Labour Market Effects of Immigration: Evidence from Canada

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Abstract:

Immigration, the subject of repeated policy debates throughout the last two decades, has once again assumed a central position on the policy agenda. This debate has become more intense in recent years in Canada; the fear is over the potential job displacement and unemployment of Canadian-born workers, and the consequence to the Canadian economy. The recent immigrant incomes have been falling compared to their older counterparts helped to trigger the current policy debate. This thesis attempts to address this debate by providing an objective assessment of the displacement of Canadian-born workers due to immigration and the unemployment-immigration dynamics over the past 40 years of immigration to Canada. The thesis consists of two objectives:

Objective-I: Job Displacement Effects of Immigration on Canadian-born

First I address the job displacement effects on Canadian-born due to exogenous shifts in immigration flows. It is, therefore, necessary to consider the substitutability or complementarity between Canadian-born and immigrant workers. This is examined by estimating the set of wage earnings equation from the "Generalized Leontief Production Function". The model specification abstracts from the role of capital, by assuming that labor and capital are separable in production. I then derive the iterated Zellner-efficient estimator (IZEF) (which is numerically equivalent to the maximum likelihood estimator) from the set of wage earnings equations. Then the degree of substitutability or complementarity is calculated using Hick's (as opposed to Allen's) elasticity of complementarity. The estimated Hicksian elasticities suggest, in the aggregate, there is no displacement of Canadian-born workers by immigration, although there is some displacement by industry.

Objective-II: Unemployment and Immigration Dynamics

Next, I consider immigrant not only as an additions to the existing labor force but also job creation effects through their effects for goods and services. Here immigrants are considered as endogenous and I model the dynamics of unemployment and immigration. As a first step, statistical causality is investigated between immigration and unemployment. But causality methods can suffer from omitted variable problem. So, I construct a theoretical labor market and use the cointegration analysis to determine the long run relationship among unemployment rate, immigration level, real wage, and real GDP. Then, I estimate the short-run dynamics with a specification in difference form where the parameters of the cointegrating vectors from the first-step are fixed and entered as an error correction mechanism. The causality test finds no evidence of a significant effect of Canadian unemployment on immigration. The estimation of the long-run and short-run parameter indicates that no statistically significant relationship exists between unemployment and immigration.

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Finally I express my special gratitude and heartfelt thanks to my parents, my Brother Mr. Rafiq for their continuous support and encouragement to go on with my education. This work is dedicated for them.

DEDICATION

To My Parents
And
My Elder Brother

Table of Contents:

List of Table:

List of Figure:

CHAPTER-1

Introduction

1.1The Debate about Immigration

Canada is a country of immigrants and sons and daughters of immigrants. Immigration has shaped the rate of growth of the Canadian population and its demographic composition; it also created much socioeconomic diversity within Canadian society. Historically, immigration has been an essential building block of the Canadian nation, the strength and validity of an astonishing society that is the envy of the world. While the post-world war II immigrants flow was from Europe, the United States, & the British Isles, the post-1967 immigration flows are more from Asia.

The debate surrounding immigration policy has become multifaceted especially in recent years over the controversy of the decline in income of recent immigrants. Studies (Coulson & DeVoretz 1993, Baker & Benjamin 1994) have shown that while earlier immigrant income has caught up to that of native Canadians, the recent immigrant income has not. There is also fear that newcomers take job away from native Canadians[1]. In light of this, recently Canada has amended the immigration policy and raised the point system for immigrants while giving priority on certain skill characteristics of immigrants. The argument now is that either immigrants steal job from native workers or immigrants are unskilled and put too much pressure on the public purse because they don't find jobs. In both cases, they are held responsible for unemployment. On the other hand, it is also argued that there are skill shortages in Canada and immigrant relieve these bottlenecks. Further immigration would expand job opportunities in general, resulting in an increased demand for labor and eventually leading to higher wages of native-born workers. Therefore, the substitutabilities or complementarities between Canadian-born and immigrants are of central concern in evaluating the validity of displacement fears.

Another concern related to this displacement fear is whether immigration during recessions merely adds to unemployment, either directly through migrants being unable to find jobs or indirectly by migrants displacing existing workers in employment,

[1] By native Canadians, I mean person who have born in Canada. Canadian, Canadian-born, Native, etc are used interchangeably.

possibly under less favorable conditions of employment (Withers & Pope 1985). But immigrants not only represent additions to the labor force, but also add capacity to real output. They contribute to aggregate expenditure directly by their own income, savings and spending and indirectly through industrial and government expenditure on their behalf and those expenditure help create employment. Therefore whether a given immigration flow adds or subtracts from the pool of unemployed depends on the relative strengths of supply and demand side effects and on the policy that accommodate those flows (Marr & Siklos 1995).

It is, however, possible that settlement requirements of migrant arrivals might add more to demand than to supply in expansionary times, because of the absence of the excess capacity that can be directed to migrant settlement needs. But the typically higher labor force participation by immigrants and the selection of immigrants by the government using labor market criteria that might direct immigrants toward 'bottleneck' areas could offset this on the supply side. In particular, government admission of migrants based on economic criteria seems to be strongly *pro-cyclical* (Withers & Pope 1985).

The thesis will focus on the question of how immigrants have interacted with native Canadians. In other words, it attempts to explore the substitutability or complementarity between native and immigrants. This kind of analysis may be used to answer some important question. For instance, has the inflow of immigrants hampered the economic progress of Canadian born workers? Alternatively, have the job opportunities available to native born worsened because of the existence of the large pool of (presumably) substitutable immigrants? These questions can easily be analyzed in the context of a multifactor production function where the factors of production are immigrants and native workers. The development of a multifactor production function (and its dual cost function) which is empirically tractable has led to the discovery of important empirical results about production technologies (Borjas 1983).

But this microeconomic study is a partial equilibrium analysis. An often neglected aspect of immigration in this partial equilibrium framework is the job creation effect of immigrants through their demand for goods and services. In a more general equilibrium

framework, immigrants create jobs through their goods and services independently of their participation to the labor market, thereby benefiting indigenous workers immediately. At constant wages, the effect on local unemployment depends, among other factors, on immigrants spending on consumption goods relative to natives, and on the types of returns to scale in production. However, new immigrants, once they enter the labor market also have an adverse effect on the search efficiency of native workers. Depending on their relative ability to find jobs, they may provide strong competition to native workers and increase their unemployment (Gross 1997). Thus, the outcome is difficult to determine in a *priori* terms. It becomes an empirical issue. This thesis will try to resolve empirically the relationship between immigration in Canada and its unemployment rate over the time periods.

So, the thesis has two objectives:

Objective-I: "Job Displacement Effects of Immigration on Canadian-born"
Objective-II: "Long-run and short-run Dynamics of unemployment and Immigration".

1.2 Motivation:

Immigration, the subject of repeated policy debates throughout the last two decades, has once again assumed a central position on the policy agenda. Canada's transformation into a diverse racial and ethnic society through immigration has attracted the attention of many other nations of the world especially attracted to other parts of the Western world. This debate has become more intense in recent years in Canada; the fear is over the job displacement and unemployment issue of Canadian-born workers, and ultimate to the Canadian economy. The recent immigrant income has been falling compared to their old counterparts helped to trigger the current policy debate. This thesis attempts to fill this information gap by providing an objective assessment of the displacement fears of natives due to immigration in recent years and also provides the unemployment-immigration dynamics over the past 40 years of immigration to Canada. The objective of this thesis is to (1) to promote a better understanding of the immigration phenomenon in Canada by assessing the effects it has had on the Canada's economy, unemployment, its people and (2) to identify the present and future challenges immigration poses for Canada.

This thesis, unlike most of the other studies takes, first, immigrants as being exogenous increase in labor supply and determines its "inflow" effect on natives wage earnings opportunity and then it develops a theoretical labor market in a general equilibrium perspective where immigrants, along with real wages, unemployment, and GDP, has been treated as endogenous . It studies the displacement issue of natives by using a production function specification to determine the immigrant-native substitution phenomenon. It then goes back to 1960 and looks systematically at how immigration has interacted with economic trends over the subsequent decades to affect the country's unemployment. It focuses on those aspects of immigration that are most amenable to quantitative analysis. I recognize that this focus may offer inadequate attention to the less tangible social, cultural, and emotional dimensions of immigration, which also play an important role in shaping the public's attitudes. However, I hope that by studying empirically based measures, the thesis can provide a basis for recasting the policy debate.

1.3 Methodology:

1.3.1 Objective-I: Substitutability and/or Complementarity

The question of complementarity/substitutability will be analyzed in the context of a multifactor production function where the factors of production are immigrants and native workers. The development of multifactor production function (and its dual cost function) which is empirically tractable has led to the discovery of important empirical results about production technologies (Borjas 1983). Assuming Leontief technology, the production function parameters will be estimated to determine whether immigrant and Canadian born are substitutes or complements, and the magnitude of the substitutability and complementarity. We will derive native earnings function from the Leontief production function where relative supply of different inputs becomes explanatory variables. We then specify an individual fixed component to capture the individual differences in effective labor supply to estimate the "full" earnings function. Estimated coefficients will be used to calculate the Hicksian elasticity of complementarity.

1.3.2Objective-II: Unemployment and Immigration Dynamics

Ben Porath (1986) shows that there is two-way causality between Israel's unemployment rate and its rate of immigration. Marr and Siklos (1995) found past

Canadian immigration and unemployment is related to each other. It is possible that settlement requirements of migrant arrivals might add more to demand than to supply in expansionary times, because of the absence of the excess capacity that can be directed to migrant settlement needs. But the typically higher labor force participation by immigrants and the selection of immigrants by the government using labor market criteria that might direct immigrants toward 'bottleneck' areas could offset this on the supply side. In particular, government admission of migrants on economic criteria seems to be strongly *pro-cyclical.* We will, therefore, determine the casual inference between immigration and unemployment by Granger Causality test. It is however, possible that the test suffers from omitted variable problem. We will therefore develop a full theoretical labor market model (VAR Model) to determine short-run and long-run dynamics among unemployment, immigration, real wage, and real GDP. We use the Johansen's test of cointegration to determine the long-run equilibrium relationship, and then estimate a vector error correction model to see if there is any short-run disequilibrium among those four endogenous variables.

1.4 A Road Map:

Chapter II discusses the trends and patterns of immigration and a brief overview of Canada's immigration policy. This chapter also covers the recent literature on substitutability or complementarity and labor market dynamics of unemployment and immigration. It also discusses the labor market effects of immigration from both micro and macro perspectives. In chapter III, I specify an econometric model and discuss the econometric issues to measure the substitutability or complementarity. I also specify the long and short-run dynamics of immigration level and unemployment rates. Chapter IV produces the estimation results and analyses their implications. The conclusion, policy recommendation and future research have been outlined in the Chapter V.

CHAPTER-2

Immigration in Canada

The first section of this chapter discusses historical pattern of immigration in Canada. Then we review immigration policy focusing on the post 1960 period. Finally, an endeavor is made to review the literature on substitutability and complementarity between immigrants and Canadian born and unemployment immigration dynamics in Canadian and other studies. Then I present groundwork for the theoretical framework to determine the labor market effects of immigration.

2.1 Trends and Patterns in Immigration to Canada

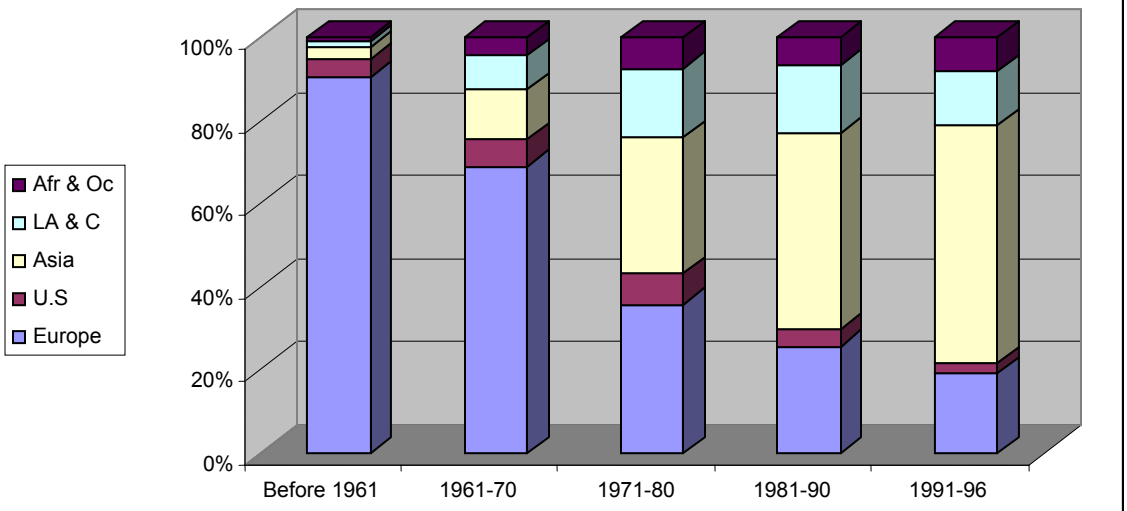
There are about 100 million people in the world who now reside in a country where they were not born. Canada experiences a massive flow of immigrants in the last 100 years. In the 1950s and 1960s, the immigrant flows originated primarily in Europe, United States, and the British isles. After the inauguration of the point system in 1967, there has been a strong increase in the proportion of immigrants from Asia; most of them are from Southern and Eastern Asia. In the year 2000, more than 40 percent of total immigrants in Canada came from only five countries of the Asia, namely- China, India, Pakistan, Philippines, and Korea. In the last two decades, Canada has admitted over 200,000 immigrants per year. This annual flow is not much higher than was in late1950s, mid-1960s, and mid-1970s.

Although the immigrant flow to Canada is significant, the immigration rate (defined as a percent of the Canadian population) is relatively low in Canada (less than 0.1%). This rate is also low compared to U.S (In the 1990s immigrants flow to U.S was almost 0.3% of its population).

Information on the size of immigrant flow and its source composition over time is presented in Figure 2.1(see the Appendix-I, Table-1 for the corresponding data). The flow of immigrant is quite variable. From Figure 2.1 it is also clear that more immigrants are from Asia- especially immigrants from Eastern Asia and Southern Asia are inflowing rapidly in recent period. At present, China and India are the major source of immigrants. They account for about 25 percent of total immigrants in recent periods. Most of the

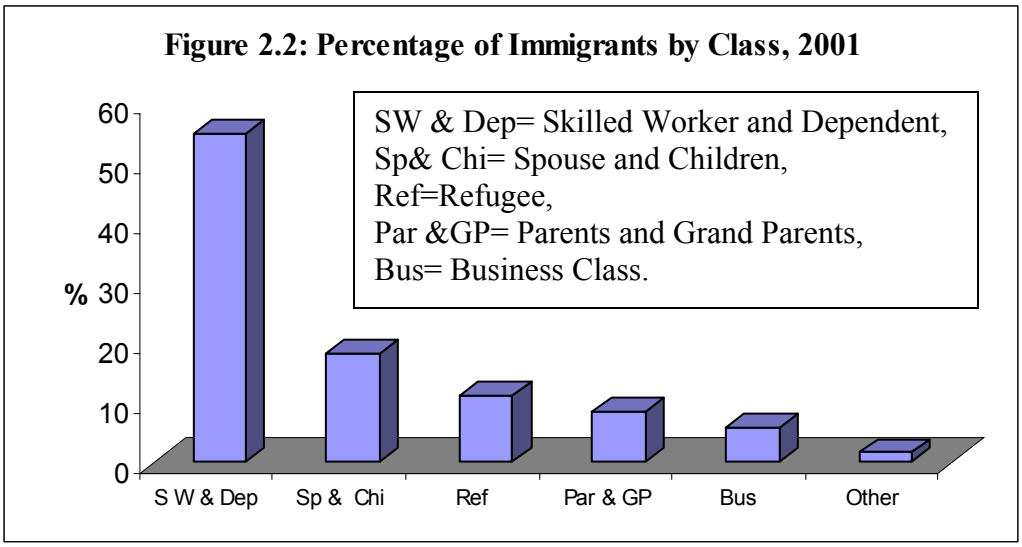
immigrants in Canada stay in Ontario, British Columbia and Quebec. Of them, Ontario is the destination for over half of total immigrants. About 50 percent immigrants used to stay in Toronto. And overtime immigrants in Toronto have been increasing and its share of immigrants among its total population is also rising.

