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Trade and Wages: A Non-Stolper-Samuelson Explanation Evidence from Canada

by

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**A thesis submitted to
the Department of Economics
for the final seminar
in partial fulfillment of the requirements for the degree of
the Doctor of Philosophy**

**Carleton University
Ottawa, Ontario**

June, 2001

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acceptance of the thesis,

**"Trade and Wages: A Non-Stolper-Samuelson Explanation
Evidence from Canada"**

submitted by

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in partial fulfilment of the requirements
for the degree of Doctor of Philosophy

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Abstract

During the 1980s and 1990s, wages of educated workers relative to those of less-educated workers increased in most industrialized countries. However, countries with relatively inflexible labour markets experienced an increase in unemployment of less-skilled (or, less-educated) workers. The search for factors that would explain this phenomenon led to vigorous debate among economists. A consensus has yet to emerge. Three main explanations of the relative wage phenomenon are:

- Trade liberalization
- Skilled-biased technological progress and
- Both trade liberalization and technological progress

The trade liberalization explanation is furnished by a well-known “Stolper-Samuelson Theorem”, which says that a lowering of trade barriers by the domestic economy would increase the real wages of educated workers and would decrease the real wages of the less-educated workers. Since the increase in the wage gap between educated and less-educated workers occurred at the same time as barriers to international transactions were coming down, some trade economists attributed the causation going from trade liberalization to the widening of the wage gap.

The second explanation would argue that it was actually the technological progress of the 1980s and 1990s that primarily generated greater demand for skilled workers, resulting in the observed widening of the wage gap. Moreover, the better fitting of the data with the latter explanation rather than the Stolper-Samuelson Theorem was taken as an evidence for skilled-biased technological change to be playing a causal role independent of “internationalization”.

The third and unifying explanation would suggest that a large part of the wage gap could be attributable to the skilled-biased technological change but trade liberalization would also be a contributing factor. Just because the observed phenomena does not fit the Stolper-Samuelson Theorem does not mean that trade as a cause should be ignored altogether. This alternative explanation was developed in a model by Bhagwati and Dehejia (1994) in their widely cited article, “Freer Trade and Wages of the Unskilled – Is Marx Striking Again?”.

Developing the Bhagwati and Dehejia alternative trade explanation and empirically testing it for Canada is the objective of this dissertation. More specifically we test:

- The relationship between trade liberalization as well as technological progress and the change in wages of educated workers and less-educated workers in Canada.
- The suggested underlying linkages between trade liberalization and the change in the wage gap between educated and less-educated workers in Canada.

We ask and answer the following questions:

- (1) Did the wages of educated workers rise relative to those of less-educated workers in Canada between 1993 and 1996?
- (2) What factors would explain such an increase in the wage gap?
- (3) Was trade liberalization a causal force behind the wage gap?

We show that after correcting for the relative supply effect of educated to less

educated workers the wage differential would have been on an upward trend. Unionization, is shown to have had little or no effect. Moreover, after holding fixed for some most likely factors influencing real wages, it is found that trade had a significantly positive impact on the wages of both educated and less educated workers. However, the impact on educated workers seems to have been some four times stronger, roughly the same as the impact of technology on relative wages. We also show that the observed relationship between trade and the relative wage of educated to less-educated workers doesn't fit the Stolper-Samuelson theoretical explanation. Rather, the theoretical explanation provided by Bhagwati and Dehejia is more in line with the observed results in this dissertation.

The Bhagwati and Dehejia explanation is based on the hypothesis that trade liberalization has made many industries "footless" (i.e. small shifts in costs can cause comparative advantage to shift suddenly from one country to another), hence making comparative advantage "Kaleidoscopic" (i.e. one country may have comparative advantage in X and another in Y one day, and next day it may suddenly be reversed). This in turn leads to increased labour turnover. The added turnover means that mobile workers could be accumulating less skills causing a reduction or stagnation in the real wages of the affected workers. However, it is assumed the less-educated will be affected by more. These factors as a whole provide a trade-dependend explanation for the observed wage differential between educated and less-educated labour.

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Table of Contents

Abstract	i
Acknowledgments	iii
Table of contents	iii
List of tables and figures	ix
Chapter 1. Introduction and Literature Review	1
1.I. Introduction	1
1.II. Literature Review	6
Chapter 2. Kaleidoscopic Comparative Advantage and Higher Labour Turnover An Alternative Trade Model	16
2.I. Introduction	16
2.II. An Alternative Modeling of the Bhagwati/Dehejia Hypothesis	17
2.III. Description of Data Sources	25
2.IV. The Period 1993-1996	27
2.V. Definitions of The Educated and the Less-Educated	29
2.VI. Summary Statistics and Mean Analysis of Key Variables	31
Chapter 3. Trade and Education Premium in Canada	35
3.I. Introduction	35
3.II. Education (Skill) Premium in Canada	36
3.III. Trade and Educated/less-Educated Wage Differential	44
3.IV. Summary	53

Chapter 4. Trade Liberalization, Trade Volatility, and Labour Turnover	54
4.I. Introduction	54
4.II. Trade Volatility and Educated/less-Educated Wage Differential	55
4.III. Trade Intensity, Job Duration, and labour Turnover	60
4.IV. Trade Volatility and Labour Turnover	63
4.V. Summary	66
Chapter 5. Labour Turnover, Jobless Spells and Relative Wages	67
5.I. Introduction	67
5.II. Labour Turnover and Relative Wages	68
5.III. Econometric Analysis of Labour Turnover, Jobless Spells and Relative Wages	70
5.IV. Econometric Analysis of Labour Turnover and Relative Wages	73
5.V. Jobless Spells and Relative Wages	75
5.VI. Fixed Effect Estimation	77
5.VII. Summary	80
Chapter 6. Conclusion and Policy Implications	82
6.I. Summary and Conclusion	82
6.II. Policy Implications	87
Appendix I. The Bhagwati and Dehejia Model	89
Appendix II. Definitions of Variables	93
Appendix III: The Effect of Tenure vs. Experience on Skill Accumulation	95
References	96

List of Tables and Figures

Figures

Figure 1.1. Relative supply and relative demand of educated workers	9
Figure 4.1. Trade intensity and labour turnover	62
Figure 5.1. Turnover and relative wages	69
Figure 5.2. Educated/less-educated relative wages	75
Figure 2.1. Edgeworth Box diagram	90

Tables

Table 1. Canada trade and tariff statistics	29
Table 2. Mean wage rates by education levels	31
Table 3. Descriptive statistics of educated/less-educated workers	33
Table 4. Education premium in percentage	37
Table 5. Relative supply of educated workers	38
Table 6. Skill premium suppressed by relative labour force growth (in percentage)	39
Table 7. Skill premium adjusted for the relative supply growth (in percentage)	39
Table 8. Wage premium suppressed due to unionisation (in percentage)	41
Table 9. Percentage by wage less-educated unemployment rate exceeds that of educated	42
Table 10: Share of educated workers in total employment	44
Table 11. Semi-log estimates of regression (1) of page 45	51

Table 12. Log-linear estimates of regression (1) of page 45	52
Table 13. Semi-log estimates of regression (1) of page 58	58
Table 14. Log-linear estimates of regression (1) of page 58	59
Table 15. Percentage of educated/less-educated workers by tenure level	61
Table 16. Results of regression (2) of page 63	65
Table 17. Estimates of equation 10 of chapter 2	71
Table 18: Estimates of log wages on labour turnover	74
Table 19. Estimates of a variant of equation 10 of chapter 2	77
Table 20. Fixed Effect estimates of wages on tenure, experience	79
Table 21. Fixed Effect estimates of wages on jobless spells	80

CHAPTER 1

Introduction and Literature Review

I. Introduction

During the 1980s and 1990s the wage differential of skilled to less-skilled (alternatively, educated to less-educated) workers widened in almost all developed countries. However, countries with relatively inflexible labour markets experienced an increase in unemployment of less-skilled workers over the same period. The search for factors that would explain this phenomenon led to a flood of possible explanations, yet a consensus has to emerge.

Two widely suggested causes of the wage differential phenomenon are trade expansion with developing countries and a skill-biased technological change. The former is usually referred to as the Stolper-Samuelson effect after the Stolper-Samuelson Theorem (SST). The SST states that the reduction in trade barriers will increase the real return to the factor that is relatively abundant in the country, and decrease the real return to the rival factor. Since wage differential has coincided with falling barriers to international transactions, particularly between the developed North and the less developed South, it has given the proponents of trade explanation such as Borjas and

Ramey (1994), Borjas, Freeman and Katz (1992), Buckberg and Thomas (1996), Leamer (1993, 1995), MacPherson and Stewart (1990), Murphy and Welch (1991), Ravenga (1992), Rowthorn and Ramswamy (1998), Saeger (1997), and Wood (1991, 1994, 1995, 1998), reasons for believing that the association between the two phenomena (i.e. the educated to less-educated workers' wage differential and reduction of trade barriers) is causal.

On the other hand, the supporters of the technological change explanation such as Bartel and Lichtenberg (1987), Berman, Bound and Griliches (1994), Bound and Johnson (1991), Davis and Haltiwanger (1991), Katz and Murphy (1992), Kruger (1993), Krugman and Lawrence (1994), Lawrence and Slaughter (1993) and Mincer (1991) reason the better fitting of the data with their story than with the Stolper-Samuelson Theorem as an evidence for skill-biased technological change to be playing a causal role independent of "internationalization". Yet, a third group of economists such as Freeman and Needels (1993) and Murphy, Riddell and Romer (1998) argue that neither trade nor technology is the culprit. They maintain that both over time and between countries the variation of rate of growth of relative wages can be explained by variation in the relative supply of more-educated workers alone

Some economists such as Bhagwati (1993), Murphy and Welch (1991); Sachs and Shatz (1994) agree that skilled-biased technological change perhaps is predominantly responsible for the wage differential phenomena; however, they maintain that the impact of trade on relative wages is too real to be ignored. Just because the observed phenomena does not fit the Stolper-Samuelson Theorem (SST) does not mean

that trade as a cause should be ignored altogether. In fact, for Canada, Baldwin and Rafiquzzaman, (1998) in a paper in which they investigated the extent to which the skilled to less-skilled wage differential had widened and to what extent it was caused by trade and/or skill-biased technological change, confirmed that both were at work. Therefore, there was a need for an alternative explanation that was trade-dependent but did away with SST. This is what Bhagwati and Dehejia (1994) did in their widely cited article, "Freer Trade and Wages of the Unskilled--Is Marx Striking Again?".

The Bhagwati/Dehejia alternative trade explanation is based on the hypothesis that trade liberalization has made many industries "footloose", hence, making comparative advantage "Kaleidoscopic". "Footloose" is a situation in which small shifts in costs can cause comparative advantage to shift suddenly from one country to another, while "Kaleidoscopic" refers to a situation in which one country may have comparative advantage in X and another in Y one day, and next day it may suddenly be reversed.

This hypothesis above in turn leads to three main consequences: (1) increased *ceteris paribus* labour turnover; (2) the added turnover means that the mobile less-educated labour could be accumulating less skills due to the "rolling-stone-gathers-no-moss" effect, causing a reduction or stagnation in real wages of less educated workers (the educated workers are assumed to be shielded from the "rolling-stone-gathers-no-moss-effect" for reasons explained in chapter 2); (3) these factors as a whole provide a trade-dependent explanation for the observed wage differential between skilled (or educated) and less-skilled (or less-educated) labour. Bhagwati and Dehejia, nevertheless, admit that they "doubt that this alternative explanation can carry the weight that the

technical-change (and technological) explanation probably does, but it could well be a contributory factor of some, perhaps also growing importance”.

The hypothesis that trade liberalization has made comparative advantage “kaleidoscopic” is based on the observed evidence that “the world economy is now increasingly integrated and that the convergence of technology among the Organization for Economic Cooperation and Development (OECD) countries and the spread of global multinational corporations around the world have brought many modern industries within the grasp of countries. Many more industries, therefore, are now ‘footloose’ than before” (Bhagwati and Dehejia, 1994). The evidence of increasing globalization is documented by many researchers such as Baumol, Backman and Wold (1989), Frankel (1994) and Dunning, Kogut and Blomstrom (1990)¹.

One of the most significant characteristics of the globalization of production is the extent to which it aids the mobility of assets, notably money capital and innovatory capacity, and of intermediate products, notably technology and management skills, across national boundaries. This mobility immediately offers the owners of these assets and products a wider option in their location of use – hence described as “footloose”.

Developing the Bhagwati/Dehejia alternative trade dependent explanation and empirically testing it for Canada is the objective of this dissertation. On the theoretical front we develop a model that bears three distinctive features:

1. It does not require that the countries be specified as North and South or that home country be relatively more or less one factor abundant in comparison with its trading

¹ Globalization of Firms and the Competitiveness of Nations, Institute of Economic Research Lund

partner as in the Heckscher-Ohlin-Stolper-Samuelson framework. The model suggests that the effect of trade on the Canadian wages is the same whether the trading partner is the United States or Mexico. If the empirical result confirms what this theory suggests, it will certainly challenge the conventional thinking about the impact of trade on unskilled workers. Usually, it is the trade with the South that is expected to affect the wages of the less-skilled adversely; however, the theoretical explanation presented in this paper suggests that it is the trade with the North that can be more effectual.

2. It does not leave out other important explanations such as supply, demand and technological change explanations as contributing factors to the widening of wage differential. As a priori the relative supply of educated to less-educated workers and a skilled biased technological change are shown to have affected the relative wages of the educated to less-educated negatively and positively respectively.
3. It separates learning by doing from technological change and explicitly enters it into the wage equation. It is then shown that it is through the learning by doing parameters that trade liberalization translates into the widening of educated to less-educated wage differential.

Empirically, on the issue of trade and the educated to less-educated (or, skilled to less-skilled) wage differential, very little research has been done for Canada. The only paper that explicitly investigated the trade effect alongside the technological change effect on the wage differential between non-production (skilled) and production

(unskilled) workers is that of Baldwin and Rafiquzzaman (1998). They found that the skilled to less-skilled wage differential, indeed, had widened in the 1980s and that both technological change and trade liberalization seemed to have been responsible for that.

Unfortunately, like most of the studies done for the U.S., Baldwin and Rafiquzzaman as well investigated the causal links between the volume of trade and relative wages without grounding their empirical findings in a theoretical framework. It is also fair to say that their study was geared more toward investigating the impact of technology rather than that of trade. This paper, nonetheless, provides a step by step investigation of the channels through which trade is hypothesized to have caused the wage differential. The by-product obtained from investigating the channels such as the impact of trade liberalization on labour turnover and of labour turnover on skill accumulation will certainly add to important empirical findings about the Canadian labour market.

II. Literature Review

A formal theoretical relationship between trade and wages was first established by Stolper and Samuelson in 1941 in their article "Protection and Real Wages" in the *Review of Economic Studies* -- now known as the Stolper-Samuelson Theorem (SST). Briefly, the SST implies that in a two-factor world with complete mobility of factors within a country, liberalization of international trade will lower the real return to one factor of production and increase the real return to the other. Back then, when the SST

was initially written, it did not create much of a debate because it was considered nothing more than a "brilliant theoretical performance" (Deardorff and Stern, 1994). The managing editor of the American Economic Review, Paul Homan, in a letter to Samuelson in which he rejected their paper, put it that their paper was "a very narrow study in formal theory, which adds practically nothing to the literature of the subject with which it is nominally concerned. it does not, in other words, have anything to say about any of the real situations with which the theory of international trade has to concern itself" (Deardorff and Stern, 1994).

Over the following four decades there were a number of articles written on the subject extending the SST in several directions. For example, Bhagwati (1959) extended the scope of the discussion around SST and showed that the impact of either protectionism or trade liberalization on real income of the factors of production (such as labour) was not necessarily the same as their impact on the real wages earned by factors in employment. That is, with some redistribution policy it was possible that a factor whose real wage falls with either protection or trade liberalization may still end up with a higher real income.

Jones (1965) proved that the SST asserted the existence of a special relationship between commodity and factor prices: namely, that an increase in the price of a commodity would bring about a more-than-proportionate increase in the price of the corresponding intensive factor. Chipman (1969) showed that the two 2-factors, 2-goods (or, 2X2) Stolper-Samuelson model could not extend to the case of n -products and n -factors such that an increase in the price of the i -th good resulted in an increase in the

real reward of the i -th factor which was used relatively intensively in the i -th industry and a decline in the real rewards of all other factors unless strict restrictions were imposed.

