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**CAPITAL FORMATION AND REGIONAL
DISPARITIES IN CANADA SINCE THE 1960s**

By

Hassan Bougrine

A Thesis submitted in conformity with the requirements for
the degree of Doctor of Philosophy at the
University of Ottawa

(Joint Doctoral Program in Economics,
University of Ottawa and Carleton University)

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To my mother, Rabha, who taught me geography,

In memory of my father, Benashir, who taught me history,

To all my brothers and sisters, with love.

Abstract

Regional disparities are a fact of Canadian life. Large income disparities among regions have persisted for a long time. Disparities in employment opportunities are also substantial. The location of key economic sectors is highly concentrated and this has resulted in a highly regionalized industrial structure. The existence of such disparities has preoccupied both academics and politicians, but few of their efforts aimed at reducing these disparities have been successful.

A review of previous research shows that although traditional economic theory has long considered capital accumulation at the heart of the growth process, regional analysis in Canada has largely ignored the importance of capital formation in determining the relative economic fates of the various regions of the country. The central issue of this study has been to examine the role which capital accumulation has played in regional disparities in Canada since the 1960s.

Two main questions were addressed. The first question considers the extent to which the regional distribution of capital stocks has affected growth in regional output, productivity, and employment. The thesis has established some strong correlations between patterns of growth of capital stocks on the one hand, and regional economic disparities in output, productivity, and employment on the other hand.

A detailed examination of the regional dynamics of capital accumulation in Canada shows that regional investment is strongly

influenced by the relative growth rate of a region, the relative size of its capital stock, local labour costs adjusted for productivity, and the level of past profits. The thesis found that one of the impediments to rapid growth of capital accumulation in the poorer regions is the limited availability of finance. Access to capital has an important influence on capital accumulation and, therefore, on regional growth.

The effect of capital accumulation on productivity growth is estimated from a productivity function which relates growth in productivity to growth in output, growth in capital-labour ratio, and technical progress. It is found that regional differences in the intensity of capital have played an important role in labour productivity differences.

The second question looks at the type of policy to be implemented in order to reduce regional disparities by altering the present pattern of capital accumulation. The thesis proposed a model of optimal allocation of investment funds that takes into account both objectives of national growth and regional equity. The model is based on optimal control theory and considers both the maximization of national income and minimization of regional inequalities in one objective function. It is shown that in such a case the optimal policy is not to concentrate investment in the more prosperous regions, but to increase capital where it is scarce. This will stimulate growth in the poor regions and provide an opportunity to reduce disparities in employment and income.

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"Since the end of the nineteenth century significant progress towards the removal of very great disparities of wealth and income has been achieved through the instrument of direct taxation....The state will have to exercise a guiding influence on the propensity to consume partly through its scheme of taxation, partly by fixing the rate of interest, and partly, perhaps, in other ways. Furthermore, it seems unlikely that the influence of banking policy on the rate of interest will be sufficient by itself to determine an optimum rate of investment. I conceive, therefore, that a somewhat comprehensive socialisation of investment will prove the only means of securing an approximation to full employment; though this need not exclude all manner of compromises and of devices by which public authority will co-operate with private initiative."

J.M. Keynes, *The General Theory of Employment, Interest, and Money*, p.372 and p.378.

Introduction

Regional disparities in growth, employment, and incomes are a major issue in regional economics. Economic theory has long considered the notion of capital formation and investment as central to the analysis of capitalist economies (Marx, 1967; Keynes, 1936; Kalecki, 1943). These theories suggest that the spatial distribution of capital is an important factor that determines the relative economic growth or decline of the various regions of a country. Yet, very few empirical studies have examined the question of regional disparities from the perspective of investment in fixed capital. While researchers both in Canada and elsewhere have paid considerable attention to regional labour markets and workers' migration (Gordon, 1985; Foot and Milne, 1984; Courchene, 1970), they have largely neglected the role played by capital formation in these interregional movements of labour.

Economic theory states that changes in output are explained by the relative contributions of two main aggregate inputs: capital and labour. Investment, and the technology embodied in it, has an important impact on productivity since it directly affects the skill levels of the labour force. Canadian regions differ greatly as to the quantity and quality of their capital stocks and industrial structure. Productivity levels also differ from one region to another. It is therefore particularly important to examine the impact of capital formation from a regional perspective.