Figure 2.1: Immigrants by Origin and Period of Arrival



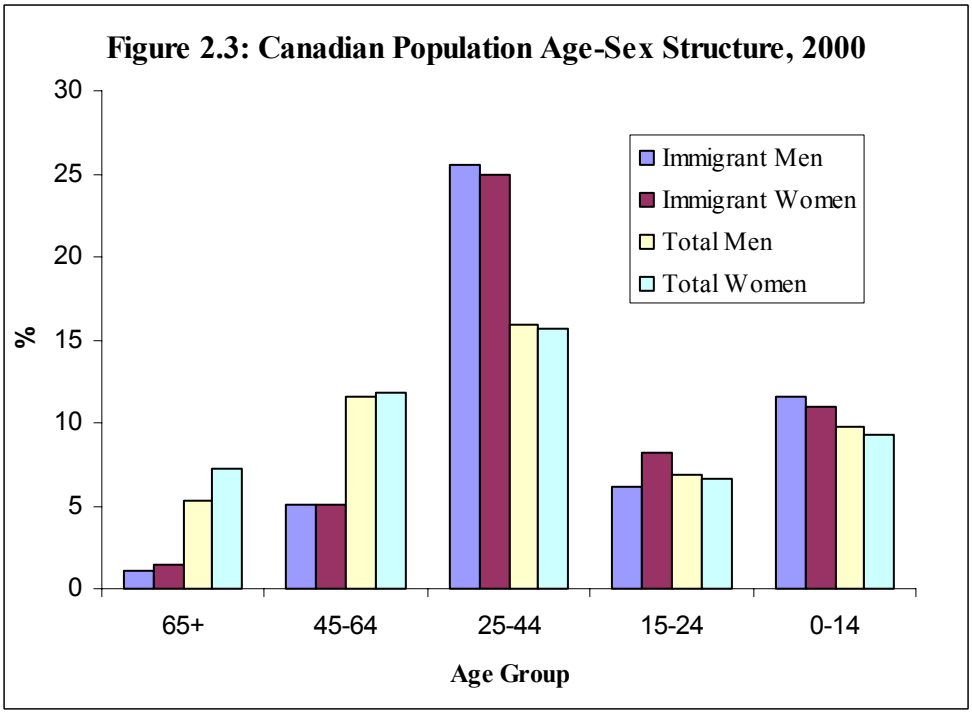
Source: Statistics Canada, 1996

About 67 percent of immigrants are admitted under the economic category and above 30 percent are in the family category. Among the immigrants from economy class, skilled workers occupy almost 60 percent of total immigrants. Over time, skilled workers are dominating and its share among total immigrants is increasing. The number of immigrants among spouses, fiancé and children are also growing over the year (see Figure 2.2).



Source: Citizenship and Immigration Canada, 2002.

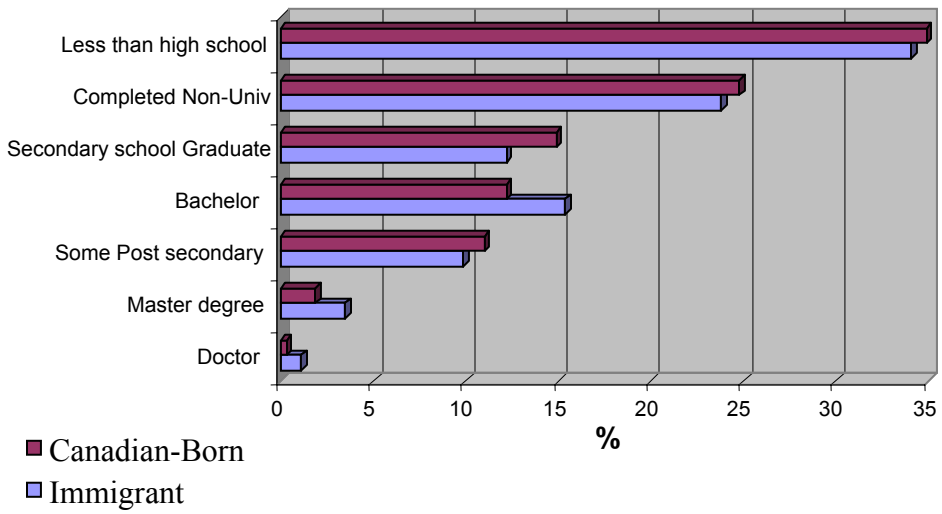
From Figure-2.3 we see that immigrant has a disproportionate age and sex structure compared to the total men and women in Canada. Most of the immigrants are in the age group15-44.



Sources: Statistics Canada, 2001, Citizenship and Immigration Canada, 2001.

The representative immigrant has a relatively higher education level than that of the Canadian-born population. As shown in Figure 2.4, proportionately more immigrants have post graduate education than those of Canadian-born.

Figure 2.4: Education by Origin (Population 15+), 1996



Source: Advisory Council on Science and Technology, Canada S.D.31

In the early 1990s[2], when the economy was in recession, labour market conditions had deteriorated markedly for new immigrants. As a result, immigrants lost considerable ground compared with workers born in Canada. In 1996, only 61.0% of the recent immigrants aged 25 to 44 held jobs, compared with 78.4% of the Canadian born population in the same age group, a gap of 17.4 percentage points. In the first half of the 1980s, a small gap in the employment rate between recent immigrants and Canadian-born workers emerged, and became extremely pronounced during the difficult years of the early 1990s. This gap between the two groups reached its peak in 1996. Census 2001 shows that the gap in labour market conditions between recent immigrants and Canadian born persisted, despite the strong economic growth of the late 1990s. In 2001, only 65.8% of recent immigrants were employed, 16 percentage points lower than the rate of 81.8%

[2] The following discussion of this section and the relevant data source has been taken from *Statistics Canada 2001 census* report on immigration and population.

among Canadian born. The unemployment rate of recent immigrants aged 25 to 44 was still twice that of the Canadian born population, 12.1% compared with 6.4%.

However, the situation was very different for men and women in 2001. Recent male immigrants aged 25 to 44 had an employment rate of 77.4%, 8.9 percentage points lower than the rate for their Canadian born counterparts. However, this was a marked improvement compared to 1996 when the gap was 12.3 percentage points, and was slightly better than 1991 when the gap was 9.3 percentage points. In contrast, only 55.6% of recent female immigrants in 2001 were employed, 21.8 percentage points lower than the employment rate of 77.4% for Canadian born women in 2001. Unlike recent male immigrants, this was similar to the gap in 1996, and doubles the gap in 1991. A large proportion of female immigrants entered as a family member of an economic immigrant, or on grounds of family reunification. Lower employment rates among recent female immigrants aged 25 to 44 may also be a reflection of their greater likelihood to be in school compared to Canadian born women. In 1995-96, 26% of recent female immigrants were attending school compared to 13% of their Canadian born counterparts. Some may have come with the intention of furthering their education, while others may be seeking Canadian credentials or to improve their English or French.

The longer immigrants have been in Canada, the more integrated they are in the labour market. The labour market conditions of immigrants aged 25 to 44 who arrived in Canada between 1991 and 1996 were particularly difficult. In the later half of the 1990s, their situation improved considerably, as they were no longer new labour market entrants, and the economy was in expansion. As a result, their employment rate was 74.3% by 2001, much higher than it had been in 1996 (61.0%). However, there was still a considerable gap of 7.5 percentage points between the immigrants of the early 1990's and their Canadian born counterparts in 2001.

The level of education of immigrants has increased over time as Canada's immigration policy has favored the entrance of better educated immigrants. Recent immigrants have been, therefore, a source of skilled workers. More immigrants are also coming as entrepreneurs. These people, as well as individuals who are well educated, tend to do better in the labour market than those who enter for family reasons, or as

refugees. In 2001, 24% of immigrants aged 25 to 64 who arrived between 1996 and 2000 were in highly skilled occupations compared to only 13% for those who had arrived between 1986 and 1990. This substantial increase occurred primarily among younger recent immigrants aged 25 to 44. It also occurred despite the fact that labour market conditions among recent immigrants were still weaker than in 1991.

New immigrants clearly played a role in the growth of highly skilled occupations over the decade, particularly computer-related occupations and accountants. For example, in 1991, only about 3% of recent immigrants aged 25 to 44 worked in information technology occupations. By 2001, the proportion had more than quadrupled to 12% reaching more than 34,400. In contrast, 3.0% of the Canadian born had an information technology occupation. Recent immigrants were also overrepresented in engineering and natural sciences occupations. In 2001, 3.0% of recent immigrants aged 25 to 44 in the labour force were in engineering compared to only 1.0% of the Canadian born. Similarly, 1.2% of recent immigrants were in natural sciences occupations compared to 0.6% of the Canadian born. A large proportion of recent immigrants were still in low-skilled jobs in 2001, although their proportion was in decline. In 2001, 43% of those aged 25 to 44 were in low-skilled occupations, compared with 51% a decade earlier.

2.2 An Overview of the Canada's Immigration Policy[3]

Canadian immigration policy traces its beginnings to the early 1820s with the establishment of the first immigrant agent, Alexander C. Buchanan. Until 1869, Canada's immigration policy was largely determined by regulations established according to countries of destination. But, beginning that year, a series of legislative enactments established specific principles of selection and associated regulatory apparatus. At present, immigration policy makers usually have two "levers" that they use to manipulate 1) the number of immigrants to be admitted; and (2) who, among, the set of potential immigrants, is admitted. The history of Canadian immigration policy illustrates the extremes of these tools. While there was a strong preference to recruit immigrants from northern Europe, only the very sick, destitute and criminals were actively screened

[3] This section has been taken from various literatures on Canadian immigration policy, Immigration Canada web site (www.cic.gc.ca).

(Green & Green 1995). The major changes in the Canadian immigration policy took place in 1962 when the government abandoned its discriminatory policy and substituted a nondiscriminatory policy where admission was based on the attributes of the prospective immigrant. This change followed a decade, in which the terms of admission for immigrants from non-preferred countries were gradually eased, especially those for immigrants from southern Europe. The main impact of this regulation was on prospective immigrants from third world countries.

At present, every year the Federal Government of Canada announces the planned number of immigration to be admitted the following year in consultation with the provinces, with an eye to minimizing any adverse impact of immigration. We can divide immigrants into assessed and non-assessed classes. The assessed classes are those immigrants who are evaluated on the basis of their likely contribution and success in the Canadian labor market. These include the traditional independent immigrants, most commonly described in economic models of immigration. These are individuals who apply for admission to Canada on the basis of their skills, and are evaluated on a relatively objective point system. This system, introduced in 1967, currently applies to the majority of the immigrants. Points are awarded for the specific skills that the immigrant has, with extra points awarded for skills perceived to be in shortage in Canada. The details of the point allocation are described in appendix-I. The point system provides the government with the most direct method of controlling the types of immigrants admitted to Canada. In principal, with enough information, the point system could be used to limit immigration only to those immigrants virtually certain to succeed in Canada, with no possible displacement of Canadian workers.

There are other, smaller economically assessed classes. The business classes, those who have the experience and resources to contribute to the Canadian economy, include investors, entrepreneurs, and self-employed immigrants. Assisted relatives are basically skilled workers, admitted under the point system, but who obtain extra points for having relatives in Canada. Finally, immigrants are admitted as retired workers, or under special occupational programs, such as those for domestic workers and nannies.

The non-assessed classes (family class and refugee class) currently comprise about 40 percent of all immigrants, a lower proportion than in the early 1990s. Reunification of family members with Canadian residents is a high priority of government policy. The definition of "family" has varied over the years, with the closeness of relatives' admissible under these criteria changing. Unlike assisted relatives, who undergo skills evaluation, family class immigrants are not selected with any consideration of the likelihood of their success in Canada. The same is true of refugees. In fact, likelihood of economic success is of no consideration for refugees, since they are admitted on the basis of humanitarian grounds, usually to facilitate escape from political persecution or violence.

The immigration policy in Canada has been driven by both the self-interested and altruistic concerns. There appear to be distinct periods in the history of Canadian immigration policy since confederation. This being the case, the effect of immigration on job displacement of the existing workers might be different in each period. For example, the reaction of immigration to falling unemployment in Canada may have been quite different during the period of relatively free labor and population mobility prior to 1906 than it was for the restrictive regime in place from 1914 to 1947. If we were looking for breaks in these relations, when might they have occurred? A glance at the history of immigration and its policy since 1867 suggests at least nine possible break points which can be approximated by the following events:

- The Immigration Act of 1869
- Regulations of 1906
- A speech by Prime Minister Mackenzie King in 1947
- Regulations of 1962
- Regulations and the point system initiated in 1967
- The Immigration Act, 1976 and regulations of 1978
- Regulation of May 1982
- Regulation of January 1, 1986
- Immigration and Refugee Protection Act, June 2002

Since our analysis and empirical results start from 1960, we will briefly go to the event regarding immigration policy that takes place after1960 till now[4].

As mentioned previously significant change in the Canada's immigration policies and regulations was heralded in 1962 when Canadian government began to end the bias that had been shown towards immigrants from Europe and United States. However, problems with this regulation emerged quickly because decisions on who should be admitted were now based on the more complicated criteria of skill or occupation rather than the simple criteria of nationality. The only yardstick available to immigration officer was years of schooling. This fell well short of an effective and defensible measure when the new rules attempted to match not just education but skills and occupation to domestic needs. The solution was the introduction of the point system on October 1967. Potential immigrants who were not sponsored would now be assessed on the basis of their education, training, occupational demand, skills, age, knowledge of Canada's official languages, and whether they had arranged employment. The 1967 regulation eliminated all discrimination on the basis of race or nationality. The regulation defined four classes of immigrant applications: (1) sponsored relatives (i.e., dependent relatives), (2) nominated relatives (3) independent applications, and (4) refugees. Sponsored relatives would be admissible merely if they could demonstrate that they were in a good health and were in a good character. Refugees, a status defined by the United Nations, would be accorded preferential treatment in admission. Finally nominated relatives and independent applications would be judged on the basis of a point system. The key feature of the point system is that it removed a good deal of subjective authority from the hands of immigration officers and assigned considerable objective authority in admission decision to labor market-related factors.

The next major change in immigration policy occurred in 1978 when a new immigration act became a law and was founded on the following principles: (1) universality (admission without regard to nationality, race, creed, or color), (2) family reunion, (3) humanitarian and compassionate admissions such as refugees, and (4) coordination with manpower requirements and other economic and social policies. One

[4] An excellent source of the Canada's immigration policy that dates back from the end of ninetieth century is Green and Green (1995).

subsequent important policy change took place in May 1982 when severe restrictions placed on independent and assisted relative immigrants significantly reduced the total inflow of immigrants in that category. Consequently, family class immigrants became a larger percentage of the total from 1983 to 1985 (Marr and Siklos 1994). Since January 1, 1986, the Canadian government has announced a policy of increasing immigration. The requirement that a guaranteed job must await for independent and assisted relative immigrants in Canada was dropped. Immigration became much easier for persons admitted into Canada in these classes. With a return to lower unemployment rates, the government announced higher and higher target levels of immigration over the period 1987 to 1990, and flows rose each year.

The new Immigration and Refugee Protection Act (IRPA) became law on June 28, 2002. This legislation replaces the former 25-year-old Immigration Act. It recognizes the many contributions that immigrants and refugees make to Canada; encourages workers with flexible skills to choose Canada; and helps families reunite more quickly. The Act introduces the permanent resident (PR) card that aims to provide new and existing permanent residents with clear, secure proof of their status. The members of the skilled workers class are accepted for entry into Canada depending on the number of points they score out of 100 in the following categories: education, language proficiency, employment experience, age and adaptability. The pass mark has been set at 75 points to respond to concerns raised by the provinces and territories and others.

Canada's immigration policy has often been referred to as a "tap-on, tap-off policy" because its flexibility and responsiveness to contemporary labor market conditions. For example, the admission of immigrants was increased sharply as a response to labor shortage in the 1950s but was curtailed during the years 1958-62 because of high rates of unemployment. Similarly, faced with a dramatic rise in unemployment rate, the Canadian government in 1982 required that potential immigrants who wanted to be admitted as selected workers or assisted relatives have a job waiting for them before they were allowed to enter Canada as landed immigrants. Therefore, in the empirical work that follows, it will be of some interest to test whether changes in

Canada's immigration regulations and policies influenced the statistical connection between immigration , job-displacement of native-born and unemployment in Canada.

2.3 Labor Market Effects of Immigration: Theoretical Framework

This section presents the theoretical framework that explains the labor market effects of immigration. It presents the different aspects of labor supply and labor demand effects of immigration, followed by a discussion on the relationship between immigration and unemployment. The purpose of the discussion in this section is to lay groundwork for objectives I and II of the thesis.

2.3.1 Effects on the Wage Rate

This section presents a simple demand-supply partial equilibrium discussion of a labour market, similar to one in Borjas(1996).