Kemp and Wegge (1969) showed that the 2X2 model devoted to the relation between product and factor prices could also apply symmetrically to a factor and output relationship. That is, in the 2X2 case an increase in a country's endowment of the i -th factor, commodity prices held constant, would lead to an increase in the output of that industry (the i -th) in which the i -th factor is used relatively intensively, and to a decline in the output of the other industry. Magee (1980) empirically tested the SST on 1973 United States data and rejected it, explaining that unlike, assumed by SST, factors actually were less mobile between industries in advanced industrial societies because of sector specific human capital and high-technology physical capital. Like the initial Stolper-Samuelson paper the above papers as well were not considered more than theoretical performances that had little to do with the real world situations.

However, this all changed in the late 1980s and 1990s when it was observed in some developed countries, particularly in the United States, that the skilled to less-skilled (or educated to less-educated) workers' wage differential was rising. For example, in the United States the wage differential between college and high school graduates rose from 38% in 1980 to 53% in 1990; and the wage differential between college graduates and high school dropouts rose from 66% to 86%. Countries with relatively inflexible labour markets experienced an increase in unemployment of less-skilled workers over the same period (Buckberg and Thomas, 1996; Gottschalk and Smeeding, 1997; Murphy

and Topel, 1997; Murphy and Welch, 1991; OECD, 1997; Wood, 1994 and 1998).

Partial equilibrium analysis of labour economics suggests that the increase in wage differential could be due either to changes in relative supply or in relative demand of skilled workers. For example, in Figure 1 if the initial equilibrium was in point a then the rise of the relative wage rate of skilled workers from w_0 to w_1 implies that either the relative-demand curve of skilled workers shifted to n_d' or that their relative-supply curve shifted to n_s' , or some combination.

Figure 1

Because during the 1980s and 1990s the wage differential seemed to be demand pulled -- that's the demand for low-skilled labour declined relative to that for skilled labour in most developed countries in the manufacturing sectors, and because this coincided with a rapid growth of imports of low-skilled-intensive manufactures, many economists saw this coincidence as a "good economic reason" for believing that the

association between the two phenomena (i.e. relative wage dispersion and reduction of trade barriers) was causal² and were therefore prompted to conclude that the dormant Stolper-Samuelson Theorem (SST) was finally at work.

Wood (1994) in his book, *North-South Trade, Employment and Inequality*, studied the effects of trade on wages for a number of OECD countries³ showing a clear inverse correlation across developed countries between rising import penetration ratios and falling shares of manufacturing in employment. Similarly, Sachs and Shatz (1994), using factor content methods to estimate the impact of the 1978-1990 change in trade on the employment of skilled and unskilled workers in the US manufacturing, showed that trade with developing countries reduced manufacturing employment, particularly of unskilled workers since output declines were concentrated on sectors with relatively few skilled workers. The result obtained in Rowthorn and Ramaswamy (1996) is much on the same line. From this, Wood concluded that no interpretation other than “the former causing the latter” was permissible (Wood, 1998). Borjas, Freeman and Katz (1991), Murphy and Welch (1991), Leamer (1992, 1995) reached much the same conclusion.

In Borjas, Freeman and Katz (1991), the authors focused on the labour market effects of immigration and trade in the United States⁴, particularly investigating: (1) how much immigration and trade altered the labour skill endowments of the US in the 1980s?

² “Good economic reasons” can be interpreted as the holding of Stolper-Samuelson Theorem which states that the reduction in trade barriers will increase the real return to the factor that is relatively abundant in the country, and decrease the real return to the rival factor.

³ They include Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Norway, Sweden, Switzerland, The Netherlands, United Kingdom, and United States of America.

⁴ Borjas, Freeman and Katz (1991), Katz and Murphy (1992), and Murphy and Welch (1991) use trade volumes and trade deficits as variables of trade liberalization. Whereas, others such as Revenga (1992) use the prices of traded goods for the same purpose.

(2) how large a contribution did they make to the decline in the relative earnings of the less-skilled workers during the same period? Their analysis revealed that immigration and trade “significantly altered the US skill endowments by enough to have contributed substantially to the decline in the relative earnings of less-skilled workers during the 1980s”.

Murphy and Welch (1991), in a thorough calculation of the effects of international trade on the changes in industrial structure of employment demand and hence wages, concluded that the evolving pattern of international trade was perhaps a primary cause of recent wage changes. Leamer (1992, 1995), in his study of the impact of the North American Free Trade Agreement, is of the view that wage differential in the North (particularly in the US) could be explained using the SST.

Other economists (still focused on the US economy), however, argued that trade has had only little or no effect on recent wage changes. For example, Borjas, Freeman and Katz maintained that although the effect of trade on wage differential has been significant, the trade flows explained at most 15 percent of the 12.4 percent increase between 1980 and 1988 in the earnings differential between college-educated and high-school-educated workers in the United States. Berman, Bound and Griliches (1994) and Bound and Johnson (1992), on the other hand, did not find much role for trade at all in the US wage changes in the 1980s either. Instead, they ascribed the observed relative wage movements to biased technological changes. Sachs and Shatz (1994) argued that the overall changes in employment and wage inequalities in the US were too large to be explained by the changing trade and price patterns. It was, therefore, possible that

technological change was playing a role independent of trade.

Krugman and Lawrence (1994) argued that the linkage between trade in manufacturing goods and manufacturing employment (and therefore the wage structure) was not causal but merely spurious. The reason they gave was that the fall in the manufacturing share of GDP had seen a secular trend since well before the rapid internationalization of the US economy that started in the 1970s. They saw the decline in the manufacturing share of GDP resulting from a secular decline in the relative prices of manufacturing goods, which in turn was caused by a relatively rapid growth of productivity in manufacturing. As they put it: "the concern, widely voiced during the 1950s and 1960s, that industrial workers would lose their jobs because of automation is closer to the truth than the current preoccupation with a presumed loss of manufacturing jobs because of foreign competition".

Lawrence and Slaughter (1993) in their widely cited article, *International Trade and American Wages in the 1980s: Giant Sucking Sound or Small Hiccup?*, argued that if trade were to be the cause of skilled to less-skilled workers' wage dispersion, then the SST implied that two intermediate steps must hold: the increase in the relative prices of skilled-intensive goods and a decline in the ratio of skilled to less-skilled workers employed in all industries. Empirical evidence was to the contrary of both steps. Bound and Johnson (1992) and Berman, Bound and Griliches (1994) in their detailed industry level study showed that the ratio of skilled to less-skilled workers had risen in almost all industries over the period under investigation.

Moreover, Bhagwati (1991) and Lawrence and Slaughter (1993), having

examined the terms of trade data for US exports and imports of manufacturers, found a slight increase in the relative prices of importable goods and a slight decrease in the relative prices of exportable goods. Lawrence and Slaughter, therefore, concluded that the fall in the relative prices of the US exportables and the decreasing ratio of skilled to less-skilled workers could not be due to trade but due to some other cause, of which skill-biased technological change seemed most likely. Economists such as Bartel and Lichtenberg (1987), Davis and Haltiwanger (1991), Katz and Murphy (1992), Kruger (1993), Krugman and Lawrence (1994), and Mincer (1991) reached much the same conclusion.

Deardorff and Hakura (1994) and Bhagwati (1995) argued that for any study of the trade effect on wages, one had to specify the linkage between the two in theoretical terms before going about testing the relationship. Unfortunately, most of the results reviewed above, whether they supported the trade explanation or the technology explanation, did not follow from a “theoretically sound” relationship between trade and wages. These studies were just focused on the empirical relationship of trade volume or trade balance and wages, without paying any heed to grounding the relationship between the alleged causes and effects in well-defined models. “We know of no general and direct relationship between the wages and the volume [or balance] of trade that exists in any general equilibrium theory of trade” (Deardorff and Hakura, 1994; Bhagwati, 1991 and 1995).

In the general equilibrium (i.e. in the Heckscher-Ohlin-Stolper-Samuelson framework) the volume and balance of trade are endogenous to the changes in the

relative world prices of tradable goods, or, changes in trade barriers just as the wages are endogenous to these changes. Moreover, Deardorff and Hakura (1994) and Bhagwati (1995) identified at least five factors⁵ (of which only one was related to trade) that could be responsible for an increase in both trade volume (or balance) and skilled to less-skilled workers wage differential concurrently. Therefore, any conclusion about the trade effect on wages that was derived from testing the relationship between wages and the volume or balance of trade, while ignoring the possible endogeneity of the latter, was suspect.

Some studies recognizing the above fact that general equilibrium trade theory explained wages in terms of prices, not volume or balance of trade, tested the relationship between prices and wages⁶. However, the problem with these studies was that they failed to identify the sources of the change in prices. Not all price changes were due to reduction in trade barriers – the effect of technological change on prices is just one example. Thus, unless we know the source of the price change, we cannot establish whether the price change is exogenous or endogenous – and if we cannot establish that, we cannot claim of the presence of the Heckcher-Ohlin-Stolper-Samuelson trade effect.

The general consensus is that the Stolper-Samuelson Theorem cannot explain the trade effect on wages. If we consider the SST to be the only trade dependent explanation, then obviously trade is not responsible for adversely affecting the less-skilled workers.

⁵ They are: 1) tariff cut on imports of less-skilled-intensive goods (LSIG) ; 2) foreign expansion in the production of (LSIG); 3) technical progress at home in the production of skilled-intensive good (SIG); 4) technical regress at home in the production of LSIG; and 5) rise in expenditure at home (please see Deardorff and Hakura (1994) for a detailed discussion).

⁶ Examples are Leamer (1993) and Lawrence and Slaughter (1993).

However, if we believe that the correlation between trade and wages is too robust to be ignored then we need to come up with some alternative trade-dependent explanation that does away with the SST. The Bhagwati and Dehejia “Kaleidoscopic Comparative Advantage and Higher Labour Turnover” explanation is one such alternative explanation.

CHAPTER 2

Kaleidoscopic Comparative Advantage and Higher Labour Turnover An Alternative Trade Model

I. Introduction

As discussed in chapter 1 the Bhagwati/Dehejia alternative trade explanation is based on the hypothesis that trade liberalization has made many industries “footloose”, hence, making comparative advantage “Kaleidoscopic”¹. This hypothesis in turn leads to three chain consequences: (1) increased *ceteris paribus* labour turnover; (2) the added turnover means that the mobile less-educated labour could be accumulating less skills due to the “rolling-stone-gathers-no-moss” effect, causing a reduction or stagnation in real wages of less educated workers. (3) these factors as a whole provide a trade-dependent explanation for the observed wage differential between skilled (or educated) and less-skilled (or less-educated) labour.

The educated workers are assumed to be shielded from the “rolling-stone-gathers-no-moss-effect” because of the presumptions that educated labour has general (rather than industry specific) knowledge and can shift their acquired know-how readily to new

jobs and that the search period spells between jobs are probably used by the educated to retool. The latter assumption is based on the reasoning that having learned once, one can learn again.

In this chapter we first develop the Bhagwati/Dehejia alternative trade explanation into a formulated and testable model in section II. In section III we provide a description of the data sources being employed in this dissertation. In section IV we explain why the years 1993-1996 for which the data is available would be appropriate for our analysis. In section V we present definitions of the “educated” and “less-educated” workers. In section VI summary statistics of the data are tabulated and mean statistics are analyzed.

II. An Alternative Modeling of The Bhagwati/Dehja Hypothesis

The Bhagwati/Dehejia modeling of their alternative trade-dependent explanation that is recapped in Appendix I embodies two limitations: (1) the result depends on the usual Heckscher-Ohlin (HO) North-South specifications in which North has to be relatively skilled-abundant. However, an interesting feature of the Bhagwati/Dehejia explanation is that it does not depend on the strict assumptions of H-O or some other trade theory. Its result does not require that the countries be specified as North and South or that home country be relatively more or less one factor abundant in comparison with its trading partner.

¹ See chapter 1 for explanations.

For example, the effect of trade on the Canadian wages will be the same whether the trading partner is the United States or Mexico. (2) it does not include other possible explanation (i.e. supply, demand and technological change explanations). However, Bhagwati and Dehejia, while characterizing their hypothesis, admit that they “doubt that this alternative explanation can carry the weight that the technical-change (and technological) explanation probably does, but it could well be a contributory factor of some, perhaps also growing importance”. We, therefore, remodel the Bhagwati-Dehejia explanation such that the above-mentioned limitations are remedied for.

The basic model we use to motivate our analysis is based on a constant elasticity of substitution (CES) function of the type used by Bound and Johnson (1992) in which the output of each of the J industries (Y_j) depends on physical capital intensity (k_j) and a constant elasticity of substitution aggregator of the i education groups (L_i).

$$Y_j = F(k, L, t, \tau, T) = k_j \left[\sum_i \phi_{ij} (A_i(t, \tau, T) L_{ij})^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \quad (1)$$

where ϕ_{ij} is the share of workers belonging to education group i hired by industry j; $A_i(t, T, \tau)$ captures both a technological change which is a function of time t, and learning by doing which in turn is a function of potential experience defined as age minus years of schooling minus six and is denoted by T and on the job tenure τ . (Please see Appendix III for an explanation for treating on-the-job-tenure separately from potential

experience). They all augment the services of education group i workers. σ is the elasticity of intra-labour substitution, which is assumed to be equal across industries.

Adding the process of learning by doing, however, makes our model distinctive from that used by Bound and Johnson. Moreover, we know of no other model that enters so explicitly the process of learning by doing the way we have (below). This allows us to claim the addition of learning by doing to the above model as a theoretical contribution of this paper.

In a competitive market in each industry the real wage rate of each type of labour is equal to its marginal product so that:

$$w_{ij}(t, \tau, T) = \frac{\partial Y_i}{\partial L_{ij}} = k_i \phi_{ij} [A_i(t, \tau, T)]^{\frac{\sigma-1}{\sigma}} \left[\sum_i \phi_{ij} (A_i(t, \tau, T) L_{ij})^{\frac{\sigma-1}{\sigma}} \right]^{\frac{1}{\sigma-1}} L_{ij}^{\frac{1}{\sigma}} \quad (2)$$

Dividing and multiplying (2) by $Y_i^{\frac{1}{\sigma}}$, the wage equation can be simplified to:

$$w_{ij}(t, \tau, T) = \left[\frac{Y_i}{L_{ij}} \right]^{\frac{1}{\sigma}} \phi_{ij} [k_i A_i(t, \tau, T)]^{\frac{\sigma-1}{\sigma}} \quad (3)$$

Let us define:

$$A_i(t, \tau, T) = N_i(t) e^{\delta_i \left(\sum_l \tau_l + E \left(T - \sum_l \tau_l \right) \right)} \quad (4)$$

N is a technology argument that is a function of time t , and δ_i captures learning by doing by worker i which can be convex, concave or linear in potential experience T and of on-the-job-tenure τ depending on whether the partial derivatives of δ_i with respect to T and τ are smaller, greater or equal to zero respectively. $l=1,2,...M$ is the number of jobs individual i has had over the period of potential experience T . This implies that $\sum_l \tau_l \leq T$. E is an operator that can take different values depending on whether an individual is educated or less-educated. It, however, is assumed by Bhagwati and Dehejia to take a value of 1 if an individual is educated and 0 if less-educated. The assignment of the binary values is based on the assumption of "rolling stone gathers no moss effect with educated labour being shielded from that effect" as explained earlier in the introduction to this chapter. Taking the logarithms of (4) we can write:

$$\ln A_i(t, \tau, T) = \eta_i(t) + \delta_i \left(\sum_l \tau_l + E \left(T - \sum_l \tau_l \right) \right) \quad (5)$$

In equation (5) η_i captures worker type i skilled-biased technological change and δ_i captures the learning by doing of worker i .