In an attempt to identify the major sources of regional

disparities in Canada, the Gordon Commission (1957) pointed to the slow rate of growth of capital investment in Atlantic Canada as a major problem (see Howland, 1957). A study by the Economic Council of Canada (1977) attributed a significant proportion of the persisting disparities in productivity among the various Canadian regions to interregional differences in the capital-labour ratios. As well, empirical studies for the U.S suggest that interregional variations in investment have, to a large extent, affected regional variations in employment growth and unemployment rates (Varaiya and Wiseman, 1981; McHugh and Widdows, 1984). Others (Bluestone and Harrison, 1982; Clark and Gertler, 1983) have established some strong interrelationships between labour (employment) and capital and maintain that regional in and out-migration are closely related to regional growth and decline.

Anderson and Rigby (1989: 121) show that there exist significant regional variations in the depreciation patterns which have led to "marked variations in the age structure of regional capital stocks" in Canada. They further argue that these differences have an important impact on regional output and employment since the latter depend on the age structure of capital which in turn determines the rate of investment and the direction of new capital.

Given the important role capital formation plays in the creation of regional patterns of economic growth and decline, of employment growth and migration, and of productivity and incomes, I propose to study the trends in disparities among Canadian regions

fixed capital. Since productivity and incomes depend, to a large extent, on the intensity of fixed capital in production, it is important to look at the changes in capital-labour ratios and in the spatial patterns of capital stocks in order to explain both the differences and the trends observed in these indicators of regional disparities.

The improvement in the living standards and the general economic well-being in the different parts of the country depends on the implementation of effective economic policies. These policies in turn depend for their success on a "good" definition of what constitutes a region. The difficulties encountered in trying to define a "region" are numerous and have been noted by many specialists in the field of regional economics. For example, Mansell and Copithorne (1986: 4) state that "there is no all-purpose definition of a region. The appropriate definition will depend on both the nature of the problem and the analysis."

Regions can therefore be defined in terms of concentration of population or on the basis of the dominant types of economic activity such as mining, agriculture, or manufacturing. Regions may also be defined according to their economic conditions, i.e., whether they are characterized by low or high incomes, low or high unemployment, low or high rates of growth, etc. Thus, the way a region is defined may not necessarily coincide with the political boundaries of the existing regions. This is problematic because if one wishes to combine contiguous areas belonging to different political jurisdictions, one encounters problems with the

inconsistency of the data or even their availability for smaller areas.

This is the case with many of the variables used in the present study. In fact, data on the main variable, capital stocks and investment, are only available at the provincial level. Unless we can disaggregate data so that we are able to define and analyze regions on the basis of some economic characteristics that are independent of the political and administrative boundaries, we are forced to accept and work with the existing (political) definitions of regions (see Stevenson, 1980).

For the purpose of this study, Canada is divided into six regions. Three of these regions are provinces (Quebec, Ontario, and Alberta). The other three are aggregated from provinces and/or territories. Atlantic Canada is comprised of Newfoundland, Prince Edward Island, Nova Scotia, and New Brunswick. Manitoba and Saskatchewan compose what is here called the Prairies. Finally, the Yukon and North-West Territories are included with British Columbia.

The thesis is divided into six chapters. In Chapter One, I review the literature on regional growth and development by examining critically each of the major theories and their predictions concerning trends in regional disparities. In particular, I isolate the mechanisms which these theories suggest would lead to either convergence or divergence in economic disparity. I show that the main argument is centred around the decentralization/concentration question. In other words, the debate

is over the direction and degree of 'the dispersion of economic expansion'.

The analysis of this question is based on different sets of assumptions, and this is what leads to the conflicting predictions of the various theories dealing with regional inequalities. Finally, I argue that, since in the real world one can find instances for both convergence and divergence, concentration and decentralization, a satisfactory theory of regional growth and development must be able to account for these conflicting tendencies.

In Chapter Two, I use time-series data to assess the extent to which the above described trends are evident in the context of recent changes in Canadian regions. The main question being asked here is the following: what was the direction of change in regional stocks of capital, output, and employment? In particular, this chapter focuses on the impact of capital stock changes on output, employment, and labour migration. This effort also includes comparisons of rates of change in regional capital stocks and an analysis of the changing share of the regional GDP by major industry sector.

In Chapter Three, I develop a model to explain the regional dynamics of the investment process. If capital accumulation is an important factor in the growth of a regional economy, then what are the determining factors of the rate of regional capital accumulation? After reviewing the literature on investment, I show that there is an important gap between theories of investment at

the national level and the real determinants of capital formation at the regional level. The model specifies the regional determinants of investment and empirically tests their influence and significance by using time-series data for each of the Canadian regions.