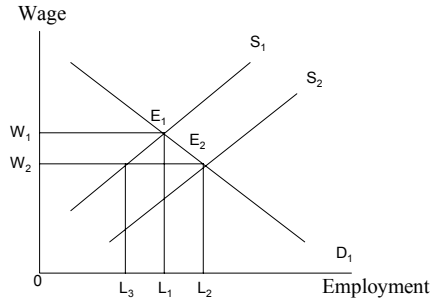
Supply Side Effect: Substitute Inputs Case

When two inputs are substitutes in production, an increase in the supply of an input will decrease the demand for its substitute. It is possible that an increase in the labor supply through increased immigration in a given labor market will lead to an increased competition for jobs among immigrants. This would reduce the market wage for immigrants. Depending upon their skill requirements, employers are likely to substitute immigrant labor for the native worker since the former is now cheaper. This competition for jobs in the local labor market between natives and immigrants would tend to reduce the earnings potential of natives. If variation in the number of immigrants relative to the native born workers across selected labor market demonstrate that a higher ratio of foreign-born to native-born worker is associated with a lower wage rate of native born, then immigrants and native born are substitutable labor inputs in production. In this case, foreign-born workers would affect adversely the earnings and job opportunities of native born workers.

When immigrants and native born workers are perfect substitutes, they compete for jobs in the same labor market and the effects are shown in Figures 2.5. Assume that the labour supply curve for native born Canadians is upward sloping, shown by the line S_1, and $(L_2 - L_3)$ immigrants enter the labor market shifting the labor supply curve to the right to S_2. Further assume that the demand for labor is fixed with or without entry of

immigrants. The market wage rate falls from $W_1$to W_2 and that L_1-L_3 amount of native workers will be displaced by immigrants. The magnitude of the job displacement and the decrease in wage depend on the relative slope of supply and demand for labor and the flow of immigration, which obviously is also an empirical issue.

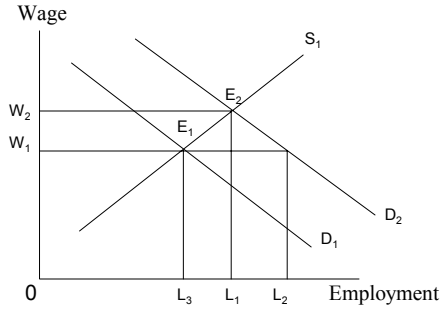
Figure 2.5: Substitute Inputs case



Complementary inputs case:

On the other hand, immigration flows could lead to increased wages for native born. If there are skill shortage in the host country and immigrant relieve these bottlenecks, it would expand job opportunities in general, resulting in an increased demand for labor and eventually leading to higher wages of native-born workers. In this case immigrants and native born workers are employed in two distinct labor markets and they are c complementary inputs in production. When they are complements in production, then an increase in the demand for labor can increase the wage rate of indigenous workers. When foreign-born and the Canadian born are complements in production, an inflow of foreign-born worker would augment the productivity of native workers. Therefore, the demand for native-born workers goes up, as shown by the shift in the demand curve from D_1 to D_2 in Figure-2.6. These will cause an increase in the wage rate from W_1 to W_2.

Figure 2.6: Immigrants and Canadians are complements



Demand Side Effects:

We have assumed here that the product demand is fixed. But immigration has both demand and supply side effects in goods market. They demand goods and services, make expenditure and therefore the expenditure generated by the inflow of immigration causes the demand curve for goods and services to shift rightward. This will, in turn, cause an increase in the demand for labor and therefore an increase in wage/employment (similar to the demand shift effects in Figure 2.6). When both demand and supply effects are present, the net effect on the native would depend on the immigrants' marginal propensity to spend and the chance of getting job relative to natives. If, for example, immigrants' relative expenditure is less than their relative employment, then the demand for labor will shift less than the supply of labor and therefore natives will loose jobs. However, this research ignores the demand side effect and attempts to address the substitute/complement issue.

2.3.2 Immigration and Unemployment

A satisfactory theory of immigration and unemployment issue is not at hand. The intent of this section of the thesis is, therefore, not to develop a full theoretical model of the labor market in the presence of international migration but rather to uncover its dynamic evolution with support of economic theory. So, this section will be devoted to the aggregate relationship between unemployment and immigration.

Let us first see how exogenous increase in consumption demand caused by immigrants affects the native and immigrants' unemployment differently. Harrison (1983) has contributed a quite good idea to the understanding of the effects of immigrants on native unemployment. He notes that an immigrant increases the demand for goods and services upon arrival and hence increases the demand for labor. If immigrant consumption is assumed (for now only) equal to the average native or family, the demand for labor goes up by one full job, and hence by the proportion 1/L that the immigrant bears to the labor force as a whole. Harrison illustrates his argument with numerical example. Simon (1989) and Gross (1997) formulize Harrison's theory, which will better analyze Harrison's theory and describes its implication with different sets of parameters.
The total impact of immigrants on native unemployment can simply be illustrated using definition of unemployment of matures overtime:

(2.1) $$U_N^A = U_N^B + I_N - O_N,$$

where U_N^A and U_N^B are native unemployment after and before the arrival of immigrants, I_N and O_N are the unemployment inflow and outflow. In the Harrison's type aggregate search framework the two effects described above resulting from arrival of immigrant is:

(2.2) $$U_N^A = U_N^B + tE_N - (tE_N + dM)\frac{(tE_N + U_N^B)}{(tE_N + U_N^B + aM)}$$

where , $tE_N = I_N$, the native turnover rate(t) times the number of natives employed (E_N). The term dM is the demand induced job creation by immigrants where "*d*" is average immigrant spending for consumption relative to average native spending for consumption, which may be thought as new jobs created by immigration ("d" is likely to be $0 < d \leq 1$); M is the number of new immigrants. The sum is (tE_N+ dM) therefore the number of new vacancies; "a" is the relative likelihood of an immigrant and native being

hired into particular job opening. So, the first two terms on the right hand side of (2.2) are, respectively, the number of natives originally unemployed, and job turnovers. From these are subtracted the sum of the jobs due to turnover and to the increased demand due to immigration, (tE_N+ dM), multiplied by number of natives seeking jobs, (tE_N+ U_N^B), to the sum of the natives seeking work plus effective number of immigrants seeking work, (tE_N+ U_N^B +aM).

Subtracting the 'pre' native unemployment from the 'post' native unemployment, we get-

$$U_N^B - U_N^A = \frac{(a-d)tE_N M - dMU_N^B}{tE_N + U_N^B + aM} \tag{2.3}$$

For native unemployment to fall, i.e., for U_N^B - U_N^A < 0, it is necessary and sufficient that-

$$(a\text{-}d)\, tE_N M - dM\, U_N^B) < 0, \text{ or } d(\, tE_N - d\, U_N^B) > atE_N$$

which is necessarily satisfied(but not only then) if U_N^B >0 and d ≥ a. That is, as long as there is any native unemployment it will fall due to immigration if an immigrant's consumption bears a higher proportion to native consumption than an immigrants' propensity to find job bears to a native's propensity to find a job in the same market.

2.3.3 Aggregate Unemployment and Immigration Dynamics

The discussion of macroeconomic relationship between immigration and unemployment centers around two important questions. First, do changes in the Canadian unemployment rate cause changes in Canada's immigration? Whiter and Pope(1993), who surveyed research studies from several countries and time periods, find that labor market conditions in receiving countries increase intentional migration inflow, unless other factor intervene. Second, do changes in the amount of immigration influence the Canadian unemployment rate? The answer to this question is less definite. Marr and Siklos (1994) shows that before 1978, changes in immigration levels do not affect the Canadian unemployment rate, but after that immigration level appear to contribute to changes in the unemployment rate. So, the causality between immigration and unemployment can go in either or both ways and it is necessary to test for causality. According to the procedure suggested by Granger (1969), x "causes" y if, in a regression

of y on both x lagged and y lagged, there is significant reduction in residual variance compared with a regression of y on lagged y alone; that is, x is said to "cause" y if lagged x has an independent effect on current y after y is purged of all its autocorrelation. In other words, x is said to cause y if, with respect to a given data set, present y can be better predicted using past values of x than by not doing so. If x causes y and also y causes x, feed back is said to exist

It is however, possible that the Granger causality test suffer from omitted variable problem. We will therefore need to develop a full theoretical labor market model to determine short-run and long-run dynamics among unemployment, immigration, real wage, and real GDP. When the natural rate of unemployment differ across different skill/demographic groups of the labor force, any change in the skill/demographic composition of the labor force will affect the long-run/natural rate of unemployment. Thus theoretically it is possible that the immigration, through changes in the composition of labor force, will affect the long-run unemployment rate. Ben-Porath (1986) has estimated unemployment of Israel as function of its past unemployment and current and past population growth rate. Winegarden and Khor (1991) determine the U.S unemployment-(undocumented) immigration relationship in a simultaneous equation model where immigrant and natives are endogenous variable. We will examine the causality test between those variable to see the effect one way or the other. From the Harrison's model we also see the relationship between unemployment and immigration. Some authors such as Layard, Nickell & Jackman (1991), and Pissarides (1991) have developed a full theoretical labor market model to determine the relationship between unemployment and immigration. Following Gross (1997), Marr and Siklos (1995) and the others mentioned above we can provide a theoretical framework for the following set of equations:

$$
\begin{aligned}
U &= U(M, Y, W, P) \\
M &= M(U, Y, W, Q) \\
Y &= Y(U, M, W, R) \\
W &= W(U, M, Y, T)
\end{aligned}
$$

where U is unemployment, M is immigration, W is the real wage, Y is for Gross Domestic Product(GDP). P, Q, R, T represent vectors of exogenous variables which may be same or different.

2.4 Labour Market Effects of Immigration: Review of the Literature

2.4.1 Substitutability and Complementarity

Since the ease with which immigrants will integrate into the host economy will be influenced by the economic success that they enjoy, a number of researchers have studied immigrant- native-born substitution. Most of the researchers have used cross-sectional data to determine whether immigrants are substitutes or complements to the native-born.

2.4.1(A) Canadian Studies

Akbari and DeVoretz (1992) analyzed the impact of immigrant workers on the employment of Canadian-born workers for 125 Canadian industries using 1980 data from different sources.. They used translog specification of the production function. The estimated cross elasticities suggest no economy-wide displacement of Canadian –born workers by immigrants. In addition, this lack of substitution was invariant to date of arrival. Also, economy-wide, immigrants were not a complementary input vis-à-vis physical capital. However, native-born worker was a complementary input to capital economy-wide. This lack of capital complementarity for immigrants might be the result of high human capital content of immigrants and is the direct contrast to the findings of Grossman (1983) for the United States. However, their results suggest a displacement effect in a portion of the Canadian economy.

Roy (1997) has studied the production function approach to analyze the job displacement effect of immigrants men disaggregate by country of origin and occupation. The study is based on the individual file of the 1981 Census of Canada(Public Use Sample tape).The study finds that (1) U.S immigrants and the Canadians are substitutes or competing groups in the labor market and the effect is quite significant for “natural sciences, engineering, and mathematics” and “managerial, administrative, and related occupations”. They had complementary skills in teaching or related occupations; (2) Canadians and Europeans are competing groups in clerical occupations, services, and processing occupations, while they have complementary skills in “natural sciences,

engineering, and mathematics" and transportation equipment operating occupations; (3) Immigrants from the third world and the Canadians are slightly competing groups in certain occupations. They are substitutes in "matching, product fabricating, assembling, and repairing" and to a smaller extent in transportation occupations. For all other occupation, third world immigrants were neither substitutes nor complements with the Canadian workforce.

Laryea (1998a) analyses the impact of foreign-born labor on wages in Canada using data from Labour Market Activity Survey for the period 1988-1990. A random effects model was used to analyze the wage impacts by broad industry groups and also by gender. Results from the instrumented wage regressions show that for the total sample, foreign-born and native born were complements in production. The relationship also held for the male and female sub-samples. However, when the data was disaggregated by industry, wage suppression by immigrants was detected in the primary, transport and storage, wholesale and retail trade industries. So, Canada-wise there appears to be complementary relationship between Canadian wage and foreign-born, but the relationship has been masked by developments in specific industries.

Laryea (1998b) employs a generalized Leontief production function to analyze substitutability or complementarity relationships between Canadian, old foreign-born and new foreign-born workers, using data from the 1991 census. He also extended the analysis to broad occupational groups. The results show that Canadian and new foreign-born workers are substitutes in production with adverse impacts on Canadian-born wage. The earlier immigrants, on the other hand, were found to be complements to Canadian-born workers. In case of occupational group, professionally trained immigrants and unskilled Canadian-born workers were found to be substitutes contrary to theory. But the relationship between unskilled immigrants and Canadian professionals and skilled Canadian workers were found to be complementary.

2.4.1(B) Other Countries

Grossman (1983) has investigated the production relationship of U.S immigrants with its domestic labor force using cross-section data for 1970. The resulting estimates shed light on the substitutability between the stock of immigrants in the United States at

that time, and the native work force. She found both second generation workers and foreign-born workers are substitutes for native-born workers, but the second generation workers are much more highly substitutable for natives than are foreign-born workers. The regression indicates that capital is complementary with all types of labor but the degree of complementarity is strongest with foreign born workers and weakest with native workers.

Borjas (1983) analyzes the extent of labor market competition among blacks, Hispanic and whites in the United States. He used the generalized Leontief production function to estimate a system of input demand functions. The estimation of the demand system using the 1976 Survey of Income and education reveals that (a) Blacks and Hispanics are complementary inputs; (b) Hispanics and Whites may also be complements; and c) Blacks and Whites are not complements and may be substitutes.

Chiswick, Chiswick, and Miller (1985) has examined whether immigrants and native-born are perfect substitutes in production when conventional measures of skills and demographic characteristics are held constant. It is hypothesized that they are perfect substitutes if natives are more intensive in country specific skills and immigrants are more intensive in the characteristics associated with favorable self-selection for migration. Their studies covers the immigrant adjustment of five major receiving countries e.g., U.S, Britain, Canada, Australia, Israel using data from household surveys and censuses. They used Constant Elasticity of Substitution (CES) specification of the production function and found estimated elasticity of substitution between native and immigrant quite high but significantly less than infinity. They found workers are relatively more intensive in the favorable self-selection characteristic of immigrants and are not perfect substitutes for workers relatively more intensive in country-specific skills.

So, the past studies have been inconclusive. Immigrants are substitutes in certain occupations, while complements in other occupations. Immigrants, therefore, displace native-born from some sectors, while they help create jobs in other sectors. The displacement effects also vary with the country of the immigrants' last permanent residence before entering the host country (Canada). In this study, I will categorize immigrants into two groups: recent and older immigrants to find their effect on job

opportunities of the Canadian-born workers and will also look at the effect among those three kinds of labor force employed in goods and service producing industries. It is hoped that this study will help to resolve some debates centered on immigrants.

2.4.2 Aggregate Unemployment and Immigration

Let us review the past studies to see if there have been any obvious links between immigration and unemployment.

2.4.2(A) Canadian Studies

Marr (1973) examined the relationship between immigration to Canada and Canadian unemployment rate, holding constant Canadian income per capita relative to real income per capita in representative sending countries, and unemployment rate in these sending countries, for the period 1950 to 1967. He found a significant negative relationship between these flows and the Canadian unemployment rate and argued that a high unemployment rate led to a lower flow of immigrants. But when total flows were disaggregated by sending area, he found, for annual data, for the sample 1956-1971, that higher unemployment rate led to lower immigration except for immigration flows from Asia, Central America and South America.

Marr and Siklos (1994) consider the joint relationship between immigration and unemployment rate in Canada, conditional on aggregate demand and supply factors, using quarterly data for the period 1962-1990. They use causality testing with time series techniques. They also present evidence about transitory versus permanent effects of unemployment on immigration in addition to performing tests based on relationships estimated for every possible sub sample as opposed to some ad hoc sub sample selection. Their study shows that before 1978, changes in immigration levels do not affect the Canadian unemployment rate, but after 1978 immigration rates appear to contribute to changes in the unemployment rate.

Marr and Siklos (1995) have considered the relationship between immigration and unemployment at the macroeconomic level in Canada using annual data from 1926 to 1992. They use both Granger causality test between unemployment and immigration and the unrestricted VAR approach involving time series regression of unemployment, immigration, wage (per capita total labor income), and real GDP. The Granger causality

tests reveal that immigration is not caused by past unemployment; however, past immigration does cause unemployment. They find that immigration and unemployment rates are inversely related and the past unemployment rate has a quantitatively smaller impact on immigration than past immigration has on current level of unemployment. When they allow for a substantial rise in immigration, via a hypothetical trend in immigration flows, the impact of immigration on unemployment is never large enough to justify the alarm that is occasionally expressed about the possible influence of immigration on future unemployment. Moreover, the impact of immigration on unemployment or vice-versa does not appear to be overly sensitive to the choice of sample periods or sampling frequencies. What does have influence on the relationship between immigration and unemployment is the level of desegregation in the time series of interest. Thus, their findings differ when they consider immigration by country of origin or by occupational group. They found unemployment shocks have a significant impact on the proportion of immigrants from Asia.

Gross (1997) analyses the ability of a regional market to absorb the growing flows of immigrant workers with declining levels of skills in times of relatively high unemployment. The region under consider is British Columbia – one of the three Canadian provinces with a major metropolitan area, the region with highest density of immigrants. The paper is an investigation into the impacts on the dynamics of a regional labor market represented by asset of aggregate structural relationships for immigration, unemployment, real wage and labor force participation. It is found that immigration is positively related to unemployment in the short-run and negatively related to unemployment rate in the long-run. Higher average skill level among immigrants makes them more competitive in the short-run.