Under free trade, the home and foreign countries' aggregate demand for the output of industry j produced at home (Q_j) relative to the same good produced in the foreign country is assumed to be:

$$Q_j = \theta_j P_j^{-\epsilon} \quad (6)$$

Where P_j is the price of good j produced at home relative to that in the foreign country; θ_j is an exogenous demand shift parameter reflecting consumer taste and other factors and is assumed to be identical across countries; and ϵ is the absolute price elasticity of product demand for each industry. Substituting (4) and (6) into (3), then taking its logarithms yields the following wage equation for workers of type i in any given industry j :

$$\ln w_{ij} = c + \frac{1}{\sigma} \ln \theta_j - \frac{\epsilon}{\sigma} \ln P_j - \frac{1}{\sigma} \ln L_{ij} + \ln k_j + \ln \phi_{ij} + \frac{\sigma-1}{\sigma} \left[\eta_i(t) + \delta_i \left(\sum_t \tau_{it} + E \left(T - \sum_t \tau_{it} \right) \right) \right] \quad (7)$$

Equation (7) is quite comprehensive in the sense that it relates the wage rate to most of the widely discussed worker-type-specific and firm-specific factors set forth to date. For example, the wage rate of worker type i in industry j is positively related to: 1) the demand shift for good j (θ_j); 2) capital intensity in industry j (k_j); 3) a positive

demand shift for worker type i in industry j (ϕ_{ij}); 4) worker-type- i skill-biased technological change (η_i); 5) learning by doing (δ_i). It is negatively related to: 6) the increase in supply of worker of education type i who has industry j specific skills (L_{ij}); 7) the loss of comparative advantage in production of good j at home represented by an increase in P_j .

It is important to note, however, that when σ goes to infinity – that is when labour types are perfect substitutes across industries – industry specific demand shocks such as changes in θ_j and P_j and labour specific supply shocks such as changes in L_{ij} will not have much of an impact on the wages of workers within an industry. This is because the impact of such shocks will spread out across all types of workers across all industries.

In order to derive an equation for the relative wage rate of labour of one education type to some other education type from equation (3) -- say the relative wage rate of labour of education type i to education type k -- we can write:

$$\frac{w_i}{w_k}(t, \tau, T) = \left[\frac{L_i}{L_k} \right]^{\frac{-1}{\sigma}} \left[\frac{A_i(t, \tau, T)}{A_k(t, \tau, T)} \right]^{\frac{\sigma-1}{\sigma}} \quad (8)$$

Suppose that worker i is educated and worker k is less-educated. Let's also assume that E takes a value of 1 for worker i and 0 for worker k as suggested above. Then $A_i(t, \tau, T)$ and $A_k(t, \tau, T)$ are reduced to $\eta_i(t) + \delta_i T$ and $\eta_i(t) + \delta_i \sum_l^H \tau_l$ for educated and less-

educated workers respectively. Let us further assume that labour is immobile across countries but freely mobile within a country across industries. This insures that for a given potential experience and on-the-job-tenure the wage rate is the same across industries for workers of the same education level – the subscript j is therefore discarded hereafter. After substituting for $A_i(t, \tau, T)$ and $A_k(t, \tau, T)$ and taking logarithms equation (8) becomes:

$$\ln \frac{w_i}{w_k}(t, \tau, T) = \ln \frac{\phi_i}{\phi_k} - \frac{1}{\sigma} \ln \left[\frac{L_i}{L_k} \right] + \frac{\sigma-1}{\sigma} [\eta_i(t) - \eta_k(t)] + \frac{\sigma-1}{\sigma} \left[\delta_i T - \delta_i \sum \tau_i \right] \quad (9)$$

Suppose worker i is educated (skilled) and worker k is less educated (less-skilled) then there are four important explanations nested in the above equation for the widening of skilled to less-skilled workers' wage differential. The first and second terms on the right hand side provide the demand and supply explanations respectively. The demand-shift in favor of educated workers increases the wage differential, whereas, the increase in the relative supply of educated workers decreases it.

The third term furnishes the skill-biased technological change explanation – that is if $\eta_i(t) > \eta_k(t)$ the wage differential will increase over time. The fourth and last term on the right hand side is the Bhagwati-Dehejia “rolling-stone-gathers-no-moss-effect-with-skilled-worker-shielded-from-that-effect” trade dependent explanation as discussed above.

For an illustration let us hold constant the impact of all other variables and suppose that $\delta_i(\tau) = \delta_k(\tau) = \delta\tau$. Next suppose that during time period T both educated and

less educated workers experience labour turnovers and resulted jobless spells for a sub-period $\bar{T}$ – so that

$$\bar{T} = T - \sum_l \tau_l . \text{ Since educated workers are assumed to be unaffected by the turnover}$$

and the resulted jobless spell, their log real wage rate due to learning by doing will have increased by δT the end of T . Whereas, that of the less-educated workers will have increased only by $\delta \sum_l \tau_l$. The log relative wage rate will, therefore, have widened by $(\sigma-1)\bar{T}$.

A distinguishing feature of this model is that it does not rule out other explanations but rather add the Bhagwati-Dehejia explanation for an additional role just as suggested by Bhagwati and Dehejia (1994). We can even further simplify equation (9) by following Murphy, Riddell and Romer (1998) in assuming that the shift in the demand for products is felt proportionately by all type of workers and that the ratio of one type of labour to another does not change across industries. Equation (9), consequently , can be rewritten as:

$$\ln \frac{w_i}{w_j}(t, \tau, T) = C - \frac{1}{\sigma} \ln \left[\frac{L_i}{L_j} \right] + \frac{\sigma-1}{\sigma} [\eta_i(t) - \eta_j(t)] + \frac{\sigma-1}{\sigma} \left[\delta T - \delta \sum_l \tau_l \right] \quad (10)$$

where C is a constant. Numerous testable forms of Equations (10), (9) and (7) are essentially what we intend to confront with the data for empirical investigation in the subsequent chapters.

III. Description of Data Sources

The essential data utilized in this study comes from the person file of the Survey of Labour and Income Dynamics (SLID). The SLID is a longitudinal survey conducted by Statistics Canada that follows individuals and families across Canada, collecting information on their labour market experiences as well as income and family circumstances. It is also designed to offer representative cross-sectional estimates of the population. It includes people from across the country with the exception of persons living in Yukon and Northwest Territories, institutions², Indian Reserves and military barracks. My analysis uses this information from 1993 to 1996, on about 31,000 persons aged 16 and over.

This provision of information on the same person through time and the measurement of changes experienced by that person is a distinguishing feature of the SLID data. Of particular interest to us is the SLID's focus on links between important events (such as movement into and out of employment, the reasons given for such movements, the length of employment and unemployment spells and wage changes) and the past experience of the individual as well as the individual specific characteristics of the respondents.

By controlling for individual specific effects and by recording changes in the labour markets status of the respondents, it makes possible the analysis of the causes of a change in the labour market status of Canadians workers³. We restrict the sample to

² Includes children's homes and orphanages, nursing homes, chronic care hospitals, residents for senior citizens, hospitals, psychiatric institutions, treatment centres and institutions for physically handicapped, correctional and penal institutions, young offenders' facilities and jails. However, school residences, monasteries, convents etc are not institution (1991 Census Dictionary, Catalogue Number 92-301).

³ (Survey of Labour and Income Dynamics: Microdata User's Guide 1996).

individuals between the age of 18 and 64 and also exclude workers who are self-employed and those without pay. Workers with a real wage rate above \$100 and below \$4 an hour in 1992 dollars are considered outliers and are also excluded. Weighted data are used throughout the analysis.

Since the SLID is a household-based survey, it does not provide any industry-specific information. The only industry level information provided by the SLID is a code indicating the industry of employment of each job holder: specific characteristics, in particular the degree of openness to international trade or technology use, are not provided. This information is central to the issues being addressed. The master SLID file does provide relatively detailed industry codes – three digit Standard Industrial Classification. I linked measures of trade openness, technology and capital-labour ratios from other sources at this industrial level and by year.

The trade data are from the International Trade Division of Statistics Canada. These data record total values of Canada's exports and imports for three digit SIC industries. However, given that some 80% of Canada's exports of goods and some 70% of its imports are to and from the United States, the trade data to a larger extent represent the Canada-US trade in goods. To convert the data into a trade openness variable we add up the exports and imports for every industry and then divide the sum by the total output produced by that industry in Canada. Output for three digit SIC industries was obtained from CANSIM.

The data on technology was obtained from special files maintained by the Micro-Economic Analysis Division of Statistics Canada. The data contains information on the use by establishments in the manufacturing sector of 22 separate technologies. The data on the capital-labour ratio came from special files maintained by the Micro-Economic Studies and Analysis Division of Statistics Canada. Moreover, the variables for labour

supply and the unemployment rate by workers' types were obtained from the Labour Force Survey (LFS) data files and merged to the SLID data sample by year, sex, age and education groups.

IV. The Period 1993-1996

The analysis of this study is limited to the period of the availability of the SLID data: 1993-1996. Two questions can naturally arise. First, is this period fitting for our analysis? Second, is the period long enough to cover enough variability in objective variables in response to trade liberalisation? In order to answer the first question we make use of the trade and tariff reduction statistics for the period 1988-1999 presented in Table 1.

Over the period covered in Table 1, three very significant developments took place for trade liberalisation in Canada. The first was the signing of the Canada-US Free Trade Agreement (CUFTA) in 1988. The second was the signing of the North American Free Trade Agreement (NAFTA) in 1994, which basically was an expansion of CUFTA to include Mexico. And the final development was the liberalisation measures flowing from the Uruguay Round of multilateral trade negotiations that created the World Trade Organisation (WTO) in 1995.

The most significant of the three developments, however, was CUFTA. Nevertheless, even-though CUFTA was signed in 1988, the elimination of trade barriers was not to follow it instantaneously but rather the barriers were to fall gradually and eventually eliminated. Table 1 shows that over the first four years of CUFTA the

reduction in average tariff rates were moderate. It was not until 1992, that big reductions started to take place getting bigger and bigger over the following four years (1993-1996) and then started to subside.

Over the same 1993-1996 period it is noticed that Canadian export growth rates, import growth rates and aggregate trade growth rates started to increase significantly. It can be argued that over this period the economies of both Canada and the US, Canada's largest trade partner, started to grow at rapid speeds and thus the increase in trade growth rates might be more a response to that than trade liberalisation. If that is true then shares of exports, imports and total trade to GDP must not vary significantly over the years. However, looking at exports, imports and total trade as shares of GDP (the last three columns in Table 1 respectively), it is obvious that the trend over the period 1993-1996 is distinctive and more in line with the trade response to trade liberalisation.

Returning to the second question, it is true that the period 1993-1996 is too short to record enough time-series variability, however, in this analysis we rely more on cross-sectional trade variability's by three digit-SIC industries. For each of the four years we have trade data on 137 industries, providing us with a total of 548 observations for the period 1993-1996. Since the tariff reductions as a result of CUFTA, NAFTA and the Uruguay Round of Multilateral Trade Negotiations applied at different rates to different industries the data available provides us with enough variations to pursue our analysis.

Table 1: Canada trade and tariff statistics

Year	average tariff reduction	Growth rates in percentage			as share of GDP in percentage		
		Exports	Imports	total trade	exports	imports	total trade
1988					22.98	21.77	44.76
1989	0.81	0.146	3.06	1.56	21.31	20.77	42.08
1990	5.76	7.41	0.77	4.13	22.25	20.34	42.6
1991	2.62	-1.99	-0.57	-1.31	21.58	20.02	41.61
1992	11.07	11.52	9.26	10.43	23.31	21.18	44.49
1993	17.17	15.16	14.81	14.99	25.86	23.44	49.31
1994	14.22	20.35	19.28	19.84	29.4	26.41	55.82
1995	23.22	16.21	11.25	13.86	32.49	27.94	60.44
1996	20.98	5.16	3.11	4.21	33.07	27.88	60.96
1997	18.75	8.06	17.35	12.31	34.11	31.22	65.33
1998	14.42	6.81	9.32	8.01	35.54	33.31	68.85
1999	3.37	11.22	7.21	9.28	37.29	33.69	70.99

Source: author's calculation from Statistics Canada's International Trade Division trade data file

V. Definitions of the Educated and the Less-Educated

Educated workers are defined as those who ever received university degrees, certificates or diplomas, ranging from college graduates to Ph.D. Conversely, less-educated workers include those who did not receive university degrees or diplomas, or, certificates or diplomas from community colleges.

This breakdown of educated and less educated workers is rationalized by the

mean wages by education levels presented in Table 2. From Table 2 it is obvious that the mean wage rates of workers belonging to the first eight education levels are not significantly different from each other. They include workers from those who never attended schools to those who graduated from high school, attended post-secondary schools but did not obtained certificates, diplomas or degrees.

However, once workers fall into the 09 education level and higher (those with non-university post-secondary certificate, university certificate below Bachelor's, Bachelor's degree, M.A. and PhD), the mean wage rate goes up significantly. We, thus, define the latter group (i.e. education level 09-12) based on the value the labour market puts on their education as educated workers and the former group (education level 01-08) as less-educated workers. In order to reconfirm the above definition of the educated and the less-educated we also allowed for the two groups of workers to include different levels of education attainment in terms of years of schooling and then compared their wage rates to one another. It was concluded that the definition retained above represented a more accurate break up of the two types of workers.

For example, when we compared the mean wage rates of workers who had 16 years of schooling and had obtained university degree with those who had 16 years of schooling but did not graduate, it was noticed that the mean wage of the latter group was significantly lower than the former. Not only that -- it was also significantly lower than the mean wage rate of workers with 14 years of schooling with a post-secondary certificates or diplomas. Similarly, the wage rate of workers with some post-secondary education who did not receive certificates or diplomas were not significantly different

from high school graduates. It should be added that our definitions of educated and less-educated workers closely resemble those employed by Murphy, Riddell and Romer (1998).

Table 2: Mean wage rates by education levels

Education Level	1993	1994	1995	1996
01: never attended school	10.19	11.25	8.91	9.09
02: 1-4 years of elementary school	11.49	10.48	11.61	11.42
03: 5-8 years of elementary school	11.20	11.37	11.30	11.08
04: 9-10 years of elementary and secondary school	11.38	11.29	11.53	11.17
05: 11-13 yrs of element. and secondary school but not graduated	10.89	10.41	10.26	10.27
06: graduated high school	11.71	11.71	11.62	11.73
07: some non-university post-second. School but no certificate	10.86	10.62	10.57	10.53
08: some university but no certificate	10.58	10.05	9.94	10.10
09: non-university post-secondary certificate	14.01	13.90	13.82	13.70
10: university certificate below Bachelor's	17.44	16.66	16.73	16.35
11: Bachelor's degree	18.44	18.08	17.62	17.42
12: graduate degree	21.52	21.36	21.25	21.47

Source: author's calculation from the SLID data.

VI. Summary Statistics and Mean Analysis of Key Variables

Table 3 presents summary statistics for some of the key variables in the sample described above. It shows that real wages (in constant 1992 dollars deflated in the consumer price index) have declined for both educated and less educated workers over the four-year period. More noteworthy is the fact that the relative wages of educated to less educated workers have slightly fallen between 1991 and 1994. This is in contrast to

what have been observed in the United States. However, in section IV we show that if we hold fixed for the increasing relative supply of educated to less-educated workers, the relative wage rate of the educated to less-educated in Canada would have actually increased.

The *years of schooling* row of the table reveals that between 1993 and 1996 the average years of schooling completed by both educated and less-educated workers has increased by some 1% and 3% respectively. This is also reflected by the decreasing values for the *years of experience* row for both types of workers since potential experience is defined as age minus six minus years of schooling. This upward trend in education acquisition, perhaps, is a response to an increasing demand for more educated labour represented by a decreasing relative unemployment rate of the educated to less-educated workers.

The row on *job tenure* shows that on the job tenure is decreasing quite dramatically for both types of workers, particularly more so for educated workers. This is consistent with the hypothesis of an increasing turnover due to the emergence of trade-liberalisation-pushed kaleidoscopic comparative advantage that make industries footloose. However, other factors cannot be ruled out either.

