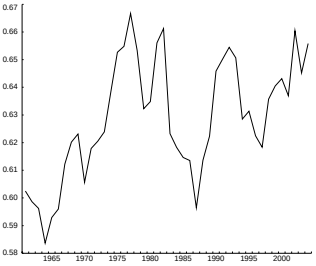


(h) Services-producing Industries



(i) Wholesale Trade

(j) Retail Trade

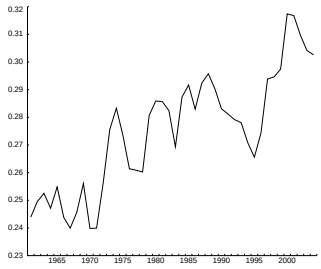


(k) Transportation and Warehousing

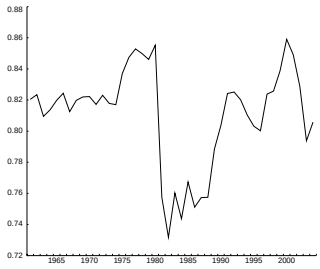
(l) Information and Cultural Industries

Figure A1: Labour's Share of Income Across Sectors (con't)

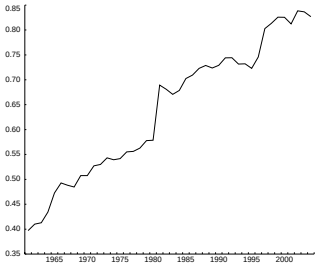
(m) Arts, Entertainment and Recreation



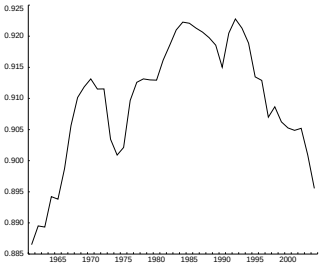
(n) Financial sector



(o) Professional, Scientific and Technical Services



(p) Business Services



(q) Educational Services

(r) Health Care and Social Assistance

(s) Accommodation and Food Services

(t) Other Services

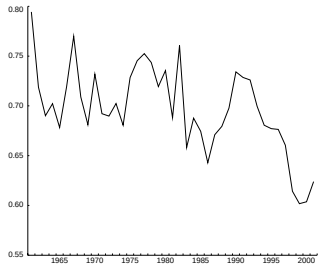
(u) Public Administration

Figure A2: Labour's Share of Income Across the Manufacturing Sectors

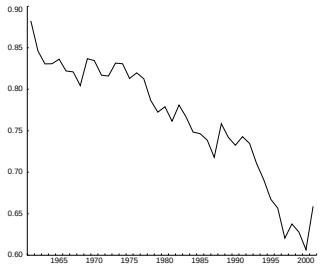
(a) Total Manufacturing

(b) Food Manufacturing

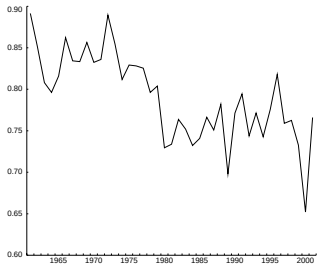
(c) Beverage and Tobacco Product Manufacturing



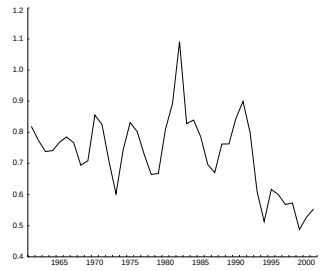
(d) Textile and Textile Product Mills



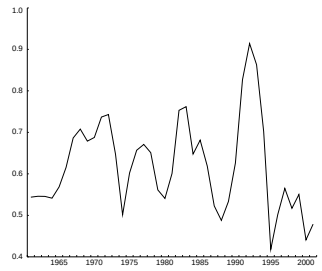
(e) Clothing Manufacturing



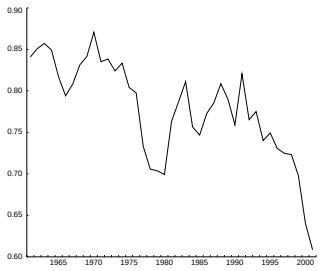
(f) Leather and Allied Product Manufacturing



(g) Wood Product Manufacturing



(h) Paper Manufacturing



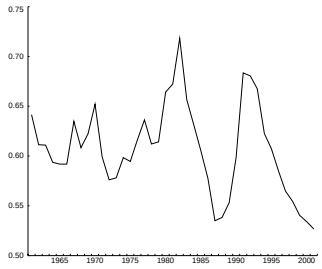
(i) Printing and Related Support Manufacturing