2.4.2(B) Other Countries

Withers and Pope (1985) have examined the immigration-unemployment relationship for Australia. Their paper uses both statistical causality techniques and conventional structural models to investigate the relationship between immigration and unemployment in the post war period in Australia. The tests find no evidence of any association from migration to unemployment, though there is a strong evidence of a

significant effect of Australian unemployment on migration. The result applies whether the total net migration or the permanent and long-term definition of net migration is used and whether the unemployment rate or the unemployment-vacancies ratio definition of labor market balance is used. His findings was strongly supported by evidence from more conventional economic analyses, including the revision and extension of the earlier relevant empirical work on frictional- structural unemployment by Harper(1980) and warren(1982). The results indicate that immigration policy should not be dictated by unfounded fears of immigration causing unemployment, at least over the range of previous Australian experience.

Winegarden and Khor (1991) use 1980 U.S. census data on the state distribution of the undocumented-alien population in analyzing the relationship between that population and unemployment among youth and minority workers. A simultaneous equation model involving unemployment and immigration as endogenous variables was estimated. The results do not support commonly-expressed fears that undocumented immigration has caused any substantial increases in joblessness among the presumably most vulnerable groups in U.S workforce, although small amounts of displacement were detected. They have found a sizeable reverse effect: state concentrations of undocumented workers tend to vary inversely with incidence of unemployment in these marginal groups, suggesting some similarities in human capital characteristics and occupational-industrial distribution.

In another study Withers and Pope(1993) surveyed research studies from several countries and time periods, and find general support for the conclusion that improved labor market conditions in the receiving countries increase migrant inflows, unless other factor intervene. This hypothesis has been explained in terms of human capital theory of migration and of the reaction of federal governments to changes in the unemployment rate. They also use here both structural disequilibrium modeling and causality testing and find a highly significant relation for unemployment causing changes to the immigration rate in Australia for the period 1861-1991, but no evidence that immigration causes unemployment. Indeed, they argue that, during 1980s, higher immigration rates probably reduced unemployment below what it would have been with lower immigration rates.

They also find structural breaks in the relationship that appear to have originated from government policy changes.

So, the past literature doesn't suggest any obvious link between immigration and aggregate unemployment or vice versa. While some studies suggest that there is a negative relationship between unemployment and immigration in the long-run, in the short-run the relationship does not exist. The results however, are not free from criticism, particularly on the ground of econometric specification, data and methodology they used. This thesis will take those aspects into account and would try to draw any causal inference (if any) about short-run and long-run dynamics of immigration and unemployment in a more general equilibrium framework.

CHAPTER-3

Model Specification

In this chapter, I specify a theoretical model to determine the substitutability or complementarity. I have started with a production function approach and estimate the Hicksian elasticity of complementarity from a set of wage equations derived from the Generalized Leontief production function. Then I consider a time series model to determine the labor market dynamics between immigration and unemployment. First, I identify a Granger casualty to determine the causal linkage between immigration and unemployment. Then a VAR model involving immigration, unemployment, real wage and GDP has been specified to find out the long-run and short-run relationship between immigration and unemployment.

3.1 Substitutability and Complementarity

3.1.1 The structure of Production

We consider three inputs in the short-run aggregate production function[5]: Canadian-born (N), recent immigrants(R) and the older immigrants (O). Assume that natives, recent immigrants and older immigrants are as a group separable from the fourth input, capital[6]. As before, we also assume that the production function h(N, R, O) is linearly homogenous and possesses the actual neoclassical properties. So, the necessary condition for profit maximization implies that-

(3.1) $$W_i = h_i(P_N, P_R, P_O) \qquad \text{i = N, R, O where,}$$

$$where, \quad h_i = \frac{\partial h(N,R,O)}{\partial i}, \text{and} \quad P_i = \frac{L_i}{N+R+O}$$

[5] A production function rather than the cost function is used to discern the underlying technology because, in this case, it is more reasonable to assume that the quantities are fixed rather than prices. Here we are dealing with input categories that can't change very rapidly. Moreover, the number of immigrants allowed into Canada is restricted by annual quota that is fixed in the previous year and is almost fully subscribed.

[6] Weak separability here means that marginal rate of substitution between any two of the three inputs will be independent on the quantity of capital used in production. This is a necessary and sufficient condition for the production function to be of the form Q=h[f(N,R,O);K]. Grossman (1983), Akbari and DeVoretz (1992) have concluded that capital and labor is separable for the kind of production relation we are dealing with. In another study Borjas (1983) found that the assumption of strong separability between capital and labor is not rejected by the data. This finding is important because difficulties in constructing a series of capital data even at the aggregate level are well-known (Roy 1997).

The determination of wage rates depends not only on the demand functions in (3.1) but also the relative supplies of the labor types to the local labor market. The measurement of substitutability or complementarity requires further specification of the production technology's structure. Following Borjas (1983), and Roy (1997), we consider the generalized Leontief production function:

$$h(L_N, L_R, L_O) = \sum_j \sum_i \gamma_{ij} (L_i L_j)^{1/2} \qquad (3.2)$$

(i, j =N,R,O)

where technology parameters are restricted so that $\gamma_{ij} = \gamma_{ji}$.(Young's theorem). The functional form given in (3.2) can be viewed as a second-order Taylor series approximation to concave neoclassical production function with constant returns to scale.

An important motivation for estimating (3.2) is to obtain the degree of substitutability and complementarities among natives, recent immigrant and older immigrants. Since, we are assuming that quantities, not factor prices are exogenous; the appropriate measure of factor substitutability is the Hicks partial elasticity of complementarity which is defined as:

$$\eta_{ij} = \frac{hh_{ij}}{h_i h_j}$$

where h_i is the first derivative of the production function h with respect to factor i and h_{ij} is the second derivative[7].The elasticity of complementarity implied by the generalized Leontief production function is given by(Borjas 1983):

$$\eta_{ij} = \frac{\gamma_{ij}\overline{w}}{2w_i w_j (p_i p_j)^{1/2}} \qquad i \neq j \qquad (3.3a)$$

$$\eta_{ii} = \frac{(\gamma_{ii} - w_i)\overline{w}}{2p_i w_i^2}, \qquad i = j \qquad (3.3b)$$

where $\overline{w} = p_R w_R + p_O w_O + p_N w_N$.

[7] Sato and Koizumi (1973) lay out the relationship among the substitution and complementary elasticities.

3.1.2 Statistical Specification

To obtain wage equations, we equate wage rates and marginal products for each type of labor input. We get-

(3.4a) $W_N = \gamma_{NN} + \gamma_{NR}(P_R/P_N)^{1/2} + \gamma_{NO}(P_O/P_N)^{1/2}$

(3.4b) $W_R = \gamma_{RR} + \gamma_{NR}(P_N/P_R)^{1/2} + \gamma_{RO}(P_O/P_R)^{1/2}$

(3.4c) $W_O = \gamma_{OO} + \gamma_{NO}(P_N/P_O)^{1/2} + \gamma_{RO}(P_R/P_O)^{1/2}$

The production technology in (4.4) imposes a set of cross-equation restrictions which are:

(3.5) $\gamma^N_{NR} = \gamma^R_{NR,} \qquad \gamma^R_{RO} = \gamma^O_{RO,} \qquad \gamma^O_{NO} = \gamma^N_{NO}$

where the superscripts denote the *ith* equation.

The system of equation derived in (3.4) gives the determination of wage levels in a particular labor market. To apply this model to micro data available, it is necessary to control the individual differences in productive skills. It is insightful to view individual k's wage as being determined by both the geographic wage level given in (3.4), W_i, and by an individual specific fixed effect, f_{ik}. This fixed effect measures the individual's deviation in productive skills from average type *i* individual in the local labor market. The simplest estimating equation is obtained by assuming that the individual wage W_{ik}, is determined by an additive fixed effect, hence $W_{ik} = W_i + f_{ik}$. That is, demand system in (3.4) determines the basic wage level, and the additive fixed effect captures the individual differences in effective labor supply. This additivity means that individual's stock of productive skills is valued independently of the racial or ethnic composition of the local labor market. Furthermore, the definition f_{ik} implies that it has a zero mean so that demand system in (3.4) determines the average level of type *i* individual in the local labor market.

It is assumed that a vector of socio-economic variables can approximate the individual fixed effects. The empirical specification of (3.4) is then given by the following:

(3.6) $$W_i = \alpha_i X_i + \sum_i \sum_j \gamma_{ij} (P_j / P_i)^{1/2} + \varepsilon_i$$

Where X_i is the vector of skill characteristic of the individual (a proxy of the socio economic characteristic) and ε_i is the random disturbance term. ε_i (i =N, R, O)is assumed to have multivariate normal distribution with mean vector zero and constant variance

matrix Ω*. The rational for the stochastic specification can simply consist of the argument that firms make random errors in choosing their profit maximizing input bundles. Alternatively, following McElroy (1987), one might argue that errors are in the eyes of beholding econometrician and are not due to firms. Specifically McElroy suggests embedding the entire optimization problem within a stochastic framework and assumes that firms differ from one another according to the parameters that are known by the firms' managers but not by the econometrician. Depending on how one specifies these parameters, the firm effects can manifest themselves as additive or multiplicative error terms in the production function, demand equations or wage equations.

3.1.3 Determination of the Socio-Economic Variables

We use the human capital earning function as the point of departure. This earnings function has been successfully applied to analyses of the determinants of the earnings in a wide variety of countries (Chiswick 1978). Assume that native-born workers have made all of their investment in human capital in Canada. If rates of return, r, to all levels of schooling, S, are constant, a year of schooling requires an investment of a full year's potential earnings; and, if the native goes to job market continuously after leaving school, the individual specific fixed effect earnings, f_{ik}, can be written as-

(3.7) $$f_{ik} = \alpha_0 + rS_i + b_1 T_i + b_2 T_i^2 + U_i$$

where T is the years of labor market experience as measured by age - schooling - 5, U_i is a residual. Among the foreign born, however, the total number of years of schooling can be decomposed into the schooling before immigration (S_b) and the schooling after immigration (S_a). Similarly, years of labor market experience (T) can be decomposed into years of experience before (T_b) and after (T_a) immigration. If there is country specific training, the training acquired prior to migration (S_b T_b) would have a weaker effect on earnings than years of training in Canada (S_a T_a). Assuming that the effect of years of training can be described by a quadratic experience variable, the individual fixed effects earnings function of the foreign born can be written as-

(3.8) $$f_{ik} = \alpha_0 + r_b S_{b,i} + r_a S_{a,i} + b'_1 T_{b,i} + b'_2 T_{b,i}^2 + b'_3 T_{a,i} + b'_4 T_{a,i}^2 + U_i$$

Since $S_i = S_{b,i} + S_{a,i}$ and $T_i = T_{b,i} + T_{a,i}$

(3.9) $$f_{ik} = \alpha_0 + r_b s_i + (r_a - r_b) s_{a,i} + b'_1 T_i + b'_2 T_i^2 + (b'_3 - b'_1) T_{a,i} + (b'_2 + b'_4) T_{a,i}^2 - 2b_2 T_i, T_{a,i} + U_i$$

Empirically there is a little difference between r_a and r_b, and the interaction of total labor market experience with Canadian experience[8]. In most of the analysis that follow, the variables S_a and TT_a are deleted from the earnings function of equation (3.9). In addition, the variable, T_a, the number of years in post-immigration training, is replaced by YSM, the number of years since migration. The individual specific fixed effects earnings function is then reduced to the following[9]:

(3.10) $$f_{ik} = \alpha_0 + r_b S_i + C_1 T_{b,i} + C_2 T_i^2 + C_3(YSM) + b'_4(YSM)^2 + U_i$$

In our regression estimation, the vector X_i of the explanatory variables will also include marital status, sex, language ability and an industry dummy to control the wage differentials arising from differences in job environment (but I will exclude the square term of YSM as it does not play a significant role). Furthermore, the industry dummy also captures the different capital-labor ratios that are bound to differ across industries and partially control for omitted capital variables.

3.1.4 Parameters of Interest

The parameters that are main interest are those with symmetry constraints, $\gamma^N_{NR} = \gamma^R_{NR,}$ $\gamma^R_{RO} = \gamma^O_{RO,}$ $\gamma^O_{NO} = \gamma^N_{NO}$. If, for instance, γ^N_{NR} is greater than zero, it means that an increase in the share of recent immigrants relative to the native-born Canadians would increase the earnings of the Canadian born, and thus recent immigrants and Canadians are complementary inputs in the labor market. This would lend support to the view that either because skill characteristics of immigrants are different from those of the domestic workforce and/or the recent immigrants take jobs that native-born workers are unwilling to accept. On the other hand, a negative coefficient implies that they are substitutes in the labor market and recent immigrants have an adverse impact on the earnings and employment opportunities of the native Canadians.

3.1.5 Econometric Issues

Although equation-by-equation OLS estimation might appear attractive, since the wage earnings function (3.6) are linear in parameters, these wage equations have the three cross-equation symmetry constraints given in (3.5). Even if these constraints hold in

[8] Chiswick (1978) has shown that the interaction coefficient is not statistically significant for U.S data.
[9] For Canadian-born earnings function YSM is set to zero.

the population, for any given sample equation-by-equation OLS estimates will not reveal such restrictions; for example, γ^{N}_{NR} in equation (3.4a) estimated by OLS will not necessarily equal γ^{R}_{NR} estimated in the equation (3.4b)[10]. Therefore, we will use Zellner's seemingly unrelated estimator (which is often shortened to ZEF and also called seemingly unrelated regression estimator (SUR) or the maximum chi-square estimator. Even if one ignores the cross-equation constraints, one would still expect the ZEF system estimator to yield different parameter estimates than those from equation-by-equation OLS, for two reasons. First, one would expect disturbances across equations given in (3.6) to be contemporaneously correlated, implying that the disturbance covariance matrix would be non-diagonal. Second, as seen in equation (3.6), each wage equation contains different regressors. For both these reasons, in large sample, ZEF estimate would provide more efficient estimates of parameters than OLS.

In effect, the ZEF estimator uses equation-by-equation OLS to obtain an estimate of the disturbance covariance matrix Ω and then does the generalized least squares given this initial estimate of Ω, on an appropriately 'stacked' set of equations. Furthermore, one can update the estimate of Ω and iterate the Zellner procedure until changes from one iteration to the next in the estimated parameters and estimated Ω become arbitrarily small. This iterative Zellner-efficient estimator is typically termed as IZEF, and in this case it yields the parameter estimates that are numerically equivalent those of the maximum likelihood estimator[11].

The discussion so far has been restricted to determine the job displacement effects of immigration on Canadian-born workers from a microeconomic perspective. The idea underlying the fear of job displacement is that there are fewer available jobs for Canadian-born workers since the immigrants are competing with Canadian-born workers for the given number of jobs. However, immigrants do not only represent an addition to the existing working force, they also help create jobs through their demand for goods and services and by the kind of their own and industrial and social expenditure undertaken because of them. Therefore, whether a given immigration flows is expansionary or

[10] This will be demonstrated empirically when we will estimate our regression in Chapter 4.
[11] For a proof see Walter Oberhofer and Jan Kamenta (1974), " A General Procedure for Obtaining maximum Likelihood Estimates in Generalized Regression Models," Econometrica, Vol. 42, No.3, p-579-590.

deflationary then depend upon whether that migration inflow adds more to demand than to supply, and the consequent accommodations in policy to this impact. We will therefore look for the immigration and unemployment dynamics at the aggregate level.

3.2 Immigration and Aggregate Unemployment Dynamics

3.2.1 Causality Test: Immigration and Unemployment

While immigration flows ultimately depends on government policies, the tap-on, tap-off approach doesn't work instantaneously. Indeed, the lags between immigration and unemployment rates can be fairly long and are also no doubt potentially variable (Marr and Siklos 1994). Therefore it seems reasonable, at least as a benchmark, to assume that two variables are jointly determined such that we can write:

$$\begin{bmatrix} M_t \\ U_t \end{bmatrix} = \begin{bmatrix} M_{t-i} \\ U_{t-i} \end{bmatrix} + \begin{bmatrix} X_{t-i} \end{bmatrix} + \begin{bmatrix} e_M \\ e_U \end{bmatrix} \tag{3.11}$$

where M_t and U_t are measure of immigration and unemployment, respectively, X_t is a vector of exogenous variables; e_t is a vector of residuals. In our context, to explain the Granger test, the relevant question could be: Is it unemployment that causes immigration ($U \rightarrow M$) or is the immigration that causes unemployment ($M \rightarrow U$), where the arrow points to the direction of causality. The Granger causality test implicitly assumes that the information relevant to the prediction of explanatory variables, M, U, is contained solely in the time series data on these variables. The test involves estimating the following pairs of regression:

$$U_t = \sum_{i=1}^{n} \alpha_i M_{t-i} + \sum_{j=1}^{n} \beta_j U_{t-j} + \varepsilon_{1t} \tag{3.12}$$

$$M_t = \sum_{i=1}^{n} \lambda_i M_{t-i} + \sum_{j=1}^{n} \delta_j U_{t-j} + \varepsilon_{2t} \tag{3.13}$$

where it is assumed that ε_{1t} and ε_{2t} are uncorrelated.