Table 3: Descriptive Statistics of Educated to less-educated Workers

Variables		1993	1994	1995	1996
real wage rate	• educated	19.13 (0.18)	18.72 (0.17)	18.46 (0.18)	18.26 (0.12)
	• less-educated	12.25 (0.05)	12.107 (0.05)	12.05 (0.05)	12.01 (0.04)
	educated to less-educated	1.561	1.546	1.532	1.521
Years of schooling	• educated	17.45 (0.05)	17.47 (0.04)	17.56 (0.04)	17.63 (0.03)
	• less-educated	12.21 (0.02)	12.33 (0.02)	12.44 (0.02)	12.57 (0.02)
	educated to less-educated	1.429	1.416	1.412	1.402
Years of experience	• educated	13.31 (0.23)	12.70 (0.23)	12.76 (0.23)	12.49 1
	• less-educated	12.59 (0.09)	12.30 (0.10)	12.32 (0.23)	(0.14) 12.46
	educated to less-educated	1.057	1.032	1.036	(0.06) 1.002
job tenure (years)	• educated	9.802 (0.82)	8.277 (2.08)	7.629 (2.06)	6.962 (1.28)
	• less-educated	6.803 (0.82)	5.99 (0.79)	5.648 (0.79)	5.523 (0.52)
	educated to less-educated	1.441	1.380	1.350	1.260
Labour supply (thousands)	• educated	6415 (12.33)	6840 (12.79)	7060 (13.32)	7279 (8.59)
	• less-educated	8248 (6.88)	7992 (7.29)	7868 (7.90)	7866 (5.40)
	educated to less-educated	0.777	0.855	0.897	0.925
Unemployment rate (percentage)	• educated	8.085 (0.04)	7.611 (0.03)	6.809 (0.03)	7.054 (0.02)
	• less-educated	13.72 (0.03)	12.78 (0.03)	11.94 (0.03)	12.45 (0.02)
	educated to less-educated	0.589	0.595	0.570	0.567
Full time/part-time ratio		3.956	3.956	3.676	3.279
Unionisation rate (percentage)	• educated	46.00	45.00	43.00	40.00
	• less-educated	30.00	28.00	28.00	27.00
	educated to less-educated	1.533	1.607	1.535	1.481
No of observations	All	16734	16977	15982	36297
	• male	8749	8853	8196	18522
	• female	7985	8124	7786	18270
	• educated	2262	2391	2327	5686
	• less-educated	14472	14586	13655	30611

Standard errors in parenthesis.

Source: author's weighted calculation from the SLID.

The important things in the *labour supply* and *unemployment rate* rows to look at are the relative labour supply and relative unemployment rate of educated to less educated workers. As can be noticed the first is rising whereas the latter is falling. In a simple demand and supply diagram the first pushes the relative wages of the educated workers down; the latter suggests that the sluggish demand for less-skilled workers has responded with a quantity adjustment (i.e. higher unemployment) rather than a price adjustment (i.e. lower wages). Both of these factors, therefore, imply that the relative real wage rate of educated workers would have been a lot higher in their absence. In section IV we derive relative wage of educated to less-educated workers in the absence of these two factors.

Lastly, the *full-time/part-time* row shows that the ratio has slightly slipped over the period 1993-1996. The falling relative full-time/part-time jobs rate is consistent with increasing incidences of labour turnover which in turn could be caused (in addition to other factors) by trade volatility due to trade liberalisation. The *unionisation rate* row shows that the unionisation rates have fallen for both educated and less-educated workers, however, with that of educated workers by more than less-educated workers (indicated by the falling ratio of educated to less-educated workers' unionisation rates). This, as suggested by some labour market studies, could probably be due to unions' protection of the less-educated workers from external competition.

CHAPTER 3

Trade and Education Premium in Canada

I. Introduction

In this chapter we study the trend of educated to less-educated (alternatively, skilled to less-skilled) workers' wage differential over the period covered by the Survey of Labour and Income Dynamics (SLID) data to check whether it is causally linked to international trade. While in the United States and some other OECD countries there is a consensus that the educated to less-educated wage differential has been widening in favor of educated workers over the 1980s and 1990s, the trend with respect to Canada is less clear. For example, Baldwin and Rafiquzzaman (1998) showed a widening of education differential but Freeman and Needels (1991) argued that the rise was next to nil. Murphy, Riddell and Romer (1998), on the other hand, presented evidence for a declining education premium over the same period.

Nevertheless, both Freeman *et al* (1991) and Murphy *et al* (1998) admitted that the education premium would have increased significantly were it not for a greater growth of the educated labour and a greater strength of the Canadian unions in wage-setting. In section II, we show that after correcting

for the supply effect the educated to less-educated wage differential would have been on an upward trend, indeed. Unionization, nonetheless, is shown to have had little or no effect.

Moreover, the finding of a no-increase or even a decrease in education differential cannot be counted as an evidence against the positive impact of trade liberalization on the wage differential. It could just be that the supply side might have overwhelmed the demand side. In fact, in section III we find that although trade had a significantly positive impact on the wages of both educated and less educated workers, the impact on the educated workers seems to be some four times stronger.

The remainder of this chapter is structured as follows: Section II discusses the existence and nature of education premium in Canada. Section III examines the relationship between the educated to less-educated wage differential. Section V furnishes the conclusion.

II. Education (Skill) Premium in Canada

To see how educational earning differentials have evolved over the period covered by SLID we calculate the wage premium for educated workers for each year¹. In Table 4 we calculate the wage premium of educated to less-educated workers for all workers, by gender and age (18-34, 35-44 and 45-64

¹ The percentage wage premium for workers type i over workers type j in year t is calculated as: $\frac{wage_t^i - wage_t^j}{wage_t^j} * 100$, where $wage_t^i$ is the real wage of workers type i in year t .

year old). The result obtained is mixed. While columns 1, 3 and 6 show a decline in the education premium of 0.25%, 2% and 10.3% for all workers, female and 45-64 age group workers, columns 2, 4 and 5 reveal an increase of 1.57%, 7.11% and 3.34% for male, 18-24 and 25-44 age group workers respectively.

Table 4: Education (or skill) premium (in percentage)

	All workers	Male	Female	18≤Age<25	25≤Age<45	Age≥45
1993	51.22	47.37	57.12	42.76	44.27	59.62
1994	47.18	43.64	52.76	36.23	43.36	59.63
1995	51.70	50.57	53.99	46.87	46.97	53.80
1996	50.97	48.95	55.09	49.87	45.51	49.29
Percentage change 96-93	-0.25	1.57	-2.02	7.11	1.28	-10.32

Source: author's calculation from the SLID data.

Two major reasons for a much smaller rise in the education premium in Canada compared to that in the United States are postulated to be greater relative growth of educated workers and greater strength of Canadian unions in wage setting (Freeman and Needels, 1991; Murphy, Riddell and Romer, 1998). Both historical and contemporary evidence on labour markets suggest that the relative wages of more educated workers fall when the supply of educated workers outpaces its demand. However, evidence also reveals that workers with different levels of education are not perfect substitutes. For example, three workers with 6 years of education cannot do what one worker with 18 years of education can do.

Table 5: Relative supply of educated workers

	All workers	Male	Female	18≤Age<25	25≤Age<45	Age≥45
1993	0.77	0.76	0.79	0.32	1.02	0.73
1994	0.85	0.82	0.88	0.32	1.12	0.85
1995	0.89	0.86	0.93	0.33	1.18	0.88
1996	0.92	0.88	0.97	0.35	1.21	0.91
Percentage change 1996-93	19.04	16.03	22.68	9.06	18.64	24.79

Source: author's calculation from the Labour Force Survey.

Table 5 shows that over the 1994-96 period covered by the SLID, a marked increase in the relative supply of educated workers, indeed, has occurred. The percentage increase in the relative supply of educated workers for all workers, male, female, 18-24, 25-34, and 35-44, 45-64 age group workers over the period 1993-1996 has been 19%, 16%, 22.7%, 9%, 18.6% and 24.8% respectively.

Murphy, Riddell and Romer (1998) found the wage elasticity of the relative labour supply of educated workers to be about 0.75 in Canada. That is, holding everything else fixed, if the relative labour force of educated workers goes up by 1%, their relative wage rate falls by about 0.75%. Making use of their measure, we calculate the values by which the skill premium has been suppressed due to the relative labour force growth in Table 6. For example between 1993 and 1994 relative supply of all educated workers increased by about $10\% \left(\frac{0.855 - 0.777}{0.777} * 100 \right)$. Multiplying that by 0.75 will give us the 7.53 skill premium suppressed due to a relative supply increase.

Table 6: Education (or, skill) premium suppressed by relative labour force growth (in percentage)

	All workers	Male	Female	18≤Age<25	25≤Age<45	Age≥45
1994	7.53	6.65	8.61	1.05	7.22	11.91
1995	3.63	3.35	3.94	2.38	4.22	3.17
1996	2.34	1.51	3.40	3.11	1.85	2.51

Source: author's calculation from Table 5 and the measure of elasticity of the relative labour supply of educated workers of 0.75 found by Murphy, Riddell and Romer (1998).

We then add the values in Table 6 to their corresponding skill premium values in Table 4 to get Table 7. Table 7 records what education premium would have been in the absence of a relative supply growth of educated labour. For example, education premium suppressed for all workers in 1994 is 7.53% and the corresponding value in Table 4 is 47.18%. Thus the education premium for all workers in 1994 in the absence of a relative supply change is $7.53+47.18=54.71$ – a value recorded in Table 7 in the cell for all workers and 1994.

Table 7: Education (or, skill) premium adjusted for the relative supply growth (in percentage)

	All workers	Male	Female	18≤Age<25	25≤Age<45	Age≥45
1993	51.22	47.37	57.12	42.76	44.27	59.62
1994	54.71	50.30	61.37	37.27	50.59	71.54
1995	55.33	53.92	57.93	49.26	51.19	56.97
1996	53.32	50.46	58.49	52.99	47.37	51.81
Percentage change 96-93	2.095	3.08	1.37	10.22	3.09	-7.82

Source: author's calculation from Table 4 and Table 6.

From Table 7 it is obvious that with the exception of workers aged 45+, the skill premium has increased over 1993-1996 both for all workers as a whole and for every category of workers individually. Furthermore, looking at Table 7 a few observations are in order. First, the increase in the skill premium is higher for male workers than that for female workers: 3.1% for men as opposed to 1.4% for women. Since sectors exposed to trade liberalization are male dominated (as verified by the trade data I employ) and if trade liberalization indeed contributes to the rising skill premium then it is a trend in the expected direction.

Secondly, the increase in the skill premium decreases as the age group goes higher from 10.2% to 3.1% to -7.8% respectively. This perhaps is due to one of the two phenomena: 1) it is the more recent or more modern and technical education that drives the education premium up and that older educated workers do not benefit from this trend. 2) the older less-educated workers are more protected by their experience and seniority from a decline in their relative wages than their younger counterparts. Looking at the declining education premium of 45+ age group workers it is even possible that for older workers experience (rather than education) is getting more and more recognized.

Next, we turn to investigating the second postulated reason for a relatively milder increase in skill premium in Canada: unions' protection of the less educated workers' wages. We first measure the education premium for non-unionized workers and then for unionized workers. We then subtract

the latter from the former and interpret that as the skill premium narrowed (upward) due to unionization. Upward, because unions don't suppress educated workers' wages but rather help raise the wages of less-educated workers (percentage-wise) by more than those of educated. The values are recorded in Table 8.

Table 8 reveals that unionization contracts the educated to less-educated wage gap quite significantly since all the values in the Table are significantly greater than zero². It, however, does not provide any evidence suggesting that unionization may also contribute toward restraining the rise in the skill premium. If that were to be true then the values recorded for each category should have been increasing over time – however, in Table 8 that is not evident. This result is in line with that found by Freeman and Needels (1991) after examining data from Canadian Survey of Consumer Finance (SCF) for 1976, 1980, 1987 and 1988 and the Canadian Census of Population for 1971, 1981 and 1986.

Table 8: Wage premium suppressed by unionization (in percentage)

	All workers	Male	Female	18≤Age<25	25≤Age<45	Age≥45
1993	31.550	33.941	13.592	10.485	22.443	33.427
1994	27.367	35.696	5.042	6.011	19.333	36.330
1995	32.662	40.622	7.175	5.835	26.342	27.352
1996	28.822	36.158	7.338	3.002	25.548	15.039

Source: author's calculation from the SLID data.

² If the education premiums in the unionized and non-unionized sectors were not significantly different from one another, their difference (recorded in Table 8) would not be significantly different from zero.

It can also be argued that the changes in skill premium recorded in Table 7 understate the market shifts against the less-educated if shifts in labour market conditions alter their labour utilization as well as their rates of pay (Freeman and Needels, 1991). More specifically, we ask if the relatively smaller increases in skill premium in Canada were offset by a smaller less-educated to educated labour utilization differential? Table 9 which records the percentages by which the less-educated unemployment rates exceed those of educated workers provides an answer to this question.

The evidence summarized in Table 9 shows that the relative employment prospects of less-educated workers worsened over the period 1993-1996. It should be noted that the increase in the relative unemployment rates for male and younger less-educated workers was more dramatic: 17.16% for male, 29.95% and 13.28% for workers aged 18-24 and 25-44 respectively. As discussed above these are the categories of workers who are relatively more exposed to volatilities due to trade liberalization.

Table 9: Percentages by which less-educated unemployment rate exceeds that of educated

	All workers	Male	Female	18≤Age<25	25≤Age<45	Age≥45
1993	86.447	85.350	85.714	68.888	90.909	67.355
1994	84.895	85.205	85.797	87.511	90.620	53.666
1995	94.531	99.527	87.692	95.408	103.437	54.414
1996	90.526	100	78.260	89.523	102.985	50.442
Percentage change 96-93	4.71	17.16	-8.69	29.95	13.28	-25.11

Source: Author's calculations from LFS and SLID surveys.

The evidence in Table 9 is consistent with the proposition that Canada has responded to the deteriorating job market for less-educated with a relatively greater quantity adjustment than with wage adjustment. Had the price adjustment been left loose, the wage premium documented in Tables 4 and 7 would have been higher, as noted by Freeman and Needels (1991).

An increase in wage differentials reported in Table 7 could be due either to a leftward shift in relative supply or a rightward shift in relative demand of educated workers, or some combination of both. As it was shown above that over the period the wage differential has widened, relative supply actually shifted to the right, leaving us with the conclusion that the change in wage differential would have been higher in the absence of a relative supply change. This suggests that the widening in the educated to less-educated wage differential could be the work of a positive relative demand shift – a fact portrayed by a rising share of educated workers in total employment for all workers, both sexes and all age groups in Table 10.

Trade intensity is one of the factors that has the potential of shifting the relative demand in favor of the educated workers. In the subsequent section it is precisely that what we investigate.

Table 10: Share of educated workers in total employment

	All workers	Male	Female	18≤Age<25	25≤Age<45	Age≥45
1993	0.453	0.448	0.458	0.257	0.518	0.433
1994	0.475	0.468	0.483	0.260	0.540	0.467
1995	0.487	0.479	0.496	0.265	0.554	0.476
1996	0.494	0.484	0.506	0.273	0.560	0.484
Percentage change 96-93	9.05	8.03	10.48	6.22	8.11	11.77

Source: author's calculations from the Labour Force survey.

III. Trade and Educated to less-educated Wage Differential

Little has been done with respect to investigating changes in wages of educated and less-educated workers with respect to Canada but in the literature there is a general consensus that there has been a positive shift in relative demand for educated (or, skilled) workers (Gera, Gu and Lin, 1999). The disagreement, nevertheless, surfaces when it comes to explaining the factors behind the positive demand shift.

The two most familiar explanations for a rightward shift in the relative demand for skilled workers in Canada are trade liberalization and a skilled-biased technological change – the latter being more popular than the first. To investigate the relative contribution of trade and technologies to changes in the skilled to less-skilled wage differential we run the following multivariate regression that is based on equation (10) of chapter 2:

$$W_{it} = \alpha_1 + \alpha_2 E + \beta_1 (TRADE_{jt}) + \beta_2 (E * TRADE_{jt}) + \pi_1 (TECH_j) + \pi_2 (E * TECH_j) \quad (1) \\ + \eta (CAPITAL_{jt}) + \theta X_{it} + \mu Z_i + \psi Y_t + \gamma RI$$

where W_{it} is the real wage rate of worker i in time t ; E is a dummy variable that takes a value of 1 if individual i is educated (i.e. ever received a university degree, certificate or diploma, ranging from a Bachelor's to a Ph.D.) and 0 if less-educated (otherwise). Since less-educated workers are the reference group, the coefficients on E and any continuous variable interacted with E measure the differential effect of being an educated relative to less-educated worker.