(j) Petroleum and Coal Products Manufacturing

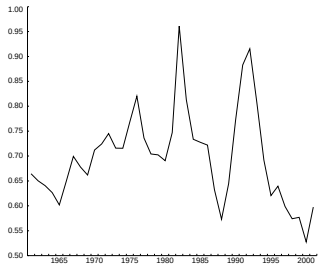
(k) Chemical Manufacturing

(l) Plastics and Rubber Products Manufacturing

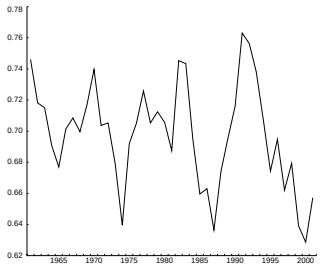
Figure A2: Labour's Share of Income Across the Manufacturing Sectors (con't)



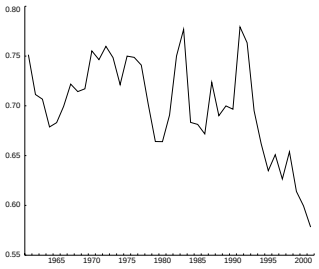
(m) Non-metallic Mineral Product Manufacturing



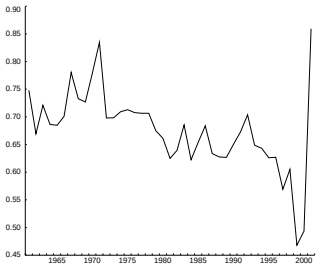
(n) Primary Metal Manufacturing



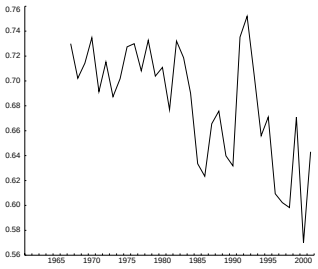
(o) Fabricated Metal Product Manufacturing



(p) Machinery Manufacturing



(q) Computer and Electronic Product Manufacturing



(r) Electrical Equipment, Appliance and Component Manufacturing

(s) Transportation Equipment Manufacturing

(t) Furniture and Related Product Manufacturing

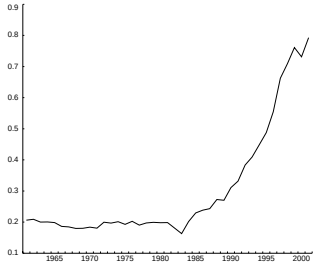
(u) Miscellaneous Manufacturing

Figure A3: Measure of Openness to Trade — Manufacturing Sectors

(a) Total Manufacturing

(b) Food Manufacturing

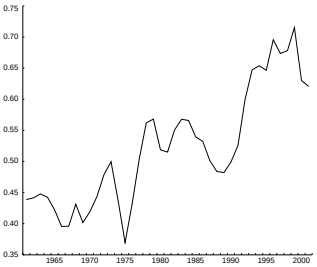
(c) Beverage and Tobacco Product Manufacturing



(d) Textile and Textile Product Mills

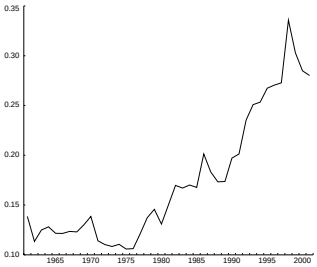
(e) Clothing Manufacturing

(f) Leather and Allied Product Manufacturing



(g) Wood Product Manufacturing

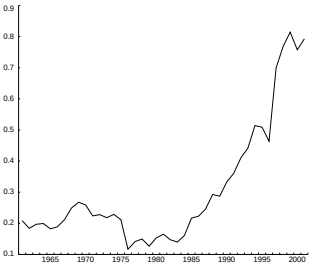
(h) Paper Manufacturing



(i) Printing and Related Support Manufacturing

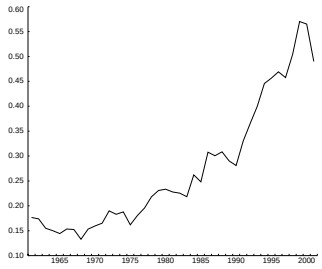
(j) Petroleum and Coal Products Manufacturing

(k) Chemical Manufacturing

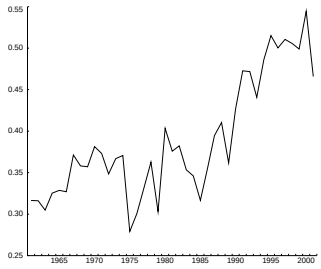


(l) Plastics and Rubber Products Manufacturing

Figure A3: Measure of Openness to Trade — Manufacturing Sectors (con't)