Equations (3.12) and (3.13) allow the examination of causality from migration to unemployment and vice versa. In the former case, the motivating hypothesis is that migration has effects upon both demand and supply, which are difficult to assess a *priori.* In the latter case, there is also a less politically significant but much debated question in the migration literature as to whether migrant supply responds significantly to

unemployment, both as a matter of individual migrant choice and as a consequence of government restrictions on inflow, i.e., reduced government demand for migrants.

The specified equations examine incremental predictability. Having produced effectively 'white noise' data series by the structure of the equations imposed, the method of explanation adopted is to ask whether a vector representation of a particular exogenous variable improves explanation of the dependent variable. If immigrant is important as a contributor to unemployment, its effect should be detectable. Nevertheless, there is an inconclusive debate in the statistical literature as to whether causality methods can suffer an omitted variable problem.

An attempt to resolve this issue would be to construct a theoretical labor market model such as the ones developed by Marr and Siklos(1995), Gross(1997). The expanded model of immigration flows can be written as:

(3.14). $$\begin{bmatrix} U_t \\ M_t \\ W_t \\ Y_t \end{bmatrix} = \begin{bmatrix} U_{t-i} \\ M_{t-i} \\ W_{t-i} \\ Y_{t-i} \end{bmatrix} + \begin{bmatrix} X_{t-i} \end{bmatrix} + \begin{bmatrix} e_U \\ e_M \\ e_W \\ e_Y \end{bmatrix}$$

where wage is measure of aggregate domestic labor market conditions and Y is a measure of aggregate domestic economic activity. Equation (3.14) is our general equilibrium framework where supply and demand effects of immigrants as well as feedbacks from wage and the labor supply determine the final impact of immigrations on the destination market.

3.2.2 Identification of the Long-run and Short-run Structure

We will now develop a strategy for identifying the dynamic adjustment of the market in the short-run and in the long run. Our goal is to estimate efficiently long-run relationship (if any) between the endogenous variables while identifying the short-run parameters. We will adopt a two-step procedure.

3.2.2(a) Identifying a Long-run Relationship

The first step is to test for the long-run relationship using the procedure developed by Johansen and Juselius (1994, 1995a, 1995b) and Engle and Granger (1987). Johansen derives the maximum likelihood procedures for testing for cointegration in a finite-order Gaussian vector autoregression (VAR). The system is:

(3.15) $$y_t = \sum_{i=1}^{p} \pi_i y_{t-i} + Dx_t + \varepsilon_t, \qquad \varepsilon_t \sim IN(0,\Omega), \qquad t = 1,.....,T$$

where y_t is a k vector of non-stationary variables[12], x_t is a *d* vector of deterministic variables (constant and dummies) and ε_t is a vector of innovations. π_i is the matrix of coefficient in the *ith* lag of y_t, D is the $k \times d$ matrix of coefficient on x_t. We can rewrite the VAR as:

(3.16) $$\Delta y_t = \pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma \Delta y_{t-i} + Dx_t + \varepsilon_t$$

where $\pi = \left(\sum_{i=1}^{p} \pi_i \right) - I_k \qquad and \quad \Gamma_i = -\sum_{j=i+1}^{p} \pi_j$

I_k is the matrix of dimension of order k. If the coefficient matrix of π has a reduced rank r< k, then there exist $k \times r$ matrix α and β each with rank *r* such that $\pi = \alpha \beta'$ and $\beta' y_t$ is stationary, *r* is the number of cointegrating relations, β is the matrix of cointegrating vector and α is the matrix of adjustment coefficient. Johansen's method is to estimate the π matrix in an unrestricted form, then test whether we can reject the restrictions implied by the reduced rank of π.

If there are *k* endogenous variables, each of which has a unit root, there can be zero to *k-1* cointegrating relations. If there are no cointegrating relations, standard time series analysis such as the unrestricted VAR will be applied to the first-difference of the data. Since there are *k* separate integrated element driving the series, levels of the series don't appear in the VAR in this case. On the other hand, if there is one cointegrating equation in the system, then a single linear combination of the levels of the endogenous series, $\beta' y_{t-1}$, will be added to each equation in the VAR. When multiplied by a coefficient for an equation, the resulting term $\alpha\beta' y_{t-1}$, is referred to as an error correction term. If there are additional cointegrating equations, each will contribute an additional error correction term involving a different linear combination of the levels of the series.

Johansen derives two maximum likelihood statistics for testing the rank of π hence the number of cointegrating vectors. In one case the alternative hypothesis is that

[12] In this stage assume that we have a non-stationary time series data of order *I(1)*. If our data becomes stationary, then there will be *k* cointegrating relations, none of the series exhibit unit root, then VAR (unrestricted) will be applied in terms of the levels of all of the series

the rank is *k*, and the test statistic is known as *trace statistic*. In the second case, the alternative hypothesis is that the rank is *r+1* and trace statistic is known as *max statistic.*

3.2.2(b) Short-run Dynamics of Unemployment and Immigration

It is possible that in the long run the variables U, M, W, and Yare in equilibrium, but there may be disequilibria in the short-run. As a second step, we now determine the short-run dynamic relationship between these four endogenous variables. We can specify the short-run equation in difference with error correction term as:

$$\Delta y_{k,t} = \alpha + \sum_{i=1}^{p} \delta_{k,t-i} \Delta y_{k,t-i} + \sum_{i=1}^{p} \theta \Delta Z_{i,t-i} - \lambda ECM_{t-p} + \varepsilon_t \tag{3.17}$$

where Z is a vector of exogenous variables in the short-run and ECM is the error correction term. The latter is the first cointegrating vector from the first-step procedure with fixed parameters. In the case of multiple cointegrating vectors there is no objective rule to choose one vector rather than the other except that the first one is strongly correlated with stationary portion of the process (see Johansen 1995b). Thus, the valid cointegration relationship that we consider is the one given by the first relationship. The lags for the differences as well as for the ECM term are dictated by the initial set up of the VAR.

CHAPTER-4

Estimation Results and Interpretation

This chapter deals with data and econometric model estimation derived in Chapter-3. A summary statistics of the data used to identify the objective-1 is provided in the first section. Then I present the estimation results and interpret those results for both objectives.

4.1 The Data and Analysis

The data used to determine the substitutability or complementarity is drawn from a 20 percent sample of Public Use Micro Data File (PUMF) from Statistics Canada 1996 census. Of total there are 6,651 numbers of observations for recent immigrants, 7,663 for the older immigrants and 49,707 for the Canadian-born population in the sample drawn from the PUMF. The data from Labor Force Historical Review 2001, DRI Basic Economics Quarterly data (for wage and unemployment), and CANSIM II (for GDP and immigration) have been taken to determine the dynamics of immigration and unemployment in the post 1960s in Canada.

Table-4.1 gives the summary statistics for the derived data set from PUMF. We see that recent immigrant has substantial lower average earnings than the older immigrants and native born. The old foreign-born immigrants have higher wage earnings than that of native-born. Recent immigrants earn 67 percent of their old counterpart and 71 percent of native-born earnings. Old immigrants earn 5 percent higher than the native-born workforce. The difference could be attributed to the fact that on average the new foreign-born worked less in the reference week, 40.04, compared with 44.25 of older immigrant and 43.75 of native-born workers. The new immigrant also works less in a week, 32.33 compared with 34.38 of older immigrant and 34.01 of native-born workers. In addition, new immigrants have lower skills suitable to the Canadian labor market; they also have a language barrier (90.6 percent of new immigrant can speak in English as opposed to 96.6 percent of the older immigrants. Furthermore, new immigrants are concentrated more in a low-paying job. For example, 54.36% of new immigrants are in clerical, sales service, intermediate/semi skilled/manual and other manual occupations compared to 41.53 and 43.56 of the old immigrants and the native-born workers. But

once they integrate into the Canadian labor market they are highly paid as they have relatively higher human capital content.

Table 4.1:
Descriptive Statistics of Selected Variables*

Immigration Status	No. of Obs.	Variable	Mean	St. Dev
Recent	6651	HRSWK	32.34	19.81
		WKSWK	40.04	16.64
		WAGE	19629.83	19666.32
		SCH	14.00	4.01
		EXPER	19.03	10.19
		AGE	38.03	8.99
		CMA	0.92	-
		SEX	45.84%	-
		LANGENG	90.62%	-
		LANGFRE	9.38%	-
		GOODSIND	44.19%	-
		SERIND	55.81%	-
Older	7663	HRSWK	34.38	18.82
		WKSWK	44.25	13.75
		WAGE	29440.23	25849.96
		SCH	13.59	4.09
		EXPER	28.12	11.39
		AGE	46.74	9.90
		CMA	82.41%	-
		SEX	45.29%	-
		LANGENG	96.72%	-
		LANGFRE	3.28%	-
		GOODSIND	39.92%	-
		SERIND	60.08%	-
Canadian-born	49707	HRSWK	34.02	18.97
		WKSWK	43.75	14.12
		WAGE	27557.50	23991.68
		SCH	13.67	3.42
		EXPER	21.34	11.25
		AGE	40.11	9.98
		CMA	61.81%	-
		SEX	46.79%	-
		LANGENG	84.52%	-
		LANGFRE	15.48%	-
		GOODSIND	38.66%	-
		SERIND	61.34%	-

* *WKSWK= Weeks Worked in 1995, HRSWK= Hours worked, WAGE: Annual Wage Earnings, SCH: Total Years of Schooling, Exper: Job Market Experience (in years), CMA: Census Metropolitan Area, Sex= Female as shown in Table, LANGENG: Percentage of people who can speak English, GOODSIND= Percentage of workers employed in good industry etc.*

Clearly a fractional of higher yearly wage earnings of old foreign-born workers is due to differences in skill and other socio economic characteristics. For example, old foreign-born workers have higher average experience of 28.11 as compared with 21.33 years of native-born and 19 years of new immigrant labor force.The new immigrants have a higher education level of 14 years as compared with 13.6 and 13.67 years of education of old and native-born workers respectively. They are more likely to stay in a census metropolitan area (91.5 percent of the new foreign-born population reside in CMAs compared with 82.5 and 62.4 percentage of population from old-foreign born and native born respectively)

The Canadian born populations are more employed in service sector than the foreign-born. 61.6 percent of native-born Canadians are working in the service sector as compared to 55.8 percent of the new foreign-born. Although, on average, old immigrants and Canadian-born are earning more in goods producing sector, recent immigrants are in the service producing sector compared to what they earn in the goods producing sector. The implication of this will be discussed later in this chapter.

Now consider the proportion of each of the groups employed in broadly defined industries and occupations. The differences in employment by industry among the samples are notable. For example, native-born Canadians have much greater percentage of workers in the public sector than either new or older immigrants. The new immigrants are underrepresented in agriculture, construction and educational industries. The occupation characteristics reveal similar depression among three groups. For example, new immigrants are more likely to be found in sales services, and manual works and less likely in a professional or senior or mid-level managers. Although the statistics are only suggestive, they do provide an "institutional" background for the empirical results presented below.

So, there are different characteristics between Canadian-born and the foreign born population in terms of their age, schooling and experience, industrial and occupational concentration which might lead to different interactions in the labor market and welfare implications for the Canadian-born workers. For example, as long as immigrants bring an accumulated bundle of labor and physical or human capital that is different from that

possessed by Canadians, the later will gain from immigration (see Johnson 1967). Pre-1979 immigrants are termed earlier immigrants and those arriving later are termed recent immigrants. This distinction between immigrant vintages is an attempt to recognize explicitly the hypothesis that the two immigrant pools are drawn from different populations. Post 1978 immigrants are obviously younger, have a greater amount of human capital and differ in their other characteristics compared with earlier immigrant flow.

The set of wage earnings equations has been estimated with some observable characteristics of the immigrant and native-born as outlined in chapter-3. The variables which are used in the analysis are described below:

Earnings: the log of wage earnings of the native-born and immigrants have been chosen for the year 1995 from census 1996.

Education (Educ): Years of schooling, a continuous variable.

Labor Market Experience (Exper): computed as age minus education minus 5. It is assumed that adult men and women (with 24 years and above) were in the labor force when they were not in school

Weeks worked: The number of weeks the native born and immigrants worked in 1995.

Urban (CMA): A dichotomous variable equal to unity for a person living in an urban/city area, otherwise it is zero.

Married: A dichotomous variable equal to unity for a person who is never married, otherwise it is zero.

Sex: A dichotomous variable equal to unity for female.

Years since migration (YSM): the number of person since the foreign-born person migrated to Canada, defined to be zero for the native-born.

Language: A dichotomous variable equal to unity for a person who can speak in English, otherwise it is zero.

The schooling and the experience variable reflect the effect of the person's skills (human capital) on earnings. Controlling for the labor market experience (Exper), the variable "years since migration" (YSM) indicates for the foreign-born whether experience in the country of origin has a different effect on earnings than experience

acquired in Canada. As the dependent variable measures the annual wage income, the weeks worked is included to hold constant differences in weeks worked during the year.

4.2 Estimation Results

We first look at whether OLS estimation would be appropriate for the system of wage equations derived from the Generalized Leontief Production function given in equation (3.6). At first, it seems reasonable to use OLS; since the wage earnings function (3.6) are linear in parameters. But these wage equations have the cross-equation constraints. So, we need to check whether these constraints hold well in our sample data from Micro data File. Applying OLS to our data set, we see that while the OLS estimates of the coefficient of the variable $(P_O/P_R)^{1/2}$ is positive in the wage equation for the recent immigrant; in the wage earnings equation for the older immigrant the estimate of $(P_r/P_o)^{1/2}$ is negative as shown in Table 4.2[13]. The Wald test, LR and LM tests also reject each of the hypotheses of cross equation restrictions. To impose these cross-equation constraints, it is necessary instead to use a system estimator.

Table 4.2 :
Symmetry Constrained Wage Equations Using OLS[14]
Dependent Variable: Annual Wage Earnings

	Canadian-born		Older Immigrant		Recent Immigrant	
Variable	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**
Constant	-29791.73	-12.23	-23870.07	-7.02	-21791.44	-11.83
Educ	1719.25	19.10	1298.20	15.03	788.00	12.43
Exper	902.23	10.29	597.25	5.61	372.26	4.99
Exper^2	-14.25	-8.33	-9.59	-5.04	-7.14	-4.67
Married	-4175.58	-6.44	-3122.12	-3.31	-1797.26	-3.18
CMA	5011.64	9.52	5906.52	8.04	1040.70	1.38
Language	844.78	1.19	1245.36	0.76	1367.11	1.79
Sex	-10389.89	-20.05	-9411.66	-16.28	-5764.01	-13.39
YSM	-	-	139.09	3.69	530.49	13.58
$(P_r/P_n)^{1/2}$	-22433.04	-9.40	-	-	-22433.04	-9.40
$(p_o/P_n)^{1/2}$	20739.67	5.53	20739.67	5.53	-	-
$(P_n/P_o)^{1/2}$	638.79	1.00	638.79	1.00	-	-
$(P_r/P_o)^{1/2}$	-	-	-8342.72	-8.07	-8342.72	-8.07
$(P_n/P_r)^{1/2}$	-207.02	-0.47	-	-	-207.02	-0.47
$(P_o/P_r)^{1/2}$	-	-	6238.34	4.94	6238.34	4.94
Adj R^2	0.29		0.25		0.26	

[13] See Berndt (1991) for some other specific example that does not support the use of OLS in this context.
[14] The set of wage equations also include the variables such as weeks worked and an industry dummy.