$TRADE_{jt}$ is the variable representing trade intensity by 3-digit SIC level (the subscript j represents industries) and is equal to total exports plus total imports divided by total output by industries by year. $E * TRADE_{jt}$ is $TRADE_{jt}$ interacted with E . $TECH_j$ is a technology variable for industry j . It is a dummy variable taking a value of 1 if an industry is technology-intensive and 0 otherwise³. $CAPITAL_{jt}$ is the physical capital intensity in industry j in time t . X is a vector of labour-market-specific characteristics such as changes in the labour supply and unemployment rates of educated and less-educated workers; Z is a vector of individual-specific characteristics such as potential experience, on the job tenure, gender, if full time and if unionized; Y controls for a time trend or business cycle. RI is a vector of dummy variables that control differences across regions and broadly defined industries.

We run ordinary least square regressions for **all workers** and then for **male** and **female** separately. The result of regression (1) is presented in Tables 11 and 12. The difference between the two tables is that in the former we estimate semi-log multivariate regressions, whereas, in the latter we take the log of all variables that appear in log in equation (7) of Chapter 2. These include physical capital, labour supply variables, labour demand proxies (the unemployment rates) and the trade variable.

The first regression is a type of Mincer's human capital equation in which the log of wages is often regressed on the level of wage-determining variables. The second one is a direct conversion of equations (7) and (10) in Chapter 2 into a regression form. This type of equation was also estimated elsewhere by Murphy, Riddell and Romer (1998). In addition, in columns (1) of the two tables the variable **CAPITAL** is not included, whereas, in the columns (2), it is. The data for **CAPITAL** for 1996 was not available. Thus the regressions that include **CAPITAL** are run on fewer observations.

The coefficients on *TRADE* and *E*TRADE* in all regressions in both Tables 11 and 12 are positive. Looking at the values in the regressions for **all workers** in Table 11, they reads that a one percent increase in the volume of trade to output ratio (the variable *TRADE*) increases real wages of all less-educated workers (both male and female) by about 0.5% to 0.9%. The impact of a one percent increase in the volume of trade to output ratio on the real wages of all educated workers (the variable *E*TRATE*), however, is an

³ The variable that represents technological intensity assigns a value of 1 to industries that uses any technology (from 1 to 9) specified in the Survey of Innovation and Advanced

additional 2% to 3%, or, a total of 2.5% to 3.9%. For less-educated male workers the impact is at the range of 0.4% to 0.6%, much larger than the -0.7% to 0.3% for the less-educated female workers. For educated male workers the additional impact of a one percent increase in trade intensity is at the range of 3% to 3.5%. Roughly the same is the range for educated female workers (i.e. 2% to 3%).

The coefficients on *TRADE* and *E*TRADE* interpreted above yield the following two implications:

- I) that trade has had a positive impact on the real wages of both educated and less-educated workers. This perhaps is due to trade putting pressure on domestic industries to become more competitive and therefore more productive, in turn, enhancing the marginal productivity of labour.
- II) The significantly positive coefficients on *E*TRADE* support the hypothesis that trade widens the educated to less-educated workers' wage differential. However, it is important to reiterate that the widening of the educated to less-educated workers wage differential does not come at the expense of the less-educated workers since both workers benefit from trade. However, in relative terms the educated workers benefit more.

Moreover, as expected, the coefficients with respect to technology are quite significant for both educated and less-educated workers. Its positive

impact on the less-educated female workers is stronger than that on the less-educated male workers. However, the differential impact on the educated male workers is stronger than that on the educated female workers. The total effect of technology, however, is roughly the same for both educated male and educated female workers.

Nevertheless, the relative impact on real wages of technology vis-à-vis trade is difficult to investigate given that the variables for technology and trade are not of identical levels and definitions. While the former is a dichotomous variable the latter is continuous. Elsewhere, Gera, Gu and Lin (1999) in their Canadian study found that technology had a much more favorable effect on the relative wages than trade did. They showed strong evidence in support of advanced technologies being biased toward the use of skilled labour and thus concluded that skill-biased technological change perhaps was the most important factor in shifting the skilled labour relative demand curve to the right.

The conclusion imparted by Gera *et al.* was to a greater extent influenced by the strong evidence in support of the technology effect on the relative labour demand and relative wages than by a weaker evidence for the effect of trade. Just because the impact of technology is strong doesn't necessarily imply that trade has no effect at all. Our finding and therefore conclusion with respect to trade and wages are more in line with Baldwin and Rafiquzzaman (1998). They found both trade and technology as contributing factors toward the widening wage differential phenomenon. As they put it:

The past twenty years have seen a change in earnings inequality, both in the United States and Canada. The debate over the causes of increasing inequality has focused on whether it is changes in trade patterns or whether it is technological change that is at fault. This paper has demonstrated that both are at work....

The coefficients on all other variables, with the exception of labour supply, are in the expected direction in all of the regressions. For example, holding everything else constant, a year added to potential experience raises the real wage of all workers by 2% to 7%; a month added to on-the-job tenure pushes the real wage up by 0.2% to 0.8%; a full-time job pays an hourly wage that is 10% to 11% higher than a comparable part-time job; on average men's wage is 20% to 25% higher than that of women; a one percent increase in national unemployment rate suppresses real wages by about 2%; unionized jobs pay 9% to 12% more than non-unionized; the coefficients on capital intensity, as expected, are positive.

The magnitude of the coefficient, however, is different for male and female. While the return to a year of potential experience is at a significant range of 2.2% to 9% for male, the return to experience for female is too small and insignificant. Similarly, the return to a month of on the job tenure for male is at a range of 0.2% to 1.1%, bigger than the 0.2% to 0.3% range for the female. The reward for being full-time versus part-time is higher for female (18% to 22%) than that for male (14% to 16%). Moreover, unemployment suppresses the wages of female workers by more than that of male workers (by about 3% for female versus 2% for male). And lastly, the unionization

premium is higher for female workers than for their male counterparts (11-14% for male versus 21-27% for female).

The puzzling part, however, is the positive coefficient with respect to labour supply: an increase in the labour supply pushes real wages up. When we separated the educated and less-educated workers it was found that the positive effect of labour supply on the real wages of educated workers was 6.5 times stronger than that on the real wages of the less-educated. This perhaps provides some support for a Lucas-type positive externality attached to the size of the educated labour stock. However, the positive coefficient on the less-educated labour supply is puzzling.

In sum, the result of regression (1) supports the proposition that trade plays a significant role in the widening of educated to less-educated wage differential. However, since the widening doesn't come even partially at the expense of less-educated workers the result doesn't fit the Stolper-Samuelson theoretical trade explanation. Instead, in the subsequent chapters we continue to use variants of equation (10) developed in chapter II to explain the relationship between trade and wages as evidenced by the result in this section. In chapters IV and V we investigate the impact of trade volatility on labour turnover and of the latter on the educated to less-educated wage differential respectively.

Table 11: Semi-log estimates of regression (1).

	All workers		Male		Female	
	(1)	(2)	(1)	(2)	(1)	(2)
α_1	2.055 (98.29)	2.034 (73.35)	2.120 (163.37)	2.084 (112.76)	2.336 (153.52)	2.238 (106.21)
α_2	0.231 (16.17)	0.233 (12.08)	0.152 (31.71)	0.153 (22.37)	0.301 (40.65)	0.310 (31.56)
TRADE	0.009 (5.44)	0.005 (2.07)	0.009 (4.91)	0.006 (2.59)	0.002 (0.568)	-0.007 (-1.61)
E*TRADE	0.022 (6.68)	0.020 (4.61)	0.036 (8.25)	0.036 (6.28)	0.037 (3.41)	0.032 (2.22)
TECH1	0.064 (5.83)	0.070 (4.87)	0.042 (4.17)	0.043 (3.27)	0.101 (4.835)	0.085 (3.15)
E*TECH1	0.149 (5.95)	0.133 (4.07)	0.136 (4.10)	0.141 (3.27)	0.129 (1.808)	0.132 (2.33)
EXP	0.018 (19.27)	0.019 (15.49)	0.022 (19.63)	0.023 (15.64)	0.0002 (0.075)	0.0002 (0.08)
EXP ²	-0.0003 (-17.88)	-0.0003 (-14.30)	-0.0004 (-12.75)	-0.0004 (-10.38)	-0.00005 (-0.817)	-0.00003 (-0.36)
TENURE	0.002 (33.34)	0.002 (26.07)	0.002 (23.93)	0.003 (19.58)	0.003 (13.49)	0.003 (10.32)
TENURE ²	-0.000004 (-19.40)	-0.000004 (-15.28)	-0.000004 (-15.44)	-0.000005 (-12.98)	-0.000004 (-8.08)	-0.000004 (-5.99)
FT	0.104 (10.26)	0.093 (6.86)	0.159 (13.39)	0.168 (10.42)	0.215 (15.97)	0.220 (12.00)
LS	0.00002 (4.68)	0.00002 (3.07)	0.00005 (12.93)	0.00005 (9.58)	-0.00002 (-2.77)	-0.00002 (-2.89)
SEX	0.228 (37.25)	0.231 (28.76)	----	----	----	----
UNEMP	-0.021 (-26.09)	-0.021 (-20.02)	-0.015 (-25.78)	-0.015 (-19.78)	-0.035 (-38.15)	-0.033 (-27.49)
UNIION	0.095 (15.04)	0.093 (11.41)	0.139 (19.88)	0.126 (13.78)	0.273 (37.00)	0.239 (24.22)
CAPITAL	-----	0.012 (2.017)	----	0.019 (4.27)	----	0.055 (12.05)

the result of all control variables such as time dummies, regional dummies and industry level dummies is suppressed here.

Rsq	0.37	0.37	0.40	0.41	0.44	0.45
No of obs.	19039	11049	9895	5745	9144	5304

t-ratios in parenthesis.

Table 12: Log-linear estimates of regression (1).

	All workers		Male		Female	
	(1)	(2)	(1)	(2)	(1)	(2)
α_1	1.713 (37.90)	1.77 (30.06)	2.157 (146.53)	2.108 (103.55)	2.405 (140.52)	2.300 (100.12)
α_2	0.193 (12.17)	0.181 (8.65)	0.110 (30.17)	0.110 (21.38)	0.273 (28.34)	0.260 (19.76)
Log(TRADE)	0.007 (5.23)	0.006 (3.72)	0.006 (4.01)	0.004 (2.33)	0.003 (2.53)	0.003 (2.29)
E*log(TRADE)	0.034 (8.51)	0.032 (6.20)	0.029 (2.96)	0.027 (2.16)	0.019 (3.18)	0.018 (2.43)
TECH1	0.049 (5.63)	0.051 (4.43)	0.044 (4.63)	0.031 (2.53)	0.097 (4.80)	0.068 (2.62)
E*TECH1	0.130 (4.54)	0.115 (3.072)	0.246 (9.25)	0.243 (6.93)	0.305 (5.27)	0.192 (2.43)
EXP	0.059 (4.92)	0.076 (5.06)	0.094 (6.14)	0.095 (5.01)	0.010 (0.41)	0.040 (1.30)
EXP ²	-0.002 (-0.63)	-0.002 (-0.61)	-0.003 (-0.86)	-0.003 (-0.78)	-0.0004 (-0.056)	-0.006 (-0.79)
TENURE	0.007 (0.937)	0.008 (0.86)	0.011 (1.20)	0.007 (0.58)	0.020 (1.26)	0.012 (0.56)
TENURE ²	-0.012 (-10.04)	-0.015 (-9.47)	-0.010 (-7.38)	-0.011 (-6.19)	-0.010 (-3.82)	-0.015 (-4.53)
FT	0.1074 (8.11)	0.115 (6.58)	0.142 (10.36)	0.151 (8.33)	0.180 (11.64)	0.187 (9.11)
Log(LS)	0.047 (8.9918)	0.037 (5.365)	0.063 (18.17)	0.064 (14.08)	0.021 (3.62)	0.012 (1.63)
SEX	0.255 (36.53)	0.250 (27.17)	-----	-----	-----	-----
Log(UNEMP)	-0.018 (-18.83)	-0.019 (-14.92)	-0.024 (-31.81)	-0.024 (-24.15)	-0.029 (-21.72)	-0.026 (-14.82)
UNION	0.120 (17.58)	0.109 (12.31)	0.131 (18.45)	0.117 (12.70)	0.247 (33.05)	0.211 (21.35)
Log(CAPITAL)	-----	0.0135 (3.03)	-----	0.022 (4.92)	-----	0.057 (12.75)

The result of all control variables such as time dummies, regional dummies and industry level dummies is suppressed here.

Rsq	0.44	0.44	0.39	0.40	0.44	0.45
No of observations	15539	8982	8080	4670	7459	4312

t-ratios in parenthesis.

V. Summary

In this chapter we studied the trend of educated to less-educated workers' wage differential over the period covered by the Survey of Labour and Income Dynamics (SLID) data and investigated if it is causally linked to international trade. In section II we showed that the widening of educated to less-educated wage differential was an occurring phenomenon in at least the groups of workers that were more likely to be exposed to international competition brought about by trade.

We also demonstrated that the wage differential would have been higher in the absence of changes in the relative supply of educated workers and in the absence of quantity adjustment (increasing relative unemployment of less-educated workers) rather than price adjustment (wage changes). In section III we identified trade as well as technology as significant contributors to the rising of education premium in Canada.

CHAPTER 4

Trade Liberalisation, Trade Volatility, and Labour Turnover

I. Introduction

As explained in chapters 1 and 2, in Bhagwati and Dehejia (1994) trade liberalisation results in increased *ceteris paribus* labour turnover. Since it is through increased labour turnover that trade makes its way to the rising of the educated to less-educated wage differential, the labour turnover effect of trade volatility (caused by liberalisation) is the core of Bhagwati/Dehejia alternative trade explanation. Our main aim in this chapter is to investigate how and to what extent trade volatility exerts its influence on labour turnover.

Labour Turnover consists of job separations and re-engagements. Job separations are defined as discharges and comprise quits and layoffs. Quits are often voluntary and layoffs are often initiated by employers (involuntary). Reasons for separations (particularly, quits) can be either personal or non-personal. Personal reasons include own illness, going back to school, moving to a new residence, found a new job and other personal and family responsibilities. Non-personal reasons, on the other hand include factors such

as: poor pay, workload, poor work environment, company moved or went out of business, seasonal nature of work, business slowdown, labour dispute, dismissal by employment and so on. Of the potential causes of labour turnover listed above are factors under non-personal reasons which can have causal links with trade volatility.

The main aim of this chapter is to investigate whether or not trade volatility makes its way to the educated to less-educated wage differential through the channels suggested by Bhagwati and Dehejia. However, for a motivation first we regress relative wages on trade volatility to test if the two variables do have any causal relationship with each other.

In section II the significantly positive response of the wage differential to trade variation, represented by the coefficient of variation of the trade variable is in line with the Bhagwati/Dehejia trade explanation of the wage differential. In section III we examine the relationship between trade intensity, job duration and labour turnover. Section IV provides a regression analysis of trade volatility and labour turnover. Section V furnishes the conclusion.

II. Trade Volatility and the Educated to less-educated Wage Differential

The results in chapter 3 supported the proposition that trade plays a significant role just as does technology, in the widening of the educated to less-educated wage differential. It, nevertheless, didn't tell us much (or

anything at all) about the Bhagwati/Dehejia alternative trade explanation in which the result must follow from the increasing trade volatility working its way through increased overall labour turnover and less less-educated workers' skill accumulation as discussed in chapter 2.

In this section we investigate if trade volatility indeed exerts a significantly positive impact on the educated to less-educated wage differential. One measure that takes count of the volatility in trade could have been the variance of the trade variable. The problem with using the variance as a proxy for variability in this situation, however, is that the trade values across the three digit industries do not fall to the same mean level.