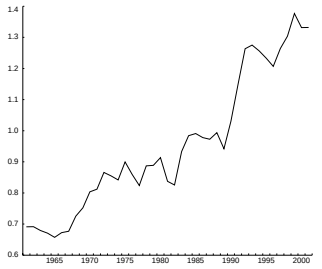


(m) Non-metallic Mineral Product Manufacturing

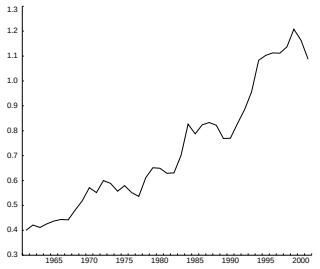


(n) Primary Metal Manufacturing

(o) Fabricated Metal Product Manufacturing



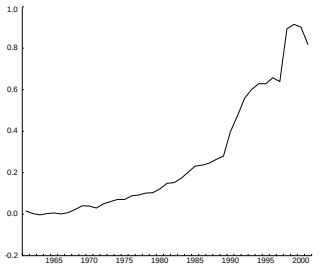
(p) Machinery Manufacturing



(q) Computer and Electronic Product Manufacturing

(r) Electrical Equipment, Appliance and Component Manufacturing

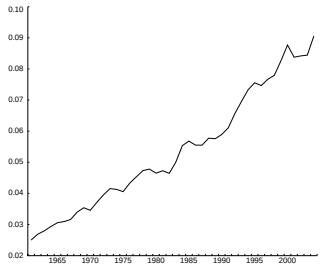
(s) Transportation Equipment Manufacturing



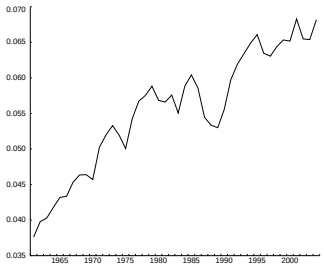
(t) Furniture and Related Product Manufacturing

(u) Miscellaneous Manufacturing

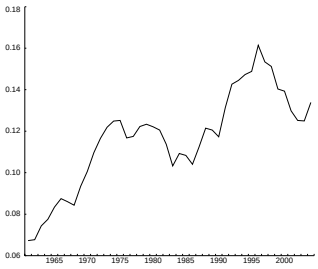
Figure A4: Labour Productivity in the Manufacturing Sectors



(a) Total Manufacturing



(b) Food Manufacturing

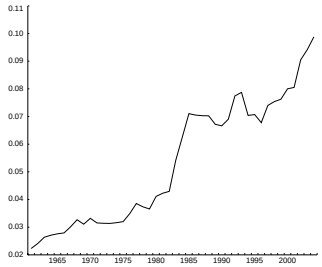


(c) Beverage and Tobacco Product Manufacturing

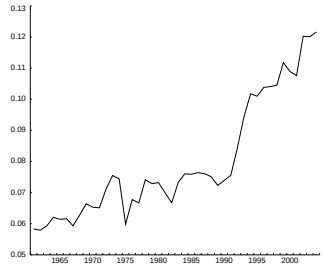
(d) Textile and Textile Product Mills

(e) Clothing Manufacturing

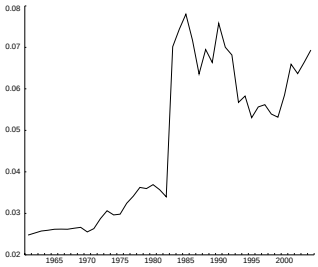
(f) Leather and Allied Product Manufacturing



(g) Wood Product Manufacturing

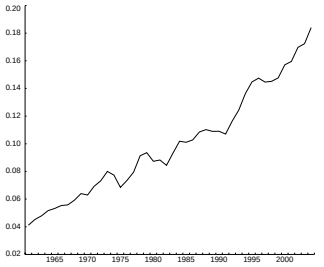


(h) Paper Manufacturing



(i) Printing and Related Support Manufacturing

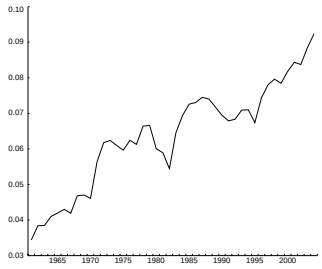
(j) Petroleum and Coal Products Manufacturing