So, Equation 3.6 was estimated using Full Information Maximum Likelihood (FIML) or iterative Zellner's seemingly unrelated regression technique (Zellner 1962) to take account of the cross equation correlations. I generate random number from the 20 percent sample data set of PUMF that produced 6651 number of observations for each of the three labor force, recent immigrant, older immigrant and Canadian-born native. The estimation results are presented in Table-4.3

Table 4.3 :
Symmetry Constrained Wage Equations Using the FIML
Dependent Variable: Annual Wage Earnings

	Canadian-born		Older Immigrant		Recent Immigrant	
Variable	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**
Constant	-33775.01	-14.88	-31071.83	-8.38	-19841.10	-9.60
Educ	1898.72	23.60	1384.89	15.58	825.91	12.22
Exper	954.15	9.38	601.88	4.73	381.90	4.33
Exper^2	-14.70	-7.28	-9.68	-4.25	-7.27	-3.94
Married	-4414.65	-5.57	-3317.20	-3.06	-1949.78	-3.06
CMA	5121.06	9.12	5770.40	7.16	1318.10	1.99
Language	981.86	0.99	1422.05	0.67	1420.68	1.38
Sex	-10724.25	-17.84	-9667.75	-14.18	-5950.54	-11.84
YSM	-	-	156.48	4.40	537.79	13.70
$(P_r/P_n)^{1/2}$	1788.46	5.32	-	-	1788.46	5.32
$(p_o/P_n)^{1/2}$	461.23	0.74	461.23	0.74	-	-
$(P_r/P_o)^{1/2}$	-	-	-1746.99	-2.13	-1746.99	-2.13
Adj R^2	0.28		0.24		0.25	

4.2.1 Elasticity Estimates

Table-4.4 presents the estimated technology parameters and the corresponding elasticity η_{ij} and η_{ii}. Factors are substitutes if η_{ij} is negative and complements if it is positive[15]. It is clear that Canadian-born native and the recent immigrant are complements to each other. The estimated γ_{ij} upon which η_{ij} is based is highly significant. The corresponding Hicksian elasticity is .16, which implies that a 10 percentage increase

[15]It is difficult to make the appropriate measures of variance to attach to the elasticity estimates. Parameter estimates should replace the γ's when computing estimates of ρ_{ij} , ρ_{ii} . This implies that in general the estimated elasticities will vary across observations. The fact that these elasticities are highly non-linear function of the estimated γ's has made it difficult to obtain estimates of the variances of the estimated elasticities. Moreover, since distribution properties of such estimates have not yet been derived, the basis for statistical inference on them does not yet exist (see Berndt 1991).

in recent immigrants will increase the wage earnings of Canadians by 1.6 percent. This result is not surprising, because new immigrants have greater amount of human capital than the older one and differ much in their ethnic background than that of older immigrants. They also tend to work in a low-paying job despite their high human capital content. The high human capital content of new immigrants might be a good substitute of capital which can be the source complementarities to the Canadian born workers. The older immigrant and the native born are neither substitute nor complements to each other.

Table 4.4:
Hicksian Elasticity of Complementarity Using FIML

Technology parameter	Estimate	t-stat (coeff)	Elasticity of complementarity
γ_{nr}	1788.46	5.315	0.160
γ_{no}	461.23	0.739	0.025
γ_{ro}	-1746.99	-2.128	-0.348
γ_{nn}	-33775.01	-14.876	-1.388
γ_{rr}	-19841.10	-9.603	-12.897
γ_{oo}	-31071.83	-8.383	-7.333

The estimate of γ_{NO}, the parameter measuring the substitution possibilities between new foreign-born workers and Canadian-born workers, is positive but insignificant. This might be the reason of high Canadian job market experience of old immigrants and therefore they are substitutes in some sectors while may have assimilated into Canadian job market and acquired skills complementary to those of Canadian-born workers. A further disaggregating data by industry or occupation may clear the picture. For example, Roy (1997) was not able to distinguish whether foreign-born and native-born were substitutes or complements in aggregate because of the corresponding statistically insignificant coefficient. However, when he disaggregated his study by area of origin, he found significant substitution between third world immigrants and native-born labor force.

Hence the hypothesis that there is no displacement of native-born workers by immigrants can be accepted for both the earlier and recent immigrant flows. However, it is important to note that recent immigrants have a positive significant influence on the wage earnings of native-born, while the older immigrants have an insignificant-positive effect on the earnings of native-born. Hence, pre- and the post 1979 immigrant has a

differential complementary effect with respect to native-born. To the extent that the insignificant coefficient value (upon which the elasticity is based on) for the earlier immigrants can be regarded as the long-run effect, and it can be argued from the regression estimates that there is a statistical difference in the long-run and short-run effects.

The regression indicates that recent immigrants substitute for the older immigrant workers as indicated by the negative and statistically significant corresponding coefficients. The corresponding elasticity is -.348. So, the recent immigrants and older immigrants might have been fighting for the same jobs in the Canadian labor market. Note that recent immigrants are complements and older immigrants are neither substitutes nor complements to the Canadian-born workers, while recent and older immigrants are substitutes of each other. So, it might seem that the result is contradictory, but neither of these categories are perfectly substitutes or perfectly complements to each other, so our results hold good.

All the own quantity factor price elasticity are negative as suggested by the theory, but are larger in absolute terms, ranging from -1.39 for the Canadian-born workers to -7.33 for the old immigrant workers, as compared to cross elasticities. They suggest that the relative increases in the supply of one type of labor can be absorbed only a large decline in its relative wage (if wages are free to adjust).

These findings do not contradict with Roy (1987), Akbari and DeVoretz(1992). Roy concludes, on the basis of his estimated interaction term on the wage equations, that all foreign-born workers are neither substitute for nor complements to the native-born workers. Akbari and Devoretz found no evidence to support the *economy-wide* displacement hypothesis. Our findings, however, are in contrast to the U.S findings (circa 1970) of Grossman (1983). Grossman concludes that both-second generation workers and foreign-born workers are significant substitutes for U.S.A-born workers. Laryea (1998b) finds that old-foreign born immigrant are complements to the Canadian-born workers and new-foreign born are neither substitutes nor complements to the Canadian born. He found a negative but statistically insignificant coefficient for the recent immigrants.

4.2.2 Substitutability / Complementarity by Industry

We now look for substitutability or complementarity by industry. This could reveal the substitutability/complementarity that might be concealed in the aggregate data as presented above. The two broad industrial groups are identified based on the Industry Canada classification. They are: goods producing and service producing industries[16]. If a group of foreign-born and Canadian-born is found to be substitutes in a group of industry, then it would imply that wages of Canadian-born labor are being depressed by that particular group of foreign-born workers. The two industry group combined with the three types of workers, that is, native-born, new and older immigrants, resulted in six equations which are given below:

$$W_{NG} = \alpha_{NGNG} + \alpha_{NGNS}(P_{NS}/P_{NG})^{1/2} + \alpha_{NGRG}(P_{RG}/P_{NG})^{1/2} + \alpha_{NGRS}(P_{RS}/P_{NG})^{1/2} + \alpha_{NGOG}(P_{OG}/P_{NG})^{1/2} + \alpha_{NGOS}(P_{OS}/P_{NG})^{11/2} + \sum_{i=1}^{N-1} x_i + \varepsilon_{NG} \quad \text{.....(4.1}a\text{)}$$

$$W_{NS} = \alpha_{NSNS} + \alpha_{NSNG}(P_{NG}/P_{NS})^{1/2} + \alpha_{NSRG}(P_{RG}/P_{NS})^{1/2} + \alpha_{NSRS}(P_{RS}/P_{NS})^{1/2} + \alpha_{NSOG}(P_{OG}/P_{NS})^{1/2} + \alpha_{NSOS}(P_{OS}/P_{NS})^{11/2} + \sum_{i=1}^{N-1} x_i + \varepsilon_{NS} \quad \text{.....(4.1}b\text{)}$$

$$W_{RG} = \alpha_{RGRG} + \alpha_{RGNS}(P_{NS}/P_{RG})^{1/2} + \alpha_{RGNG}(P_{NG}/P_{RG})^{1/2} + \alpha_{RGRS}(P_{RS}/P_{RG})^{1/2} + \alpha_{RGOG}(P_{OG}/P_{RG})^{1/2} + \alpha_{RGOS}(P_{OS}/P_{RG})^{11/2} + \sum_{i=1}^{N} x_i + \varepsilon_{RG} \quad \text{.....(4.1}c\text{)}$$

$$W_{RS} = \alpha_{RSRS} + \alpha_{RSNG}(P_{NG}/P_{RS})^{1/2} + \alpha_{RSRG}(P_{RG}/P_{RS})^{1/2} + \alpha_{RSNS}(P_{NS}/P_{RS})^{1/2} + \alpha_{RSOG}(P_{OG}/P_{RS})^{1/2} + \alpha_{RSOS}(P_{OS}/P_{RS})^{11/2} + \sum_{i=1}^{N} x_i + \varepsilon_{RS} \quad \text{.....(4.1}d\text{)}$$

$$W_{OG} = \alpha_{OGOG} + \alpha_{OGNS}(P_{NS}/P_{OG})^{1/2} + \alpha_{OGRG}(P_{RG}/P_{OG})^{1/2} + \alpha_{OGRS}(P_{RS}/P_{OG})^{1/2} + \alpha_{NGOS}(P_{NG}/P_{OG})^{1/2} + \alpha_{OGOS}(P_{OS}/P_{OG})^{11/2} + \sum_{i=1}^{N} x_i + \varepsilon_{OG} \quad \text{.....(4.1}e\text{)}$$

$$W_{OS} = \alpha_{OSOS} + \alpha_{OSNG}(P_{NG}/P_{OS})^{1/2} + \alpha_{OSRG}(P_{RG}/P_{OS})^{1/2} + \alpha_{OSRS}(P_{RS}/P_{OS})^{1/2} + \alpha_{OSOG}(P_{OG}/P_{OS})^{1/2} + \alpha_{OSOG}(P_{OG}/P_{OS})^{11/2} + \sum_{i=1}^{N} x_i + \varepsilon_{OS} \quad \text{.....(4.1}f\text{)}$$

The above six equations and has been estimated using the full information maximum likelihood method.Table-4.5 reports the coefficient estimates of the parameter of interests and the corresponding elasticity estimates. Nine out of fifteen coefficients on

[16] See Appendix-I, Table-A.3 for Industry Canada Classification

which elasticity is based on appear to be significant. The new immigrants employed in goods and service producing industries are substitutes for the Canadian-born employed in respective industries, but they are complements in the cross-industry. For example, new foreign-born employed in service producing industry are complements to the Canadian-born in goods producing industry and vice versa. But old foreign-born who are employed in goods sector are complements to native born in that sector while they are substitutes for the Canadian-born employed in service sector.

Table 4.5:*
Symmetry Constrained Wage Equations Disaggregated by Broad Industrial Classification
Dependent Variables: Annual Wage Earnings

Coefficient	Coefficient value	t-Stat for coeffcient	Elasticity of complementarity for the coefficient estimates
β_{ngrg}	-14772.47	-4.653	-1.261
β_{ngrs}	17078.17	6.754	1.321
β_{ngns}	19200.46	2.275	0.431
β_{ngog}	8121.31	2.401	0.427
β_{ngos}	5187.47	1.488	0.283
β_{nsrs}	-14709.57	-5.624	-1.335
β_{nsos}	-3068.82	-0.834	-0.174
β_{nsrg}	16212.10	5.073	1.159
β_{nsog}	-10341.45	-2.914	-0.557
β_{rgog}	-3388.44	-2.384	-0.535
β_{rgrs}	7353.63	4.896	1.812
β_{rgos}	1988.93	1.173	0.346
β_{rsog}	1041.69	0.860	0.187
β_{rsos}	-3832.97	-1.995	-0.740
β_{osog}	-2321.60	-0.899	-0.279
β_{ngng}	-54291.20	5.980	-1.807
β_{nsns}	-47486.59	-4.946	-1.718
β_{rgrg}	-21933.70	-7.107	-9.173
β_{rsrs}	-30304.31	-7.555	-13.823
β_{ogog}	-12041.26	-2.128	-4.695
β_{osos}	-36371.45	-4.838	-4.677

**N=native-born, R=Recent immigrants O=Older immigrants*
G=Goods producing industry S= Service producing industry
ng = Native-born employed in goods producing industry
rs = Recent immigrant employed in service producing industry, and so on.

The old foreign-born employed in good sector are substitutes for the Canadian-born employed in service sector, while those of old foreign-born employed in service sector are neither substitutes nor complements to native-born in goods sector. The Canadians employed in the production of goods are complements to their counterpart employed in delivering service. Recent and Old immigrants are competing each other in goods and service producing sector, those employed in goods producing sector are substitutes to their counterpart in that sector, while neither substitutes nor complements to other sector employed by their counterpart.

Let us now focus on the magnitude of the cross elasticities. The cross elasticity between Canadian in service industry and Old immigrant in service industry is -.174, which implies that a 10 percent increase in old immigrants would depress the Canadian-born wage by 1.7 percent. The elasticity of complementarity between Canadian-born in the goods sector and new immigrants in that sector is -1.26, indicates that there will be a decrease in Canadian wage in the goods sector by 12.6 percent for a corresponding increase of recent immigrants by 10 percent. Similarly, the cross elasticity between Canadian-born in the goods sector and recent immigrant employed in the service sector is 1.32, implying that for a 10 percent increase in recent immigrants in the goods sector, there will be a 13.2 percent increase in the wage of Canadian-born. The elasticity estimates of η_{ngrg} and η_{nsrg} are -1.26 and 1.16 respectively, that is, if there is a 10 percent increase in labor employed from the pool of recent immigrants, there will be a decrease in wage of Canadian born in the goods sector by 12.6 percent, but will increase the wage of Canadian born in the service sector by 11.6 percent. Moreover, Canadians are more employed in the service sector (61.6 percent of native-born Canadians are working in service sector as compared to 55 percent of the foreign-born), so the relative benefits will go in favor of the Canadian born workforce by admitting immigrants. The own wage elasticities are all negative as suggested by theory. Immigrants have a sizeable impact on the determination of their own wage. For example, a 1 percent increase in recent immigrant reduces the wages of immigrants employed in that sector by 9.17 percent, where as a 1 percent increase of old immigrants in the service sector reduces the wage of the old immigrants by 4.68 percent in the service industry.

4.3 Aggregate Unemployment Immigration Dynamics

4.3.1 Estimation of Statistical Causality

The specific estimating form of the causality equations and measurement variables deserves some mention prior to reporting the results. We use immigration (number of immigrants) and the unemployment rate to measure the causality[17]. The examination of data does not indicate any substantial seasonality, and we have not made any effort, at this stage, to control for the seasonality. We have used the seasonally unadjusted quarterly data for the period 1961:1-2002:1 as prior seasonal adjustment of data would be quite inappropriate because pre-adjustment use moving average techniques that would remove part of the lag sensitivity that is of direct concern in causality analysis. In distributed lag model, we need actual data to avoid bias (Sims 1974).

Table 4.6:
Tests for Statistical Causality between Immigration and Unemployment

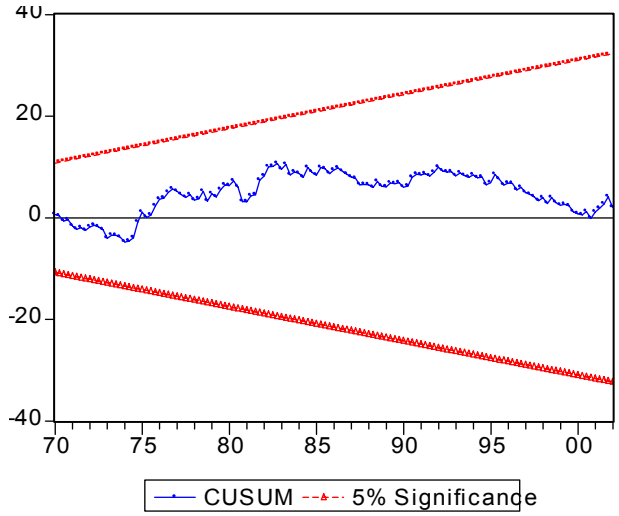
Dependent Variable	Causal Variable	Causal Lag	Test Statistics			Significant Individual Causal Lags
			F statistic	Likelihood ratio	Wald	
UN	IMMI	2	3.94**	7.89*	7.89*	1,2
UN	IMMI	4	2.64**	10.74**	10.55**	1,2,3,4
UN	IMMI	6	1.98*	12.35**	11.87*	1,4,5
UN	IMMI	8	1.76	14.98*	14.11*	1,4,5,8
UN	IMMI	10	1.20	13.23	12.03	1,4,5,8,9
UN	IMMI	12	0.90	12.30	10.80	1,4,5,8
IMMI	UN	2	0.36	0.731	0.71	No
IMMI	UN	4	3.47***	13.97***	13.86***	4
IMMI	UN	6	2.16**	13.39**	12.92**	4
IMMI	UN	8	1.41	12.04	11.24	4
IMMI	UN	10	1.29	14.15	12.90	4
IMMI	UN	12	1.52	20.28	18.28	4,12

Notes: UN= Unemployment rate
IMMI= Immigration (Number of people immigrated into Canada)
* significant at the 10 percent level,**significant at the 5 percent level,*** significant at the 1 percent level

[17] Another way of detecting the causality between immigration and unemployment is to use the immigration rate (the number of immigrants coming into Canada as a percentage of total population), and the change in the unemployment rate.

Table-4.6 outlines the results of the Granger causality test. We select the lag length *p* using the multivariate generalizations of the AIC. First, a twelve-quarter lag dependent variable is adopted following AIC. We use F-test, Wald (W), and Likelihood Ratio (LR) tests for testing the null hypothesis that the causal lags are jointly zero. The W and LR statistics are tested as χ^2 statistics. From Table-4.6, the test statistics indicate that there is no causality from migration to unemployment or vice versa[18]. The F statistic from the regression results with other lag specifications suggest that the direction of causality is from unemployment to immigration at lags 4 and 6 and there is a reverse causation from immigration to unemployment at lags 2 and 4. This result is also supported by the Wald test and Likelihood Ratio test. This indicates that the outcome of the Granger test in sensitive to the number of lags introduced in the model. There is no significant relationship to be found for immigration causing unemployment, but causality from unemployment to migration can not be rejected for some lags. This result also confirms the Withers and Pope (1985) results for the Australian data.