Since variance is defined as the average squared deviation between the observations and the mean and if the mean is not the same across industries, bigger variances do not necessarily imply greater variability. An ideal proxy in this situation is the one that measures relative variability across the three digit industries. One such measure is the coefficient of variation. The coefficient of variation is the standard deviation of a distribution divided by the distribution's mean. Thus, we run the following regression which is also based on equation (10) in chapter 2:

$$W_{it} = \alpha_1 + \alpha_2 E + \beta_1 (CVTRADE_{jt}) + \beta_1 (E * CVTRADE_{jt}) + \pi_1 (TECH_j) + \pi_2 (E * TECH_j) + \eta (CAPITAL_{jt}) + \theta X_{it} + \mu Z_i + \psi Y_i \quad (1)$$

The rest of the variables are as those in regression (1) of chapter 3 except now *TRADE* is replaced with *CVTRADE_j*, the coefficient of variation of the volume of trade to output ratio to surrogate trade volatility. The result of regression (1) is presented in Tables 13 and 14. As in chapter 3, the difference between the two tables is that in the former we estimate semi-log multivariate regressions. Whereas, in the latter we take the log of all variables that appear in log in equation (7) of Chapter 2. In addition, in columns (1) of the two tables the variable *CAPITAL* is not included but in columns (2) it is.

The coefficients on all other variables carry similar signs and magnitude as well as similar interpretations as those in Tables 11 and 12 of chapter 3. The important finding in this section, however, is that the coefficients on both *CVTRADE* and *E*CVTRADE* for all workers and also for male and female separately are significantly positive in both tables suggesting that the increasing trade volatility somehow benefited both educated and less-educated workers. For example, in Table 13, a one percent increase in the coefficient of variation of the trade variable increases the log wages of the less-educated by 0.1 to 0.8 per cent and of the educated workers by another 0.9 to 3.5 per cent. However, the significantly positive and much greater coefficient on *E*CVTRADE* supports the fact that educated workers are affected more favorably as suggested by Bhagwati and Dehejia.

Table 13: Semi-log estimates of regression (1).

	All workers		Male		Female	
	(1)	(2)	(1)	(2)	(1)	(2)
α_1	1.998 (90.11)	1.961 (67.37)	1.072 (33.34)	1.072 (34.91)	1.015 (30.95)	1.017 (50.90)
α_2	0.203 (18.20)	0.210 (16.22)	0.142 (39.16)	0.155 (20.34)	0.273 (34.55)	0.270 (30.76)
CVTRADE	0.001 (2.81)	0.001 (2.41)	0.006 (13.60)	0.005 (8.42)	0.006 (18.71)	0.008 (17.29)
E*CVTRADE	0.009 (13.73)	0.009 (10.49)	0.026 (26.59)	0.025 (19.22)	0.031 (33.76)	0.035 (27.16)
TECH1	0.099 (10.29)	0.087 (6.58)	0.105 (12.12)	0.036 (2.98)	0.176 (16.35)	0.1425 (10.06)
ETECH1	0.137 (6.484)	0.101 (3.58)	0.243 (8.51)	0.234 (6.14)	0.222 (6.31)	0.175 (3.56)
EXP	0.018 (19.52)	0.020 (15.78)	0.041 (36.15)	0.041 (27.49)	0.036 (29.78)	0.030 (17.72)
EXP ²	-0.0003 (-17.64)	-0.0003 (-14.22)	-0.0005 (-19.72)	-0.0006 (-15.38)	-0.0006 (-15.82)	-0.0004 (-8.22)
TENURE	0.104 (10.34)	0.092 (6.86)	0.034 (27.93)	0.032 (22.30)	0.031 (29.69)	0.030 (20.09)
TENURE ²	0.00002 (5.86)	0.00002 (3.90)	-4.79E-06 (-17.05)	-5.06E-06 (-14.42)	-5.84E-06 (-17.93)	-5.23E-06 (-11.94)
FT	0.227 (37.28)	0.231 (28.92)	0.796 (55.93)	0.825 (42.98)	0.336 (38.62)	0.312 (23.95)
LS	0.002 (33.23)	0.002 (25.85)	0.002 (45.90)	0.002 (33.88)	0.002 (49.54)	0.002 (41.11)
SEX	0.000004 (19.17)	0.000004 (15.04)	-----	-----	-----	-----
UNEMP	-0.018 (-22.44)	-0.018 (-17.28)	-0.038 (-41.98)	-0.035 (-29.36)	-0.061 (-78.52)	-0.066 (-70.49)
UNION	0.102 (16.17)	0.098 (12.05)	0.157 (19.59)	0.122 (11.55)	0.227 (24.85)	0.141 (11.79)
CAPITAL	-----	0.017 (3.21)	-----	0.071 (14.51)	-----	0.077 (14.95)

The result of all control variables such as time dummies, regional dummies and industry level dummies is suppressed here.

Rsq	0.37	0.37	0.39	0.93	0.40	0.40
No of obs	19039	11049	9895	5745	9144	5304

t-ratios in prentices.

Table 14: Log-linear estimates of regression (1).

	All workers		Male		Female	
	(1)	(2)	(1)	(2)	(1)	(2)
α_1	1.994 (32.49)	2.107 (26.65)	1.106 (23.54)	1.702 (21.30)	1.465 (20.25)	1.412 (25.17)
α_2	0.180 (13.16)	0.182 (10.05)	0.101 (27.87)	0.110 (19.17)	0.260 (28.33)	0.262 (20.45)
CVTRADE	0.004 (0.91)	0.006 (0.90)	0.001 (3.87)	0.002 (3.70)	-0.0002 (-0.82)	7.22E-05 (0.20)
ECVTRADE	0.073 (13.33)	0.072 (9.75)	0.007 (10.49)	0.006 (6.59)	0.010 (13.66)	0.014 (13.88)
TECH1	0.085 (11.22)	0.081 (7.95)	0.061 (8.69)	0.036 (3.77)	0.103 (12.92)	0.107 (10.37)
ETECH1	0.076 (3.08)	0.044 (1.33)	0.139 (6.25)	0.160 (5.33)	0.156 (5.77)	0.003 (0.09)
EXP	0.058 (4.87)	0.078 (5.26)	1.195 (28.44)	1.143 (20.99)	0.926 (20.54)	1.106 (18.04)
EXP ²	0.003 (0.92)	-0.002 (-0.60)	-0.217 (-21.42)	-0.212 (-16.00)	-0.117 (-10.69)	-0.168 (-11.22)
TENURE	0.001 (0.18)	-0.015 (-1.61)	0.014 (2.06)	0.014 (1.59)	-0.017 (-2.79)	-0.045 (-5.56)
TENURE ²	0.012 (10.65)	0.015 (10.02)	0.015 (14.24)	0.015 (10.75)	0.018 (18.12)	0.023 (17.01)
FT	0.111 (8.49)	0.112 (6.50)	0.270 (17.99)	0.282 (13.37)	0.113 (15.52)	0.103 (10.90)
log(LS)	0.047 (9.13)	0.036 (5.41)	0.094 (21.22)	0.100 (17.22)	0.053 (12.64)	0.045 (7.96)
SEX	0.254 (36.68)	0.247 (27.10)	-----	-----	-----	-----
log(UNEMP)	-0.213 (-16.67)	-0.226 (-13.70)	-0.128 (-12.26)	-0.123 (-8.99)	-0.004 (-0.41)	-0.017 (-1.19)
UNIION	0.132 (19.65)	0.124 (14.02)	0.135 (21.12)	0.115 (13.60)	0.183 (26.79)	0.184 (21.09)
log(CAPITAL)	-----	0.006 (0.918)	-----	0.027 (6.92)	-----	0.002 (0.45)

the result of all control variables such as time dummies, regional dummies and industry level dummies is suppressed here.

Rsq	0.44	0.4576	0.93	0.93	0.96	0.96
No of obs	15539	8982	8080	4670	7459	4312

t-ratios in pernicious.

III. Trade Intensity, Job Duration, and Labour Turnover

One way through which one can examine the impact of trade on labour turnover is to look at the relationship between trade intensity and on the job tenure (or, job duration). Under the Bhagwati/Dehejia hypothesis, as trade intensified over the period 1993-1996 year after year as a result of the Free Trade and North American Free Trade agreements, one would expect an increase in labour turnover resulted from fluctuations in labour demand, reflected in a decline in long-term employment or/and a rise in shorter on the job tenures.

In Table 15 we examine if short-term jobs indeed are becoming more common, or, long-term jobs are becoming less common. To do that we break down tenure by different year-intervals for both educated and less-educated workers and then estimate and record the average on-the-job-tenure for every year over the period 1993-1996 for both type of workers. The result in Table 4 reveals that the number of jobs with shorter tenures have increased whereas the number for longer tenure has fallen for both educated and less-educated workers. For example, between 1993 and 1996 the number of jobs with tenure less than or equal to a year have increased by 10.57% and 7.16% for educated and less-educated workers respectively.

On the other hand, the number of jobs with tenure more than 10 years have fallen by 9.46% and 4.49% for the two types of workers respectively. It is also noticed from the higher change figures for the educated workers that on relative terms they are more on roller-coaster than the less-educated. This

can be explained by the fact that turnover can be either voluntary (quits) or involuntary (layoffs). Whereas the latter could affect both types of workers symmetrically the former could be higher for educated workers for their flexibility in the labour market.

Table 15: Percentage of Educated to less-educated Workers by Tenure Levels

	1993	1994	1995	1996	Change: 1993-1996
Educated					
• Tenure≤1 year	18.48	20.37	19.51	29.05	10.57
• 1<Tenure≤3 years	10.39	17.90	24.54	18.83	8.44
• 3<Tenure≤5 years	14.01	12.08	10.70	9.14	-4.87
• 5<Tenure≤10 years	22.37	19.32	17.92	17.67	-4.70
• Tenure>10 years	34.75	30.32	27.33	25.29	-9.46
Less-educated					
• Tenure≤1 year	33.81	36.99	35.19	40.97	7.16
• 1<Tenure≤3 years	13.02	18.43	23.88	18.07	5.05
• 3<Tenure≤5 years	12.47	9.79	8.95	8.35	-4.12
• 5<Tenure≤10 years	16.35	13.89	12.54	12.93	-3.42
• Tenure>10 years	24.35	20.89	19.44	19.66	-4.49

Source: authors calculation from SLID.

In order to link labour turnover directly to trade intensity, in Figure 4.1 we plot the two variables against each other. The variable of trade intensity for a given (3-digit SIC) industry is defined as total exports plus total imports divided by total domestic output of that industry. Whereas, the variable for

labour turnover intensity for a given industry is defined as the number of job turnovers divided by the number of employees in that industry.

From Figure 4.1 it is obvious that labour turnover is more intensive in industries that are relatively more trade-intensive indicated by the positively sloped curve. Thus both the result in Table 4 and in Figure 4.1 support the Bhagwati/Dehejia proposition that with increasing trade intensity comes increasing labour turnover incidences. Next, we turn to regression analysis in which labour turnover is the dependent variable and trade volatility is an independent variable.

Figure 4.1

IV. Trade Volatility and Labour Turnover

In order to investigate the effect of trade volatility on labour turnover we run the regression:

$$TURNOVER_{it} = \alpha_1 + \alpha_2 E + \beta(CVTRADE_{jt}) + \pi(TECH_j) + \eta(CAPITAL_{jt}) + \theta X_{it} + \mu Z_i + \psi Y_i \quad (2)$$

where now *TURNOVER* is a dummy variable taking a value of 1 if worker *i* experiences a labour turnover over the period 1993-1996 and 0 otherwise. The results of regression (2) are recorded in Table 16.

Like in Tables 13 and 14, the second column of Table 16 includes the variable *CAPITAL* whereas the first one does not. In both columns the coefficients on *CVTRADE* (coefficient of variation of the *TRADE* variable) are significantly positive implying that the trade variation significantly intensifies the incidence of labour turnover.

The result is in line with that reported by Heisz (1996) in which it was shown that over the period we suspect trade liberalization to have made industries ‘footloose’ (perhaps, through kaleidoscopic comparative advantage) job turnover rates in almost all industries have increased. Similarly, Baldwin and Rafiquzzaman (1994) in their paper, *Structural change in the Canadian manufacturing sector 1970-1990*, report a marked increase in labour turnover in all manufacturing industries -- the highest

turnover occurring in industries that are relatively more exposed to international competition.

The coefficients on other variables can be interpreted as following. Holding everything else constant the incidence of labour turnover is higher among educated workers, men and unionized workers. Labour turnover rates increases with the intensity in technology. It falls with potential experience but increases with on-the-job tenure. An increase in labour supply also increases labour turnover but higher unemployment rate reduces it. Full time workers experience lower incidence of labour turnover than part-time workers.

Table 16: Results of regression (2) from Logistic Procedure of Maximum Likelihood Estimation.

	(1)	(2)
α_1	-0.9273 (42.25)	-0.6389 (11.44)
α_2	0.4053 (24.55)	0.4099 (13.17)
CVTRADE	0.0131 (32.34)	0.0153 (25.42)
TECH1	0.2712 (28.67)	0.2793 (16.24)
EXP	-0.011 (35.10)	-0.0128 (29.78)
TENURE	0.0323 (2256)	0.0309 (1387)
FT	-0.2865 (20.05)	-0.363 (17.48)
LS	0.0003 (102.6)	0.00025 (50.45)
SEX	0.1564 (13.85)	0.1582 (7.889)
UNEMP	-0.0393 (42.01)	-0.0418 (27.72)
UNION	0.0641 (1.836)	0.0809 (1.702)
Y1994	0.0861 (1.854)	0.0737 (1.356)
Y1995	0.2044 (10.15)	0.1893 (8.562)
Y1996	0.4143 (56.08)	-----
CAPITAL	-----	-0.067 (5.590)

the result of all control variables such as time dummies, regional dummies and industry level dummies is suppressed here.

No of obs.	19083	11067
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Chi-square statistics in parenthesis.

V. Summary

In this chapter we studied the causal links between trade volatility, labour turnover and the educated to less-educated workers' wage differential. In section II, it was found that although trade volatility affects the wages of both educated and less-educated workers favourably, its impact on the educated is some 8 times stronger than that on less-educated workers.

In section III, we examine the relationship between trade intensity, on-the-job-tenure and labour turnover. It confirmed that the number of jobs with shorter tenures have increased whereas the number for longer tenure has fallen for both educated and less-educated workers, and that labour turnover is more intensive in industries that are relatively more trade-intensive.

Section IV provided a regression analysis of trade volatility and labour turnover. It also confirmed that trade volatility's contribution to the incidence of labour turnover is significant. Thus, the result as a whole supports the part of the Bhagwati/Dehejia hypothesis which states that trade liberalisation leads to trade volatility which in turn intensifies labour turnover.

Chapter 5

Labour Turnover, Jobless Spells and Relative Wages

I. Introduction

It was shown in chapter 4 that trade volatility, brought about by falling barriers to international trade, leads to increased labour turnover. The next and final step is to investigate whether or not labour turnover and the subsequent jobless spell adversely affect the wages of the less-educated by more than that of the educated workers.

In Bhagwati and Dehejia they do so for two reasons: First, educated workers are assumed to possess more of a general knowledge which is easily transferable between industries. Their stock of human capital and hence wages are not affected when they experience a turnover. Less-educated workers on the other hand are assumed to possess industry-specific skills. Their human capital depreciates when they encounter a turnover hence leading to a drop in their wages.

Moreover, as explained by Bhagwati and Dehejia the subsequent jobless spell (or, search) period between jobs is more likely to be used by the

educated to add to their skills through study than by the less-educated. "Once you have been trained and socialized to train, it is easier to find the motivation to retool and retrain; if you have never been socialized to train in the first place, you may turn more readily into a couch potato watching TV during fallow periods" (Bhagwati, 1995).

Therefore, there are two important issues that we look into in this chapter. First, in section II and III we investigate if labour turnover affects the wages of the less-educated by more than those of the educated. Then in section IV and V we examine whether or not the subsequent jobless spells stalls the skill accumulation (and hence the wage growth rate) of the less-educated but leaves that of the educated less-affected. In section VI, we provide a summary of the findings.

II. Labour Turnover and Relative Wages

Bhagwati and Dehejia suggest that because educated workers possess relatively more of a general knowledge, their wages will not be affected by as much as those of less-educated workers when they experience a labour turnover. This implies that if the relative wage curve of the educated to less-educated workers is graphed against the frequency of labour turnover one would expect it to have a positive slope. In Figure 5.1 we do exactly that.