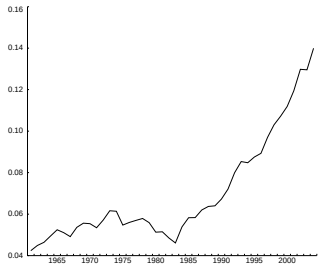
(k) Chemical Manufacturing

(l) Plastics and Rubber Products Manufacturing

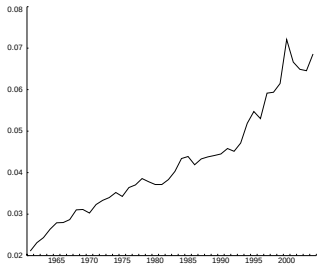
Figure A4: Labour Productivity in the Manufacturing Sectors (con't)



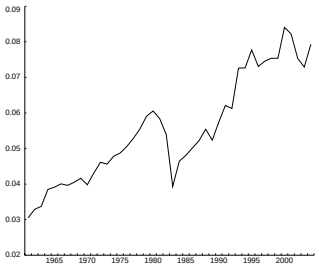
(m) Non-metallic Mineral Product Manufacturing



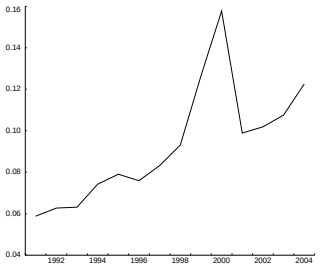
(n) Primary Metal Manufacturing



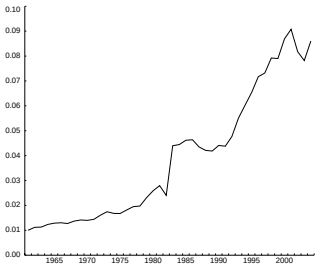
(o) Fabricated Metal Product Manufacturing



(p) Machinery Manufacturing



(q) Computer and Electronic Product Manufacturing



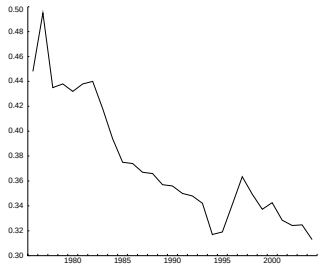
(r) Electrical Equipment, Appliance and Component Manufacturing

(s) Transportation Equipment Manufacturing

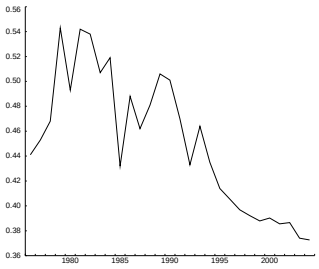
(t) Furniture and Related Product Manufacturing

(u) Miscellaneous Manufacturing

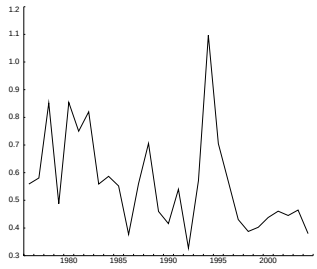
Figure A5: Union Density Within Manufacturing Sectors



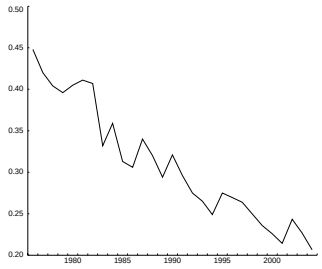
(a) Total Manufacturing



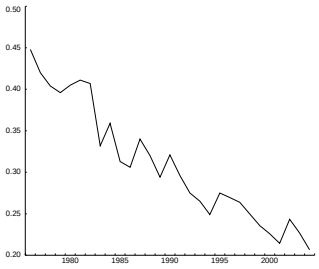
(b) Food Manufacturing



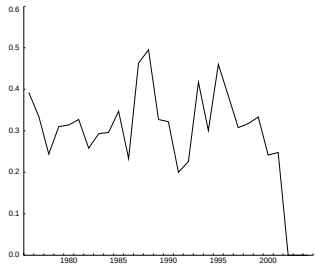
(c) Beverage and Tobacco Product Manufacturing



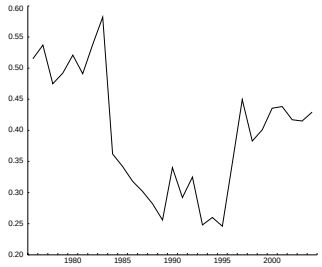
(d) Textile and Textile Product Mills



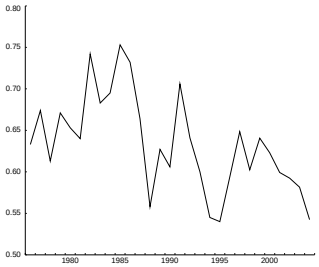
(e) Clothing Manufacturing



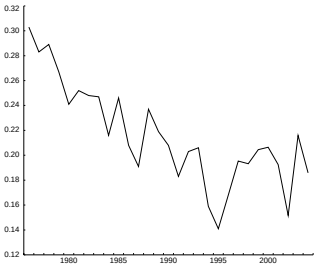
(f) Leather and Allied Product Manufacturing