Figure 4.1: Test for Structural Break in Data



We next address the matter of stability. To examine for changes in the relationship being considered the standard statistical tests for stability were considered. These are the CUSUM statistics of model stability proposed by Brown, Durbin, and Evans (1975) based on recursive residuals. This technique is more appropriate for our data as we are uncertain about the structural change that might have taken place due to changes in immigration policy in different time periods and the different war and oil price shock e.g., Vietnam War(1964-73), Oil price shock(1973-74, 1978-79) etc. The

[18] The 95 percent critical value from the χ^2 distribution with 12 degree of freedom is 21.03; the computed F value is also less than critical value at the 5 percent level of significance.

stability tests produced no evidence of instability at the conventional level of significance (see Figure-5.1)

4.3.2 Cointegration Analysis

4.3.2(a)The E-G Methodology

Cointegration analysis confronts spurious regression, attempting to identify conditions for which relationships are not spurious (Engle and Granger 1987). If time series variables are cointegrated, then their secular (permanent) trends according to an equilibrium constraint and the cyclical (transitory) components of the series fit into the dynamic specification in the class of error correction models (Miller 1991). Engle and Granger showed that it is quite possible for a linear combination of integrated variables to be stationary. In this case the variables are said to be cointegrated. Consider a set of variables in long-run equilibrium (static equilibrium) when: $\beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_n x_{nt} = 0$. The equilibrium error is then $e_t = \beta' x_t$. If the equilibrium is meaningful it must be the case that the error is stationary. e_t measures the short-term deviations from the long-run (equilibrium) relationship.

Table 4.7:

Test for Unit Root

Variable	ADF Test statistic with		
	Intercept but no trend	trend and Intercept	Lag
Log(Y)	-2.15	-2.50	5
Log(W)	-1.76	-2.52	5
Log(M)	-3.19	-3.52	5
log(U)	-2.40	-2.42	7

Initially, stationarity of the data has been checked by using Augmented Dickey-Fuller (ADF) tests (Dickey and Fuller 1979). Table-4.7 summarizes the ADF test statistic for the specific lag length. The order of the lag of unit root test has been chosen by the AIC i.e. we choose the minimum AIC value for the unit root test. The test statistics indicate that all the variables except the log of immigration have unit root with intercept and/or trend component in the ADF test. The F statistic, however, does not support the

inclusion of the trend or intercept in the log of immigration in the unit root test, so we can not reject the hypothesis of unit root in log (M)[19].

Now assume that all the four variables are jointly determined, so the long-run equilibrium relationship can be determined using either of the four as the "left-hand-side" variable. The four estimates of long-run relationship (with t-values in parenthesis) are given below:

(4.2a) $\log(Y) = -27.48 + 0.21\log(M) - 0.02\log(U) + 4.22\log(W)$ $R^2=.94$ F=334.32
(-26.53) (8.05) (-0.564) (33.67)

(4.2b) $\log(M) = 35.2 + 1.41\log(Y) - 0.41\log(U) - 4.6\log(W)$ $R^2=.61$ F=31.66
(6.21) (8.05) (-4.30) (-5.35)

(4.2c) $\text{Log}(U) = -1.28 - 0.257\log(M) + 0.785\log(W) - 0.093\log(Y)$ $R^2=.38$ F=12.23
(-0.257) (-4.30) (1.06) (-0.56)

(4.2d) $\log(W) = 6.69 - 0.033\log(M) + 0.208\log(Y) + 0.009\log(U)$ $R^2=.91$ F=214.59
(90.08) (-5.35) (33.67) (1.06)

Next we determine whether the residuals from the equilibrium regression are stationary. However, there is no presumption that any one of the four residual series is preferable to any of the others. So, the residuals from each regression were checked for unit root. The unit root tests here are straightforward since the residuals from a regression equation have a zero mean and do not have a time trend.

Table 4.8:
Test for Cointegration[20]

Error term of the 'left-hand' variable	**Test Statistic**		
	ADF	PP test	Lags*
GDP	-2.37	-4.29	8
Immigration	-4.71	-4.71	0
Unemployment	-2.36	-2.36	0
Real wage	-2.08	-3.91	8

*Lag length is determined by AIC.

Table-4.8 reports the estimated values of γ from ADF and Phillips-Perron (PP) test. Using any one of the four equilibrium error, we can conclude that all the residual

[19] The ADF test with trend and intercept is: $\Delta x_t = \mu + \beta t + \gamma x_{t-1} + \sum_{j=1}^{k} \delta \Delta x_{t-j} + \varepsilon_t$, where x is a vector of variables consisting of the model. The null hypothesis H_0: γ=0 against the alternative H_1: γ<0.

[20] Since the estimated residual is based on the estimated parameters, the Augmented Dickey-Fuller (ADF) test critical significance values are not quite appropriate. Engle and Granger (1987) have calculated these values and unit root test in this context is known as Augmented Engle Granger (AEG) test

series are *I(0)* as the computed τ value exceed the critical τ value at the chosen level of significance. Hence equation (4.2) is a cointegrating regression and these regressions are not spurious, even though individually all the variables are non-stationary. As an alternative of finding out whether U, M, Y, W are cointegrated, we choose the Cointegrating Regression Durbin -Watson (CRDW) test. In CRDW we use the Durbin-Watson *d* obtained from the cointegrating regression and tests the null hypothesis *d=0* rather than standard $d=2$[21]. Again, we do not reject the null hypothesis of cointegration as all the computed *d* values are greater than the critical *d* value at the conventional level of significance.

4.3.2(b) The Johansen Methodology

In the next step we consider whether there exists a cointegrating vector between the unemployment rate (U), immigration (M), real GDP(Y) and real wage (W). We use Johansen test of cointegration to determine the cointegrating vector[22]. The results of the Johansen test can be quite sensitive to the leg length, and so we use the most common procedure of estimating a vector auto regression using the *undifferenced* data (see Enders 1995). Then use the same lag length tests as in a traditional VAR. The lag length test AIC does not give clear indication of the length of lag, so we use another test statistic Likelihood ratio statistic (LR) for testing the order of the VAR. The null hypothesis here is that the order of the VAR is $P_0<P_1$, so the null hypothesis is nested within the alternative hypothesis and thus can be tested by a likelihood ratio test which is distributed as χ^2 (q) where $q=k^2(p_1-p_0)$, k is the number of variable in the model. The LR test indicates there are six lags in the VAR specification of our model (see appendix II).

To test for the presence of an intercept in the cointegrating vector as opposed to the absence of intercept, we first estimate the two forms of the model (see Enders 1995). Let us denote the ordered characteristic roots of the unrestricted π matrix by $\hat{\lambda}_1, \hat{\lambda}_2, \hat{\lambda}_3, \ldots\ldots\ldots \hat{\lambda}_n$ and the characteristic roots of the model with the intercept(s) in

[21] This is because $d \approx 2(1-\hat{\rho})$ where $\hat{\rho}$ is the estimated first order coefficient of correlation, so if there is to be a unit root the estimated ρ will be about 1, which implies that *d* will be about zero.

[22] We have used two exogenous variables, one for war and oil price shock (OW) and the other is 'policy dummy (PD)' to reflect the immigration policy changes in different time periods. We also used three quarter dummy variable to check the seasonality.

the cointegrating vector(s) by $\hat{\lambda}_1 *, \hat{\lambda}_2 *, \hat{\lambda}_3 *, \ldots\ldots \hat{\lambda}_n *$. Suppose the unrestricted form of the model has non-zero characteristic roots. Asymptotically, the statistic:

$$-T\sum_{i=r+1}^{n}[\ln(1-\lambda_i^*)-\ln(1-\lambda_i)] \tag{4.3}$$

has a χ^2 distribution with (n-r) degrees of freedom.

If the constraint is not binding then all the values of $\ln(1-\lambda_i^*)$ and $\ln(1-\lambda_i)$ should be equivalent. Hence small values of the test statistic imply that it is permissible to include the intercept in the cointegrating vector. For testing the presence of time trend in the data as opposed to the absence of time trend, we repeat the same procedure.

We now look for different possible options for the Johansen cointegration test as shown in Table-4.9[23].We first test the restriction that our model does not have a drift. We found two cointegrating vector among lnU, lnM, lnY, and lnW, so set *n=4* and *r=2*. The calculated value of χ^2 statistic is 18.2. With two degree of freedom; this is significant at the conventional level of significance and concludes that it is not appropriate to include the constant in the cointegrating vector. We now test whether there is any linear trend in the data and we found no evidence of linear trend based on the χ^2 statistic. The test also rejects the hypothesis of quadratic linear trend in the data.

Table 4.9:
Johansen Cointegration Test

Cointegration Equation (CE) and VAR specification	**Information**	$-T\ln(1-\hat{\lambda}_i)$
Test assumes no deterministic trend in data	The test VAR is estimated	
No Intercept or trend in CE or test VAR	in differenced form	50.02
Intercept (no trend) in CE- no intercept in VAR		68.23
Test allows for linear deterministic trend in data	CE and data trend assumptions	
Intercept (no trend) in CE and test VAR	apply to levels	58.84
Intercept and trend in CE- no trend in VAR		75.86
Test allows for quadratic deterministic trend in data		75.07

Let us now look at the long-run properties of the VAR model[24]. Table-4.10 reports the cointegration analysis for the VAR model with 6 lags as suggested by the lag

[23] Note that there are different tables of critical values, and the tables differ according to various possible specifications of the VAR with respect to inclusion of intercepts and time trends in both the VAR equations and cointegrating equations.
[24] Since we have quarterly data, we include three dummies

length test. The Table includes Johansen's trace statistic that is used to determine the cointegration rank, which involves finding the number of linearly independent columns of π. The four characteristic roots of the estimated π matrix are given in the second column below. The third column reports the various λ_{max} statistics as the number of usable observations. For example, -158 ln(1-0.1551)= 26.33. The last column reports the λ_{trace} statistics as the summation of the λ_{max} statistics.

First, to test the null hypothesis *r=0* against the general alternative *r =1, 2, 3* or *4*, we use the λ_{trace} statistic. Since the null hypothesis is *r=0* and there are four variables, the calculated value of is 62.91. For *n-r = 4*, the critical values of λ_{trace} statistics are 45.248, 48.419 and 55.551 at the 90, 95 and 99% levels, respectively. Since 62.91 exceed the critical value of the λ_{trace} statistic at any level of significance, we reject the null hypothesis of no cointegrating vectors and accept the alternative of one or more cointegrating vectors. Next, we use the $\lambda_{trace(1)}$ statistic to test the null of r ≤1 against the alternative of two or more cointegrating vectors. In this case, the statistic is 32.02. Since 32.02 is less than the 99% critical value of 37.291, we can not reject the null hypothesis at this significance level. However, 32.02 does exceed the 95% critical value of 31.256; so we can still reject the null hypothesis and accept the alternative hypothesis of two or three cointegrating vectors. The $\lambda_{trace(2)}$ statistic indicates no more than two cointegrating vectors at the 90% level of significance.

Table 4.10:
Cointegration Test for the System

H_0: rank=r	$\hat{\lambda}_i$	$\lambda_{\max} = -T\ln(1-\hat{\lambda}_{r+1})$	$\lambda_{trace} = -T\sum\ln(1-\hat{\lambda}_i)$
r=0	0.1776	30.89	62.91
r≤1	0.1551	26.63	32.02
r≤2	0.0294	4.71	5.39
r≤3	0.0043	0.68	0.68

In contrast to the λ_{trace} statistic, λ_{max} statistic has a specific alternative hypothesis. The calculated value of λ_{max} (0,1) statistic is 30.89 which exceeds the 95 and 97.5% critical values of 27.341, 29.599, but does not exceed the 99% critical value of 32.616. So, we can reject the null and accept that we have one or more cointegrating regression. We also reject the null hypothesis of r=1 against the specific alternative of r=2 at any

level of significance, but we do not have a significant evidence of more than two cointegrating vectors.

So, both tests, the trace test and the maximum eigenvalue test, predict there is only two cointegration vectors, and is given by the first two rows of the standardized β′ matrix. Rewritten in the form of the long-run equilibrium relationship:

The first cointegrating equation is (t-statistic is in parenthesis):

((4.4) $\log(U_{t-p}) = \underset{(-0.278)}{-0.059}\log(M_{t-p}) \underset{(-2.42)}{-0.789}\log(Y_{t-p}) + \underset{(3.57)}{1.55}\log(W_{t-p})$

The second cointegrating equation is:

(4.5) $\log(U_{t-p}) = -0.693\log(M_{t-p}) -0.132\log(Y_{t-p}) + 1.21\log(W_{t-p})$

We therefore conclude that unemployment, immigration, wage, and GDP are cointegrated. In both relationships, there is a negative relationship between unemployment and the flows of immigrants in the long run. Hence, in the long-run there is a net job creation by immigrants. However, the coefficient is statistically insignificant, so we can not draw any conclusion based on the corresponding long-run parameter estimates. So, in the long-run, there is not detectable relationship between immigration and unemployment

4.3.3 Error-Correction Models

It is possible that in the long run the variables U, M W, and Y are in equilibrium, but there may be disequilibria in the short-run. The final stage in the model building process, therefore, requires the construction of an error correction models. This involves regressing the first difference of each variable in the cointegrating equation onto lagged values of the first differences of all the variables plus the lagged values of the error-correction term[25] (that is, the error term from the cointegrating regression).

[25] We use the same lag length as that of Cointegration test

Table 4.11:
Temporal Causal Test from Error Correction Models

	Coefficients of					
Equation	EC(-1M)	EC(-1U)	Σdln(M)	ΣdlnU	Σdln(Y)	Σdln(W)
dlnM	-0.192	0.083	0.606**	-0.271	-1.047	5.518
	(0.046)	(0.064)	(33.35)	(6.91)	(10.48)	(4.71)
dlnU	-0.001	-0.042	0.009	0.551**	-0.077	-4.341*
	(-0.07)	(-1.96)	(9.45)	(43.82)	(4.14)	(12.59)
dlnY	0.001	-0.008	0.009	0.020*	0.004**	0.875
	(0.28)	(-1.06)	(6.40)	(11.83)	(141.72)	(7.37)
dlnW	0.000	-0.002	-0.027*	0.063*	0.173	0.386*
	(0.01)	(-0.55)	(12.56)	(13.95)	(9.60)	(14.51)

Note: EC is an error correction term with M and U indicate the error term from the cointegrating regression with the left-hand variables. The numbers in parenthesis are chi-squared [J] statistics (where J is the number of restrictions), except the first two columns of the coefficient, which are t-statistics for the error correction term.
**, *, indicate significant at the 1, 5, percent level respectively.

We consider for each of the error correction models using all lags from one to six. These results are reported in Table-4.11 where the sum of the coefficients is reported in the first line. The number in parenthesis under the sum of the coefficients is a chi-square statistic testing whether the sum of the coefficients is significantly different from zero. From table we can conclude that there is no short-run relationship between unemployment and immigration.

The error-correction technique allows the consideration of issues of temporal causality (Miller 1991). Granger causality involves the vector autoregression; the error-correction technique allows for an additional channel through which temporal causality can be uncovered. For example, the standard test for temporal causality between x and y examines the significance of the sum of the coefficients on lagged changes in y(x) in the change in x(y) regression, where lagged changes in x(y) are also included (see Granger 1986;Engle and Granger 1987 for specific example). Table-4.11 provides no temporal causality between immigration and unemployment and vice versa, but there is strong evidence that there are two-way temporal linkage between unemployment and real wage. Table-4.11 also suggests that all of the variables are econometrically endogenous; every variable provides explanatory power over and above the other variable. So, all of the regression equation possess feedback effects between ln(M), ln(U), ln(Y) and ln(W)

CHAPTER-5

Conclusion and Future Research

The objectives of the thesis were to determine the job displacement effects of immigrants on Canadian-born and to delineate the long-run and short-run dynamics of unemployment and immigration. The question of job displacement has been analyzed in the context of Generalized Leontief production function and those estimates were used to calculate the Hicksian elasticity of complementarity between Canadian-born and two groups of immigrants, recent immigrant and older immigrant. Then I disaggregate the data by goods and service producing industry for recent, older and Canadian-born workers and estimate the elasticity of complementarity among the six groups of workers.