From the SLID data which provides information on up to 9 turnovers and subsequent wage rates, we calculate the average relative wage rate of the

educated to less-educated and then graph it on the number of turnovers workers experience. The relative wage curve in Figure 5.1 is negatively sloped. This is contrary to what is suggested by the Bhagwati and Dehejia hypothesis. Before we draw any conclusions or provide any explanation to this contradiction, we first turn to an econometric testing of the relationship between the two variables in the subsequent section to check if the evidence of this section can be replicated.

Figure 5.1

III. Econometric Analysis of Labour Turnover, Jobless Spells and Relative Wages

In this section we make use of the on-the-job-tenure variable (*TENURE*) and the potential experience variable (*EXP*) to get to find the impact of job turnover and the subsequent jobless spells on the relative wages of the educated to less-educated workers. It is basically regression (1) of chapter 3 that we return to however now we interact the dummy variable *E* with on-the-job tenure (*TENURE*) and potential experience (*EXP*) in order to measure and test the learning by doing part of the model¹ (Note that the two variables, *E*TENURE* and *E*EXP* are included to provide an answer for the effect of job turnover and spells on the relative wages – bellow we explain how the coefficients on these two variables imply the causal direction of the jobless spells). On the job tenure measures the returns to being on the same job (Mincer and Jovanovic1981), or in other words, returns associated with firm specific skills. The return associated with general skills is picked up by the coefficients on the potential experience (please see Appendix III for details).

Suppose we go along Bhagwati and Dehejia's assumption that educated workers possess more of a general knowledge that can readily be applied at any firm or industry. Then from among the workers who experience job turnovers and spells, we expect the coefficient associated with

¹ recall that *E* takes a value of 1 if a worker is educated and 0 otherwise.

job tenure to be significantly less positive and that associated with potential experience to be significantly more positive for educated workers. If the result holds this could be due to job turnover and jobless spells having a more negative impact on less-educated workers, as suggested by the theory. Other variables included are expected to carry the coefficients suggested by standard economic theories.

The result is presented in Table 17. As before, the difference between columns 1 and 2 is that the first includes the variable CAPITAL whereas the latter does not. The significantly positive differential impact of potential experience on the wages of educated workers for All workers and for Male and Female separately is what was hypothesized. However, the positive coefficients on on-the-job tenure interacted with E ($E \cdot \text{TENURE}$) are once again contrary to what was suggested a priori. This perhaps implies, unlike suggested, it is the educated workers whose knowledge is more industry specific.

Table 17: Estimates of Equation 10 of chapter 2

	All workers		Male		Female	
	(1)	(2)	(1)	(2)	(1)	(2)
α_1	1.987 (93.63)	1.967 (69.94)	1.81 (55.06)	1.78 (41.02)	1.19 (28.50)	1.18 (26.23)
α_2	0.14 (12.40)	0.13 (9.53)	0.16 (12.80)	0.11 (8.10)	0.10 (8.34)	0.10 (8.40)
TRADE	0.012 (7.20)	0.007 (3.02)	0.019 (11.87)	0.002 (1.06)	0.022 (11.52)	0.003 (1.35)
TECH1	0.075 (6.99)	0.077 (5.57)	0.061 (6.39)	0.026 (2.08)	0.105 (9.01)	0.110 (7.37)
EXP	0.018 (18.50)	0.019 (15.07)	0.028 (24.55)	0.029 (19.80)	0.027 (20.85)	0.026 (15.20)
EXP ²	-0.0003 (-16.44)	-0.0003 (-13.38)	-0.0003 (-10.01)	-0.0003 (-8.93)	-0.0003 (-8.96)	-0.0002 (-5.40)
E*EXP	0.016 (8.16)	0.012 (4.21)	0.041 (11.17)	0.030 (5.80)	0.087 (17.27)	0.081 (11.09)
E*EXP ²	-0.0003 (-5.55)	-0.0002 (-2.76)	-0.001 (-8.94)	-0.0006 (-4.44)	-0.003 (-16.76)	-0.003 (-11.10)
TENURE	0.002 (31.08)	0.002 (24.27)	0.002 (20.58)	0.002 (16.31)	0.003 (27.84)	0.003 (21.21)
TENURE ²	-3.7E-06 (-17.54)	-3.7E-06 (-13.83)	-3.32E-06 (-11.58)	-3.52E-06 (-9.94)	-5.27E-06 (-15.63)	-5.57E-06 (-12.51)
E*TENURE	0.002 (5.29)	0.002 (4.90)	0.004 (9.99)	0.005 (8.42)	0.007 (12.49)	0.009 (9.97)
E*TENURE ²	-5.7E-06 (-5.75)	-6.6E-06 (-4.98)	-1.30E-05 (-10.15)	-1.45E-05 (-8.68)	-3.50E-05 (-14.09)	-4.53E-05 (-11.76)
FT	0.097 (9.74)	0.087 (6.52)	0.950 (61.53)	0.997 (48.33)	0.304 (30.41)	0.314 (23.77)
LS	2.64E-05 (6.71)	2.38E-05 (4.51)	0.0002 (47.69)	0.0002 (33.45)	0.0002 (64.08)	0.0003 (44.73)
SEX	0.226 (37.21)	0.230 (28.85)	-----	-----	-----	-----
UNEMP	-0.017 (-20.43)	-0.017 (-15.89)	0.044 (53.28)	0.038 (35.12)	0.073 (105.53)	0.071 (76.60)
UNION	0.103 (16.38)	0.103 (12.62)	0.135 (16.77)	0.101 (9.62)	0.141 (15.01)	0.118 (9.80)
Y1994	0.005 (0.41)	0.008 (0.67)	0.208 (19.11)	0.139 (12.82)	0.318 (28.54)	0.216 (19.48)
Y1995	-0.004 (-0.37)	0.0002 (0.02)	0.254 (22.94)	0.187 (16.81)	0.395 (34.96)	0.292 (25.93)
Y1996	-0.014 (-1.30)	-----	0.242 (26.50)	-----	0.365 (40.18)	-----
CAPITAL	-----	0.012 (2.19)	-----	0.090 (17.52)	-----	0.089 (16.18)
Rsq	0.37	0.38	0.38	0.38	0.38	0.38
No of obs	19037	11047	10090	5857	8947	5190

t-ratios in parenthesis.

If knowledge specificity is what is driving the above result, it is more likely to do it through the incidence of labour turnover rather than the resulted jobless spells. Since the SLID data does provide data on both job turnover and the jobless spells, we can separate the impact of the two variables on the relative wages. Next we investigate the direct causal link between job turnover and relative wages and jobless spells and relative wages.

IV. Econometric Analysis of Labour Turnover and Relative Wages

In Table 18 we record the result of a simple wage regression in which labour turnover (TURNOVER), and labour turnover interacted with the dummy E (recall, E takes a value of 1 if a worker is educated and 0 otherwise) enter as independent dummy variables. TURNOVER takes a value of 1 if a workers has experienced a turnover and 0 otherwise. ETURNOVER, however, takes a value of 1 if a worker is educated and experiences a labour turnover and 0 otherwise. ETURNOVER, therefore, measures the differential impact of labour turnover on the educated workers.

Under Bhagwati and Dehejia's explanation one would expect that the coefficient on TURNOVER be negative and that on ETURNOVER be positive. Looking at Table 18 in which the coefficients on all other explanatory variables are suppressed it is evident that the coefficients on TURNOVER is negative in all of the seven regressions as expected, however,

the coefficients on ETURNOVER are all negative consistently. More specifically, a turnover depressed the wage rate of less-educated workers by about 13 to 18 percent, however, it pushed the wage rate of the educated workers by a further 2 to 8 percent. This confirms the graphic evidence of section II in which it was shown that the relative wage rate of the educated to less-educated falls with the increase in the incidence of labour turnover.

Although the observed labour turnover effect itself does not comply with the suggestion put forward by Bhagwati and Dehejia, it cannot reject their overall explanation. The core of the Bhagwati and Dehejia hypothesis is the "rolling stone gathers no moss effect" explanation, or in other words, the jobless spell effect on wages. Recall, that spells between jobs were argued to be used by educated workers to retool and retrain themselves. The less-educated workers, having failed to train (or, study) in the first place, are likely to fail again, thus resulting in the widening of skills and hence differentials. In the next two sections we investigate that explanation in depth.

Table 18: Estimates of log wages on labour turnover.

	all workers	Men	Women	Age≤4	age>44	unionised	Non-unionised
				4			
TURNOVER	-0.13	-0.09	-0.18	-0.16	-0.04	-0.17	-0.01
ETURNOVER	-0.05	-0.08	-0.02	-0.05	-0.05	-0.06	-0.06

The result of all other explanatory variables is suppressed.

Rsq	0.98	0.98	0.97	0.98	0.98	0.97	0.98
No of obs	9117	6796	2321	6416	2701	5419	3698

Shaded vales are significant at the 1 percent level.

V. Jobless Spells and Relative Wages

In this section we check if the length of jobless spell hampers skill accumulation of less-educated workers by more than that of educated workers as suggested by Bhagwati and Dehejia. A quick descriptive answer is provided by Figures 5.2 in which we map the relative wages of the educated to less-educated (of the workers who experience labour turnover) on the length of jobless spells (in weeks).

If the Bhagwati and Dehejia's "rolling stone gathers no moss effect" with the educated workers being shielded from that effect" explanation holds true, one would expect that the relative wage curve is increasing over the time spent out of the labour market.

Figure 5.2

Figure 5.2 shows that if less-educated workers get back into the job market within about 18 months (or, 72 weeks), their wage rate relative to educated workers experiencing jobless spells of similar length will not be affected. However, if the spell extends beyond that, they start to experience depreciation in their relative skills hence leading to an increase in the educated to less-educated wage rate. This supports the “rolling stone gathers no moss effect” part of the Bhagwati/Dehejia explanation.

For a further investigation of the impact of jobless spells on skill accumulation and hence on human capital growth profile of relative wage rates, we resort to regression analysis below. To our regression that is still based on equation (10) of Chapter 2 we now add the jobless-spell variable. Recall in equation (10) of Chapter 2, the term $\delta_i T - \delta_k \sum_l \tau_l$ which was interpreted as the total potential experience minus the sum of job tenure was precisely the jobless spells. The new regression thus replaces the potential experience and on the job tenure variables with the jobless spells variable. The result of the new regression is presented in Table 19.

In Table 19 the significantly negative coefficients on *SPELL* (the variable for jobless spells) and the significantly positive coefficients on *E*SPELL* (the education dummy E interacted with the SPELL variable) in all of the six regressions (two for each All workers, Male and Female) clearly is evidence in support of the Bhagwati and Dehejia hypothesis that less-educated workers are affected more adversely by jobless spell than are

educated workers. The result is in line with the graphic evidence of Figure 5.2.

Table 19: Estimates of a variant of equation 10 of chapter 2

	All workers		Male		Female	
	(1)	(2)	(1)	(2)	(1)	(2)
SPELL	-0.0007 (-5.20)	-0.0008 (-4.13)	-0.002 (-6.24)	-0.001 (-3.49)	-0.001 (-9.85)	-0.001 (-7.70)
SPELL ²	6.19E-07 (3.87)	1.07E-06 (3.51)	1.93E-06 (2.75)	4.88E-07 (0.50)	8.59E-07 (6.07)	1.20E-06 (4.42)
E*SPELL	0.003 (4.23)	0.003 (3.85)	0.011 (10.08)	0.011 (8.07)	0.026 (16.63)	0.024 (11.63)
E*SPELL ²	-8.67E-06 (-2.11)	-8.61E-06 (-1.92)	-3.24E-05 (-6.57)	-2.91E-05 (-5.35)	-0.0002 (-13.11)	-0.0002 (-8.91)

***Coefficients on other explanatory variables are suppressed**

Rsq	0.21	0.22	0.38	0.38	0.38	0.38
No of obs	6451	3870				

t-ratios in parenthesis.

VI. Fixed Effect Estimation

One of the problems inherent in panel data is heterogeneity. Although in our regressions so far we control for observed heterogeneity among workers, we do not do so for unobserved heterogeneity. Unobserved heterogeneity is a time-invariant latent individual effect correlated with the explanatory variables. If there is no unobserved heterogeneity present in the data then the result presented above would be unbiased and consistent, otherwise it won't be (Greene 1997). However, with a panel data some argue

that it is more likely the case that the data is affected by it (Griliches 1977; Hausman and Taylor 1981; Neal 1995; Osberg 1986).

For example, a higher wage rate associated with higher tenure may not be due entirely to skill a worker accumulates through on-the-job-learning-by-doing but it might be due to his/her latent individual specific ability. Because of that ability the worker may have a longer tenure on the job in the first place. The same argument goes for education: the fact that an educated worker commands a higher wage rate may not be due to his/her high education but rather to his/her individual specific ability which probably also has helped him/her to achieve higher education.

One way of correcting for unobservable heterogeneity is the well-known Fixed Effect approach (Greene 1997; Johnston and DiNardo 1998). This eliminates the individual effects in the sample by transforming the data into deviations from individual means and, therefore, is dubbed the Within Group Estimator (WGE). In order to provide a check on the result obtained above, we run a WGE Fixed Effect regression model:

$$w_{it} = \alpha_1 + \alpha_2 E + \rho_1(tenure_{it}) + \rho_2(E * tenure_{it}) + \psi_1(exp_{it}) + \psi_2(E * exp_{it})$$

Where, $w_{it} = W_{it} - W_{i\cdot}$; $tenure_{it} = TENURE_{it} - TENURE_{i\cdot}$; $exp_{it} = EXP_{it} - EXP_{i\cdot}$; $spell = SPELL_{it} - SPELL_{i\cdot}$. W_{it} is the wage rate of an individual in group i in time t and $W_{i\cdot}$ is the mean wage of an individual belonging to group i . $TENURE_{it}$, and $TENURE_{i\cdot}$, EXP_{it} , and $EXP_{i\cdot}$ and $SPELL_{it}$ and $SPELL_{i\cdot}$ have similar interpretations. Although the coefficients of the Fixed Effect model

are of a different scale, their interpretations are similar to that of an ordinary least square regression.

The results of the Fixed Effect regression are presented in Tables 20 and 21. The significantly positive coefficients on *tenure*, *exp*, *e*tenure*, *e*exp* and *e*spell* and the significantly negative coefficients on *spell* make the result identical to that obtained and discussed above. Fixed Effects estimation, thus, enhanced the validity of the result obtained from ordinary least square estimation procedure above.

Table 20: Fixed Effect Estimates of wages on tenure and experience

	All workers	Male	Female
α_1	0.793 (27.87)	1.048 (30.23)	0.653 (12.23)
α_2	0.777 (10.25)	1.030 (8.75)	0.301 (6.36)
<i>Tenure</i>	0.020 (57.86)	0.019 (33.19)	0.181 (30.48)
<i>Tenure</i> ²	-0.000008 (-4.86)	-0.000005 (-5.50)	-0.00002 (-3.58)
<i>E*tenure</i>	0.005 (6.60)	0.006 (9.30)	0.021 (10.22)
<i>E*tenure</i> ²	-0.00004 (-8.97)	-0.00003 (8.26)	-0.0001 (-10.50)
<i>Exp</i>	0.090 (43.91)	0.103 (44.98)	-0.058 (22.80)
<i>Exp</i> ²	-0.005 (-40.19)	-0.020 (32.14)	-0.018 (23.65)
<i>E*exp</i>	0.1482 (21.87)	0.092 (18.92)	0.090 (14.46)
<i>E*exp</i> ²	-0.006 (-13.87)	-0.001 (6.23)	0.011 (9.12)
Rsq	0.17	0.16	0.19
No of obs	85980	63625	22355

t-ratios in parenthesis.

Table 21: Fixed Effect estimates of wages on jobless spells

	All workers	Male	Female
<i>Spell</i>	-0.006 (-8.60)	-0.013 (-4.13)	-0.030 (-7.70)
<i>Spell</i> ²	0.000005 (5.86)	0.00002 (3.85)	-0.00005 (-6.42)
<i>E*spell</i>	0.003 (1.76)	0.006 (4.42)	-0.003 (-5.20)
<i>E*spell</i> ²	-0.000004 (-2.22)	-0.000001 (-2.24)	0.000001 (3.91)
***Coefficients on other explanatory variables are suppressed**			
Rsq	0.23	0.24	0.21
No of obs	9117	6796	2321

t-ratios in parenthesis.