(g) Wood Product Manufacturing

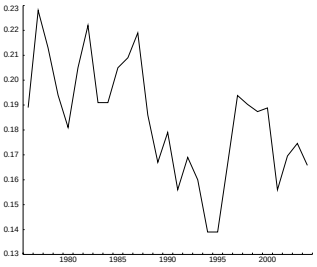


(h) Paper Manufacturing

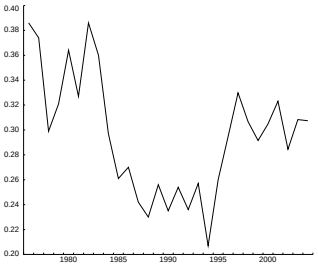


(i) Printing and Related Support Manufacturing

(j) Petroleum and Coal Products Manufacturing

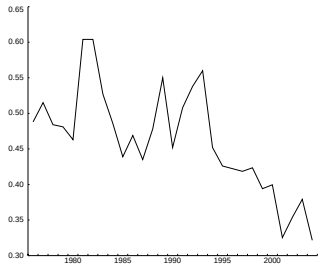


(k) Chemical Manufacturing

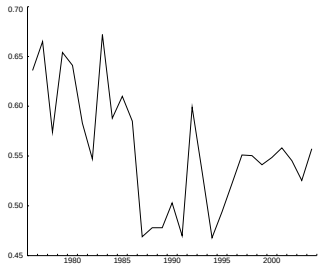


(l) Plastics and Rubber Products Manufacturing

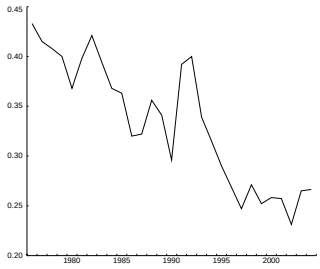
Figure A5: Union Density Within Manufacturing Sectors (con't)



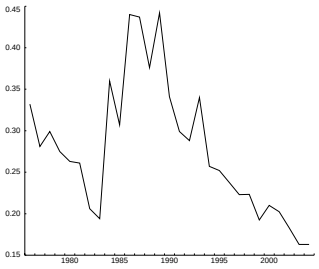
(m) Non-metallic Mineral Product Manufacturing



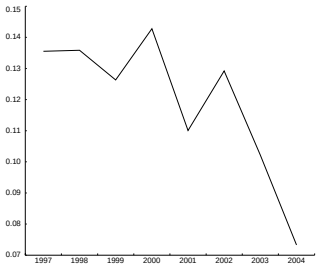
(n) Primary Metal Manufacturing



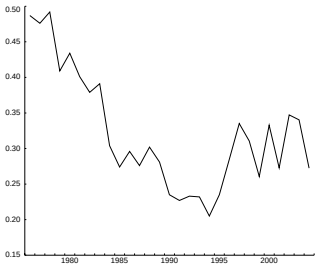
(o) Fabricated Metal Product Manufacturing



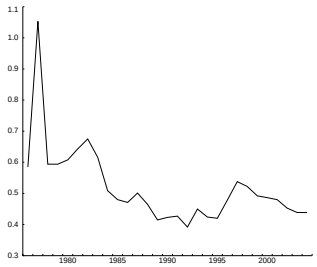
(p) Machinery Manufacturing



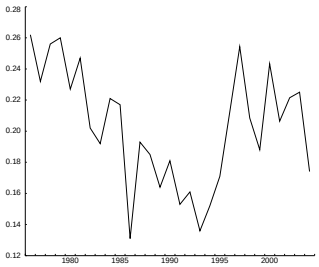
(q) Computer and Electronic Product Manufacturing



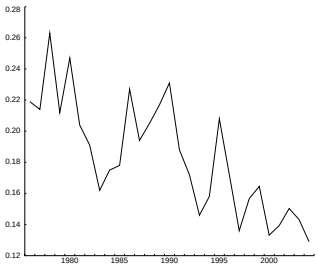
(r) Electrical Equipment, Appliance and Component Manufacturing



(s) Transportation Equipment Manufacturing



(t) Furniture and Related Product Manufacturing



(u) Miscellaneous Manufacturing