Immigrants help create jobs through their demand for goods and services; they also make up the skill shortage in the Canadian labor market. The other concern is that immigrants take away jobs from Canadian-born and immigration during recessions merely adds to unemployment. So, whether a given immigration flows creates an unemployment problem or resolves the problem depend upon relative strength of supply and demand sides of immigration and the resulting adjustment in strategy to this impact. So, the net outcome is uncertain. In a macro context, I therefore endeavor to determine the causal linkage between immigration in Canada and the aggregate unemployment rate in the post 1960s period. Because of the perceive weakness of the Granger causality test, I felt to necessary to develop a VAR model and its error correction representation to determine short-run and long-run dynamics in a more general labor market framework.

The thesis finds that 'economy-wide' there is no job displacement of Canadian-born by the inflow of immigrants into Canada. Recent immigrants are complements to the Canadian-born while their older counterparts are neither substitutes nor complements to Canadian-born workers. The findings that immigrants and Canadian-born are not substitutes but rather complements should prove useful to researchers trying to measure the extent of wage discrimination in the labor market. It is usually assumed that immigrants and Canadians are (perfect) substitutes. My results indicate that the measures of wage discrimination based on the assumption of perfect substitution may be seriously biased since immigrant and native-born Canadian are not, on average, substitutable

inputs. It is important to emphasize the substantive implications of these results. The estimation of the derived demand functions implied by the generalized Leontief technology leads to the finding that Canadian-born labor is not hurt by the inflow of immigrants. In fact, there is evidence that the complementarities in production between native worker and older immigrants have been helped by the presence of recent immigrants.

However, when I disaggregate data by industry I found some evidence of job displacement mostly where immigrants and Canadian-born are working in the same industry. But they appear to be complements of each other by cross industry. So, although there is job displacement among the same class of workers within the industry, across industry they appear to be complements to each other and, on average, the job displacement effect is offset by the positive job creation effect due to inflow of immigrants.

All the socio-economic and demographic variables appear to have the expected sign of their parameters. Controlling for other impact on earnings, the value for $(\partial \ln E/\partial YSM)$ after one year of immigration shows 2.74% disadvantage for the recent immigrants. The return to education for an extra year of schooling is 4.7% for the older immigrants and 4.2% for the recent immigrant. This return is comparatively high for the Canadian-born (6.9%). Similarly, the return to experience for immigrants for an extra year of labor market experience is significantly lower than the native-born (1.98% and 1.88% for older and recent immigrants respectively versus 3.4% of native-born). Persons living in urban/city area and/or have English language proficiency have higher earnings than those living in rural area and/or do not have English speaking ability. All the sample results and estimation dictate that male have higher earnings than females.

Several comments should be made concerning the elasticity estimates. First, it is difficult to make the appropriate measures of variance to attach to the elasticity estimates. Parameter estimates should replace the γ's when computing estimates of η_{ij}, $\eta_{ii.}$ This implies that in general the estimated elasticities will vary across observations. The fact that these elasticities are highly non-linear function of the estimated γ's has made it difficult to obtain estimates of the variances of the estimated elasticities. Moreover,

since distribution properties of such estimates have not yet been derived, the basis for statistical inference on them does not yet exist. Second, the Generalized Leontief production function should be checked to ensure that it is monotonically increasing and strictly quasiconcave in input prices, as required by theory. For monotonocity, it is required that the fitted shares all are positive, and for strict qusaiconcavity the n×n matrix of substitution elasticities must be negative semi definite at each observation (see Berndt 1991).

The thesis assumed that relative supplies of natives and immigrants are perfectly inelastic with respect to the real wage. This assumption helped to simplify the presentation of the model and estimation of the production function parameters. In the long run, it is likely that immigrants will migrate to a destination where higher wages are assured. The same can be true for native workers. So, one can incorporate the role of indigenous migration decision into the model. In this thesis, I have assumed that relative employment rates given by $\left(P_i/P_j\right)^{1/2}(i \neq j)$ in equation (4.6) were exogenous. But over time migration patterns might respond to regional wage differentials creating some correlation between the employment variable and the disturbance ε_t in (4.6). A simple solution to this econometric problem is to obtain instruments for these variables, and then reestimate the wage determination system (see Borjas 1983).

Furthermore, to study the effect of immigrants on the Canadian labor force, one can consider an alternative production function- the translog approximation to a production surface (see Berndt & Christensen 1973) where we estimate the production function using output shares, implicitly assuming that the production function is characterized by constant returns to scale, and firms are price takers in the output market[26]. This alternative specification can help us to identify more about the substitutability or complementarity between Canadian-born and immigrants. The estimates obtained from the two production function can be used to draw more accurate conclusion if we have the same data set. Unfortunately because of the unavailability of data at hand, and time constraint, despite my interests to look into this aspect, I was not able to measure the extent of substitutability or complementarity using the translog

[26] Again the production function can be used instead of cost function because factor quantities are viewed as exogenous instead of factor prices.

specification of the production function. For translog model estimation, we need share as opposed to wage earnings of the Leontief production function. So, we need industry output, and the three kinds of labor employed in those particular industries.

One can also examine the effect of a percentage increase in the number of immigrants using the three-factor production function involving Canadian-born, recent immigrants and older immigrants[27]. When an economy experiences a new flow of workers, the adjustment may involve various combinations of employment and price changes. Whether employment displacement occur, or whether the effect has been to reduce the relative wage rates of Canadians, depends on whether in fact relative wage rates of Canadians are rigid. Therefore we can measure the impact of the increase in immigrants under two extreme assumptions of completely flexible and completely rigid wages in the Canadian born labor market. These extreme assumptions will help us to set bounds on the likely outcomes.

The concern occasionally expressed by policy makers and popular press about the impact of immigration on the aggregate unemployment rate have been studied. The concern that immigration is contributing to aggregate unemployment is not supported. The statistical causality analysis was unable to find any association from migration to unemployment, though there was evidence of significant effect unemployment on subsequent migration. I did not find any statistically significant long-run or the short-run relationship between unemployment and immigration. Both the long and short-term coefficient estimates suggest that there is no adverse effect on unemployment, rather there may be a net job creation effect in the short and long run due to immigration. These results are very much consistent with the micro data analysis where it has been found that recent immigrants are complements while the older immigrants are neither substitutes nor complements to the Canadian-born. The insignificant coefficient value for the earlier immigrants can be regarded as the long-run effect, while the statistically significant coefficient value for the recent immigrant can stand-in as the short-run effects of immigration.

[27] See Appendix-III for a discussion on this aspect and how to measure it.

The degree of association between unemployment rate and immigration might be sensitive to the chosen sample, and thereby we need to select with care period of study. As an extension of this study, one can decompose the period of immigration into two different time periods, before 1978 and after 1978, and can see whether the current or past unemployment rate have any relation with immigration and vice versa.

Appendix-I

Table A.1: Percentage of Immigrants in Canada by Origin and Period of Arrival

Region	Before 1961	1961-70	1971-80	1981-90	1991-96
Europe	90.40%	69%	35.80%	25.70%	19%
U.S	4.30%	6.40%	7.40%	4.20%	2.80%
Asia	3.10%	12.30%	33%	46.90%	57%
Latin Am. & Caribbean	1.40%	7.90%	16.40%	16.40%	12.90%
Africa & Oceana	0.90%	4.40%	7.40%	6.80%	8.30%

Source: Statistics Canada, 1996

Table A.2: Summary Statistics by Industry and Occupation

Industries:	**Immigration Status**		
	Recent	**Older**	**Native-born**
Agriculture	2.23	1.87	3.43
Primary Industries	0.59	1.16	2.3
Manufacturing	22.75	17.6	13.85
Construction	3.70	6.67	6.02
Transportation	3.19	4.4	4.65
Communication	1.79	2.73	3.76
Wholesale	6.22	4.8	5.14
Retail	10.61	9.81	10.38
Finance Ins. & Real Est.	6.00	6.76	6.19
Business Services	8.68	7.46	6.95
Govt Service (Fed.)	0.83	2.35	2.98
Govt Service (Other)	1.53	2.87	4.25
Educational Services	4.33	7.71	8.19
Health & Social Services	8.46	10.44	10.99
Accommod, Food & Bev.	9.95	5.83	4.44
Other	9.14	7.53	6.49
All Industries	**100**	**100**	**100**
Occupations:			
Senior managers	0.99	1.44	1.1
Middle & Other managers	7.47	10.35	8.82
Professionals	13.8	16.96	16.38
Semi-Prof. & Technician	5.04	5.42	5.85
Suprv, Cleric & SalesSer	0.84	1.38	1.41
SuprCraftsTrades	2.15	3.5	4.1
Administrative Senior Clerical	3.83	5.95	6.5
Skilled Sales Service	5.04	4.98	4.5
Skilled CraftsTrades	6.47	8.48	7.79
Clerical Personnel	10.12	10.34	11.77
Intermdiate Sals Service	12.49	9.98	10.86
Semi-Skilld & ManualWork	15.98	10.84	10.98
Other Sales Service	10.57	7.62	6.83
Other Manual lWorkers	5.2	2.75	3.12
All Occupations	**100**	**100**	**100**
Number of Observations	6651	7663	49707

Source: Computed from PUMF 20 percent sample

Table A.3: Industry Classification

Service-Producing	Goods-Producing
Wholesale Trade	Agriculture, Forestry, Fishing and Hunting
Retail Trade	Mining and Oil and Gas Extraction
Transportation and Warehousing Services	Utilities
Information and Cultural Industries	Construction
Finance and Insurance	Manufacturing
Real Estate and Rental and Leasing	
Professional, Scientific and Technical Services	
Management of Companies and Enterprises	
Administrative Support Services	
Educational Services	
Health Care and Social Assistance	
Arts, Entertainment and Recreation	
Accommodation and Food Services	
Other Services	
Public Administration	

Source: Information from Industry Canada, 1999

Table A5: Skilled Worker Selection Grid[28]

FACTOR	Points
Education	25
Language	24
Experience	21
Age	10
Arranged employment	10
Adaptability	10
Total	**100**

[28] For more and latest information about new law and point system for skilled category immigrants, visit www.cic.gc.ca

FACTOR		Marks
EDUCATION		**Maximum 25**
University Degrees		
PhD, or Master's, AND at least 17 years of full-time or full-time equivalent study		25
Two or more university degrees at the Bachelor's level AND at least 15 years of full-time or full-time equivalent study		22
A two-year university degree at the Bachelor's level AND at least 14 years of full-time or full-time equivalent study		20
A one-year university degree at the Bachelor's level AND at least 13 years of full-time or full-time equivalent study		15
Trade or Non-university Certificate or Diploma		
A three-year diploma, trade certificate or apprenticeship AND at least 15 years of full-time or full-time equivalent study		22
A two-year diploma, trade certificate or apprenticeship AND at least 14 years of full-time or full-time equivalent study		20
A one-year diploma, trade certificate or apprenticeship AND at least 13 years of full-time or full-time equivalent study		15
A one-year diploma, trade certificate or apprenticeship AND at least 12 years of full-time or full-time equivalent study		12
Secondary School Educational Credential		5
LANGUAGE		**Maximum 24**
1st Lang.	High proficiency (per ability[1])	4
	Moderate proficiency (per ability)	2
	Basic proficiency (per ability)	1 to max. of 2
	Possible maximum (all four abilities)	16
2nd Lang.	High proficiency (per ability)	2
	Moderate proficiency (per ability)	2
	Basic proficiency (per ability)	1 to max. of 2
	Possible maximum (all four abilities)	8

EXPERIENCE	**Maximum 21**
One year	15
Two years	17
Three years	19
Four years	21
AGE	**Maximum 10**
Maximum 10 points for:	21-49
Less two points for each year:	over 49 or under 21
ARRANGED EMPLOYMENT IN CANADA	**Maximum 10**
HRDC-confirmed permanent offer of employment	10
• Validated by HRDC, including sectoral confirmations	10
• Exempt from HRDC validation under international agreements (e.g., NAFTA) or significant benefit (i.e., intra-company transferee)	10
ADAPTABILITY	**Maximum 10**
Spouse's or common-law partner's education	3-5
Minimum one year of full-time authorized work in Canada[2]	5
Minimum two years of full-time authorized post-secondary study in Canada[2]	5
Points received under the Arranged Employment factor	5
Family relationship in Canada[2]	5
TOTAL	**Maximum 100**

Appendix-II

Table-A6:
Lag length tests for Cointegration:
AIC and log likelihood value from unrestricted VAR

	AIC		log likelihood	
lag	Intercept	No Intercept	Intercept	No Intercept
0	-3.8	6.9	323.4	-562.8
1	-12.8	-12.7	1081.1	1063.5
2	-14.4	-14.4	1220.6	1212.3
3	-16.1	-16.0	1360.2	1352.8
4	-16.9	-16.8	1436.3	1426.0
5	-17.6	-17.6	1499.9	1492.3
6	-17.6	-17.5	1506.1	1498.2
7	-17.5	-17.4	1503.3	1494.2
8	-17.4	-17.3	1507.6	1497.6
9	-17.5	-17.4	1517.8	1505.9
10	-17.4	-17.3	1520.8	1509.8
11	-17.4	-17.3	1530.6	1516.2
12	-17.4	-17.2	1533.2	1517.3

Appendix-III[29]

Assume identical firms have constant returns to scale in production. As usual let w_i be the price of factor i, (i= N, R, O), and assume that w_i are flexible except that of Canadian born, whose wage is fixed at w_N^*. Firms determine their factor inputs from the usual marginal productivity conditions[30]:

(1) $W^*_N = h_N(N, R^*, O^*)$ (i = R,O)

(2) $W_i = h_i(N, R^*, O^*)$

where R* and O* are the employment of recent and older immigrants, which are exogenous to the economy under the assumption of inelastic labor supply. Differentiating (1) and (2) we have-

$$h_{NN}\,\partial N - h_{NR}\,\partial R^* - h_{NO}\,\partial O^* = 0$$

$$\partial W_i - h_{iN}\,\partial N - h_{iR}\,\partial R^* - h_{iO}\,\partial O^* = 0 \qquad (i = R, O)$$

So, if all wages are flexible except the native wage, solving the above system yields-

(3) $\partial N/\partial R^* = h_{NR}/h_{NN}$, $\partial N/\partial O^* = h_{NO}/h_{NN}$

(4) $\partial W_i/\partial R^* = (-h_{iN}h_{NR} + h_{iR}h_{NN})/h_{NN}$ (i = R, O)

By multiplying (3) by R/N and O/N for expression dN/dR* and dN/dO* respectively; (4) by R*/ W_i; and using the property of constant returns to scale production function that $h_{ij} = w_i w_j \eta_{ij}$ and $X_i = QS_i/W_i$ (here X_i is employment of the *ith* factor(X_i = N, R,O), S_i is the output share of factor i), we have-

$$(5.a) \qquad \frac{\partial \ln N}{\partial \ln R^*} = \frac{-S_R \eta_{N,R}}{S_N \eta_{N,N}}$$

$$(5.b) \qquad \frac{\partial \ln N}{\partial \ln O^*} = \frac{S_O \eta_{N,O}}{S_N \eta_{N,N}}$$

Similarly multiplying both sides of (4) by R*/W_i and making the same substitution for h_{ij} and X_i, we get -

[29] This discussion is modeled after that in Johnson (1980), Grant & Hamermesh (1981) and Grossman (1982).

[30] Though I wish to simulate the employment effects, the estimates are based on man-hours of inputs. Assuming, as in the standard literature, that the exogenous change produces no long run change in the relative prices of persons and hours, the estimates are appropriate for simulating the long-run effect of the influx of immigrants.

(6.*a*) $$\frac{\partial \ln W_i}{\partial R^*} = \frac{S_R(-\eta_{i,N}\eta_{N,R} + \eta_{i,R}\eta_{N,N})}{\eta_{N,N}}$$

(6.*b*) $$\frac{\partial \ln W_i}{\partial O^*} = \frac{S_o(-\eta_{i,N}\eta_{N,O} + \eta_{i,O}\eta_{N,N})}{\eta_{N,N}}$$

When native wage rates are inflexible, not only is a factor complementarity with immigrants are important, but also with natives The first term in (5.a) reflects the effects of the firm switching away from natives, whose ages were downward inflexible *toward* factor *i*. The second term reflects the substitution *away* towards immigrants.

Equation (5) and (6) allow us to use estimates of elasticities calculated via Translog and Leontief production functions to calculate the effect of an increase in immigrant employment on employments of Canadian workers, and the wage rate of workers among two types of immigrants. Equation (5) states simply that the effect on the employment on the Canadian worker is larger and more negative, the greater is the extent of q-substitutability of Canadian and immigrants, the larger is the share of immigrant in output, and the smaller is the share of Canadians. Equation (6) states that the effect on other factor prices depends both on their partial elasticities of complementarity with immigrants and degree to which they are q- complements or substitutes with immigrants. If all wages are flexible, the calculation reduces to the following:

(7.*a*) $$\frac{\partial \ln W_i}{\partial \ln R} = S_R\eta_{i,R} = \sigma_{i.R}$$ (i = R, O)

(7.*b*) $$\frac{\partial \ln W_i}{\partial \ln O} = S_O\eta_{i,O} = \sigma_{i.O}$$

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