VII. Summary

In this chapter we studied the causal links between labour turnover and the relative wages of the educated to less-educated workers and the relationship between the latter and subsequent jobless spells. In section II and III it was discovered that unlike suggested by Bhagwati and Dehejia labour turnover itself has a negative impact on the relative wages. This perhaps implies that contrary to what was expected it is the educated workers whose skills are more firm-specific and will lose some wage when they switch firms.

In section IV and V, however, it was found that the subsequent jobless spells flattens the wage growth profile of the less-educated workers by more than the educated workers. This is precisely what the Bhagwati and Dehejia's "rolling stone gathers no moss effect" explanation suggests. Since the latter

explanation is the core of the alternative trade and wages explanation, the result in this chapter supports the Bhagwati/Dehejia hypothesis as a whole.

CHAPTER 6

Summary and Conclusion and Policy Implications

I. Summary and Conclusion

Trade liberalization has become an essential feature of the evolution of the world trade facilitated by successive rounds of GATT and WTO negotiations and has been recognized as the engine of global economic growth. It is mainly for this belief that over the past couple of decades more and more of the world economies are pushing toward a “globalizing” world market. Globalization necessitates a wide range of formal economic relations such as free mobility of goods, easing up restrictions on foreign direct investment, access to government procurement, the movement of business and technical personnel and trade in some services among trading partners, lest any one of them should see its desirability as an investment location diminish and its standards of living endangered.

Therefore, many countries have departed from the traditional trade policy which concentrated on negotiations on barriers such as tariffs and

quotas to a policy that calls for no barriers at all. Canada is one of those countries that has been in pursuit of such policies. For example, over the period 1988-1999 alone Canadians witnessed their federal government implement five free trade agreements: the Canada-US Free Trade Agreement (FTA, 1988), which was expanded to include Mexico in 1994 to form the North American Free Trade Agreement (NAFTA), the liberalization measures flowing from the Uruguay Round of multilateral trade negotiations that created the World Trade Organization (WTO, 1995), the Canada-Israel Free Trade Agreement (1997) and the Canada-Chile Free Trade Agreement (1998). As a result, Canadian two-way international trade grew at an average annual rate of 8.27% over the first six years (1988-1994) and at 9.83% over the last five years (1994-1999).

As more and more of the world economies are opening up their markets to one another, more and more theoretical and empirical studies focused on the causing role of trade in such important variables as technological change, labour productivity, wages, economic growth and so on. In particular, many trade and labour economists were attracted to investigate the differential impact of trade on the wages of the educated vis-à-vis the less-educated after it was observed that the gap between the two was widening in the US over the 1980s and 1990s – a period that coincided with falling barriers to international trade and foreign direct investment. Some studies concluded that trade indeed was a culprit for the widening of the educated to less-educated wage gap. Others, on the other hand found no role

for trade and saw skill-biased technological progress (independent of trade) to be behind the wage gap widening instead. A consensus has yet to emerge and the question whether the observed correlation between trade and the relative wages of the educated to less-educated is causal is still debated by economists.

However, some economists have recently suggested that both trade and technological progress could be behind the wage trend and that the relationship between trade and wages may not be all spurious, but rather the latter may pick up some genuine causal effects from the former. The question that comes next, then, is how trade liberalization can translate into the widening of the educated to less-educated wage gap? As discussed in chapter 1 the observed relationship between trade and wages could not fit the channels of the classical Stolper-Samuelson Theorem (SST). Further, it was because of this failure that trade as a cause was dismissed in favour of skilled-biased technological progress altogether. Therefore, there was a need for an alternative theoretical explanation that was trade-dependent but did away with SST. This need was filled by Bhagwati and Dehejia in their (1994) article, "Freer Trade and Wages of the Unskilled--Is Marx Striking Again?".

As stated in the introduction, the objective of this dissertation was to develop the Bhagwati/Dehejia alternative (non-Stolper-Samuelson) trade dependent explanation and empirically test it for Canada. Bhagwati and Dehejia (1994) hypothesize that trade liberalization leads to a rising education (or, skill) premium through the following process:

- lower barriers to trade make industries footloose which in turn leads to increased labour turnover.
- increased labour turnover dwindles the skill accumulation of less-educated workers but doesn't affect that of the educated by as much.
- different patterns of skill accumulation evolving from labour turnover and jobless spell lead to a widening in the educated/less-educated skill differential.

This as a whole provides a trade-dependent explanation that carry the same end as that of Stolper-Samuelson yet is different in the process of getting from the alleged cause to the observed effect.

In chapter 2 we developed the above explanation into a rigorous model and derived an equation for empirical testing in the subsequent chapters. In Chapter 3 we studied the trend of educated to less-educated (alternatively, skilled to less-skilled) workers' wage differential over the period covered by the Survey of Labour and Income Dynamics (SLID) data and examined if it is causally linked to international trade.

It was found that, after correcting for the relative supply effect, the widening of the educated to less-educated wage differential was occurring in Canada and that the wage differential would have been higher in the absence of changes in the relative supply of educated workers and in the absence of quantity adjustment (increasing relative unemployment of less-educated workers) rather than price adjustment (wage changes). The quantity adjustment rather than price adjustment is also an evidence obtained by

Beaulieu (2000) in his study of the Canada-US Free Trade Agreement (CUSTA). We also identified trade as a significant contributor to the rising education premium and showed that its impact on relative wages is just as significant as that of technology.

In chapter 4 we tested the causal links between trade volatility and relative wages and investigated if trade volatility makes its way to the educated to less-educated wage differential through the channels suggested by Bhagwati and Dehejia. It was found that although trade volatility (represented by the coefficient of variation of the trade variable) affects the wages of both educated and less-educated workers favourably, its impact on the educated is many times stronger than that on less-educated workers. Next, it was confirmed that labour turnover was more intensive in industries that were relatively more trade-intensive and that trade volatility was significantly causally linked to increased labour turnover.

Chapter 5 finally investigated whether or not labour turnover and the subsequent jobless spell adversely affected the wages of the less-educated by more than that of the educated workers. Although labour turnover itself was found to have a negative relationship with the relative wages of the educated to less-educated, jobless spell (due to increased labour turnover) was shown to have affected educated workers more favorably than less educated workers which resulting in the widening of their relative compensation. Based on the evidence summarized above it can be concluded that the Bhagwati/Dehejia alternative trade explanation partially holds for Canada because unlike

suggested by Bhagwati and Dehejia labour turnover itself depresses the skills of the educated workers by more than that of the less-educated workers. It is only the subsequent jobless spells then bring the differential effect in line with explanation provided by Bhagwati and Dehejia. The result in this dissertation compares favourably with other findings and explanations that find increased North-North trade (rather than North-South trade as in SST) as a (possible) cause for the rise in wage inequality of the educated to less-educated workers (Beaulieu, 2000; Beaulieu et al. 2001; Sener, 2001).

II. Policy Implications

The empirical findings in this dissertation carry the following implications for policy. First, conventionally, it is the trade with the south that is implicated for influencing the labour market, particularly the relative wages of the educated to less-educated (or, skilled to less-skilled) workers. The results in this dissertation, by confirming the Bhagwati/Dehejia hypothesis, however, challenge the conventional wisdom and the policies that are based on it. It is because in today's globalized North it is the North-North trade that exerts the Stolper-Samuelson type influence over the relative wages in the developed economies rather than the North-South trade.

Second, although the findings in this dissertation implicated trade as a possible cause of the widening in educated to less-educated wage differential, it is not necessarily harmful for the latter type of workers. The real wages of

both type of workers respond positively to increased trade liberalization -- it is just that the educated benefit by more than the less-educated. But this also implies that trade can be considered as a cause of earning inequality between skilled and less-skilled workers – a phenomenon that is less desirable by the society and warrants government intervention. Since the findings in this dissertation reveal that trade works its way to earnings inequality through stalled skill accumulation because of increased labour turnover and jobless spell incidences, the government, perhaps, can target the latter through providing retraining and job search funds and facilities.

Last, since this is the first study that empirically tests the Bhagwati/Dehejia hypothesis it would be worth replicating the same analysis using different data sets to check the findings of this dissertation. What is even more worthwhile is to investigate whether the Bhagwati/Dehejia hypothesis can also hold in the long run. One would expect that when countries fully liberalize their trade, harmonization of domestic policies that affect comparative advantages will follow suit. The stability in comparative advantages will lead to stability in trade and ultimately to stability in labour markets. Thus the Bhagwati/Dehejia hypothesis may not hold in the long-run and the support for government intervention based on this hypothesis may not be as strong as it would otherwise be.

Appendix I

Bhagwati and Dehejia Model

In Bhagwati and Dehejia (1994), their alternative trade dependent explanation is modeled in the standard 2x2x2 HOS framework with factors being skilled labour, H, and unskilled labour, L. Suppose the home country is H-abundant so that it exports H-intensive good. Suppose both H and L accumulate human capital through learning by doing, at a rate δ (>1) per period of time. H (being shielded from the “rolling-stone-gathers-no-moss-effect”) augments at the same rate δ in either sector. In other words, it is unaffected by a shift between sectors. However, L augments only if it remains in the same sector - not so if it moves between sectors. Now we evaluate the effects of a *terms-of-trade* volatility.

Suppose p the relative price of the skilled-intensive good in terms of unskilled-intensive good becomes p' such that $p' > p$ at the beginning of the period and then returns to p at the end. H being unaffected by the shifts will augment to δH , whereas, L augments to $\delta(L - \Delta L) + \Delta L$. ΔL is the amount of unskilled labour moving between the two sectors in response to the initial terms of trade shift from p to p' .

This is illustrated in Figure 2.1 with the help of an Edgeworth box diagram that combines information about the two industries within the home

country, where each industry uses two inputs, skilled (or, educated) labour and unskilled (or, less educated) labour. The origins of the two sectors are depicted by 0 and 0', connected by a contract curve 0PP0'.

Figure 2.1

Suppose that at the initial terms of trade (p), the economy is at point P on the contract curve. The change in the terms of trade from p to p' induces a shift in the equilibrium to a new point, P' . Dropping vertical lines from P and P' to the horizontal axis and labeling the corresponding points A and B , respectively, the change in less-skilled labour can be identified by the distance AB along the horizontal axis. In the final equilibrium, when the terms of trade has returned to p (which corresponds to P on the contract

curve), there is no change in the real wage per effective unit of skilled or less-skilled labour. However, the effective stocks per worker of the two factors now differ because of differential augmentation induced by the fluctuation of p to p' then back to p . The effective stock of skilled labour is now δH , whereas the effective stock of less-skilled labour is $\delta(L - \Delta L) + \Delta L$.

Although real wages per effective worker are unchanged, the observed real wages per worker now differ. Recall that H and L represent total effective stocks of skilled and less-skilled labour, respectively. Normalizing $H+L=1$ for simplicity, H and L may be interpreted as the total stock of skilled labour per skilled labourer and the total stock of less-skilled labour per less-skilled labourer, respectively. Initially, the real wages of the skilled worker is $W_H H$ and of the less-skilled worker $W_L L$, where W_H and W_L are the respective real wages per effective worker. At the end real wages per effective worker are unchanged, however, real wages per worker have increased to $W_H \delta H$ and $W_L [\delta(L - \Delta L) + \Delta L]$, respectively.

The relative wages of skilled to less-skilled workers at the beginning and end of the period are $\frac{W_H}{W_L}$ and $\frac{W_H \delta H}{W_L [\delta(L - \Delta L) + \Delta L]}$ respectively. Clearly the latter relative wage is greater than the former implying that the real income of less-skilled labour will therefore be lower, as compared with having no terms of trade volatility in this model. It is important to note that this result is not due to the Stolper-Samuelson effect on real wages but due to the differential human capital accumulation that leaves less-skilled labour

relatively poorly endowed with human capital at the end. On the other hand, skilled labour is impervious to the volatility in terms of trade by the model's assumption. Thus, it is obvious that the real wage per less-skilled labourer will be lower than if the rolling-stone effect were absent.

Appendix II

Definitions of Variables

1. AGE person's age as of December 31 of the reference year
2. CAPITAL a continuous variable on the capital to labour intensity for 3-digit SIC industries
3. EDUCAT flag to indicate (yes=1) if a person ever received a university degree, certificate or diploma, ranging from below Bachelor's to Ph.D. (SLID)
4. EDULVL highest level of education of person.
 - 01: never attended school
 - 02: 1-4 years of elementary school
 - 03: 5-8 years of elementary school
 - 04: 9-10 years of elementary and secondary school
 - 05: 11-13 years of elementary and secondary school but not graduated
 - 06: graduated high school
 - 07: some non-university post-second. school but no certificate
 - 08: some university but no certificate
 - 09: non-university post-secondary certificate
 - 10: university certificate below Bachelor's
 - 11: Bachelor's degree
 - 12: Master's
 - 13: degree in medicine, dentistry, veterinary
 - 14: medicine or optometry
 - 15: doctorate (Ph.D.)
5. EXP number of years of work experience (full-year full-time equivalents). Definition includes all work (part-time and full time) since first starting to work full time. A value of zero is give for people with less than a year of experience and for those who never worked full time.
6. EXPORTS values in million C\$ of Canadian annual aggregate exports by 3-digit *SIC industries*
7. FT flag to indicate whether job was full time (yes=1). Refers to last work schedule in reference year. "Part-time" is less than 30 hours per week.
8. IMPORTS values in million C\$ of Canadian annual aggregate imports by 3-digit *SIC industries*
9. LS labour supply by gender by age group by education level for the reference year
10. OUTPUT values in million C\$ of Canadian annual aggregate output by 3-digit SIC industries.
11. REASON reason why work came to an end. 01: reason work-related; 02: reason not work related
12. SEX person's gender. 1: if male; 0: if female
13. SIC3 industry code (3-digid SIC) of employer

14. **SPELL** duration of jobless spell in weeks
15. **TECH** represents technological intensity and assigns a value of 1 to industries that use any of the six technologies: Design and Engineering, Fabrication and Assembly, Automated Material Handling System, Inspection and Communications, Manufacturing Information Systems and Integration and Control, as explained in Baldwin and Rafiquzzaman (1998)
16. **TENURE** tenure on the current job expressed in months
17. **TRADE** trade variable defined as: total exports + imports divided by total domestic output by 3-digit SIC-industries
18. **TURNOVER** unique turnover identifier (numbers from 1 to 9) for each turnover for up-to 9 job turnovers
19. **TYPE** type of job separation – 1: if voluntary; 2: if involuntary
20. **UNEMP** unemployment rate by gender by age group by education level for the reference year
21. **UNION** flag to indicate (yes=1) whether person was a member of a union or covered by a collective agreement in his/her job
22. **WAGE** hourly wage for this job at start of reference year in 1992 dollars
23. **WEIGHT** internal cross-sectional weight for the person for the reference year, adjusted for labour non-response
24. **YRSCHL** numbers of full time equivalent years of schooling completed by person

Appendix III

Wage Effect of Tenure and Experience

A simple model can make the distinction between the wage effects of tenure and experience and the relationship between the two clear. Suppose the wage function is of the form:

$$W_i = F(TR_i, EXP_i) \quad \text{where,} \quad (A21)$$

$$EXP_i = G(TR_i) \quad (A22)$$

Where W_i is the real wage rate, TR_i is the tenure on the current job and EXP_i is the life time experience of a worker belonging to education group i . The slope of the wage, tenure profile is:

$$\frac{dW_i}{dTR_i} = \frac{\partial W_i}{\partial TR_i} + \left(\frac{\partial W_i}{\partial EXP_i} \cdot \frac{dEXP_i}{dTR_i} \right)$$

In view of (A23) above, it is incorrect to interpret the coefficient of TR_i , dW/dTR_i , as a measure of on the job learning by doing rate. Such rate is measured by $\partial W/\partial TR_i$ -- that is by coefficient of TR_i when experience is included. Since the second expression on the right hand side of equation (A23) is positive, dW/dTR_i clearly overstates human capital accumulation by on-the-job learning by doing.

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