In Chapter Four, I develop a model to explain regional differences in income and in growth of output. The model is based on Verdoorn's law, which is extended to include the effect of capital accumulation on productivity growth. In fact, the model combines Verdoorn's law with Kaldor's technical progress function to construct a productivity function relating growth in productivity to growth in output, growth in the capital-labour ratio, and technical progress. Using times-series data spanning the period 1960-1990 for each of the Canadian regions, I estimate the extent to which changes in capital-labour ratios and the industrial structure have contributed to a reduction in labour productivity differences and, therefore, to a convergence in regional disparities in incomes and other indicators.

Chapter Five considers the policy implications of the interregional distribution of investment. A major question is how should a central (federal) government allocate investment funds to its various regions in order to alleviate regional disparities while maintaining high levels of growth? A model based on two criteria is proposed. The first criterion consists of maximizing average national income. In the second criterion, the objective is to minimize interregional income differences. These two goals are

combined in one objective function which the government must maximize in order to determine the optimal allocation of investment funds. Such an approach to policy would ensure that national income is maximized while each region of the country enjoys a comparable standard of living.

Chapter Six summarizes the major findings of the thesis and concludes with some suggestions for policy issues that governments may pursue in the search for solutions to reduce the divergent patterns of economic growth in this country. Some comments on the limitations of the study and a brief discussion of further research are also presented.

Chapter One

Theories of Regional Growth and Development

1.1 Introduction

One of the major concerns in regional economics is the analysis of factors determining unequal distribution of productive activity and spatial differences in income and social well-being. Theories of regional growth and development have dealt with this question at two levels: (1) they have attempted to give an explanation of the very existence of regional inequalities; and (2) they have examined the trends in such inequalities, i.e., how they have evolved over time. In both cases, theories differ a great deal in their assumptions and their predictions.

For some, the existence of regional disparities is due to the deficient functioning of product and factor markets -- market "imperfections." The gradual removal of such deficiencies or imperfections leads the self-adjustment mechanism of the market to eliminate gradually regional imbalances. Capital and labour mobility permits a dispersion of economic activity to less industrialized regions which results in structural changes that are conducive to a reduction in return differentials and, therefore, to convergence. This is particularly the view of the neoclassical school (Borts and Stein, 1964; Isard and Smith, 1969).

For others, regional disparities are caused by the dynamics of the productive system. They are an outcome of capitalist

production relations and as such they are likely to persist and even increase because the mechanisms governing growth are 'cumulative'. Factors such as agglomeration economies are conceived of as complex forces inducing spatial concentration of firms, households and public infrastructure. These are factors preventing convergence and leading to a dual and hierarchial organization of space between 'rich' and 'poor', 'dominant' and 'subordinated', 'core' and 'peripheral' regions (Myrdal, 1957; Kaldor, 1970).

For others still, the logic of capital accumulation leads private capital to use its mobility to relocate production facilities from one region to another in the search for more profitable sites, thus leading to an even more dramatic scenario in the evolution of regional disparities. This idea is associated with the restructuring school (see, among others, Massey, 1978; Bluestone and Harrison, 1982) which contends that the imperatives of competition are forcing firms to abandon older, less economical product lines and to switch investment to new and growing activities using "more efficient techniques which economize on input (e.g. labour) costs and therefore improve profitability" (Clark et al., 1986: 309; see also Schoenberger, 1988).

The restructuring process described by these authors has an important spatial dimension since the techniques and conditions of production are key factors determining location. It is also argued by these authors that technological changes are more easily implemented in less urbanized areas, therefore implying a relative decline in the growth of previously 'core' regions and the rise of

newly industrialized areas (Casetti, 1981; Clark et al., 1986). This change in the relative economic performance of regions is interpreted as an unexpected reversal of long run trends.

In the context of major technological developments and increased integration of the 'world economy', authors of the restructuring school envision the possibility of a complete reversal in the economic experience of regions. Interregional shifts in population and economic activity from 'core' to previously 'peripheral regions' have been formalized in a theory of sudden change, or a catastrophe theory. The dynamics of this process have been used to explain the relative economic decline of areas such as the traditional industrial heartland of the U.S., the 'frostbelt' and the rise of a newly industrialized south-west, the 'sunbelt'.

The above conflicting explanations and predictions are based, explicitly or implicitly, on a variety of opposing assumptions concerning the investment process. Despite the difference in approaches and terminologies used by these theories, it is possible to show that their contending explanations of regional growth and decline stem essentially from two basic yet contradictory conceptions of investment.

Models attempting to explain the general tendencies of the change in regional economies have conceptualized investment either (1) as a self-reinforcing process which leads to cumulative growth and forces change in future investment to be concentrated or (2) as a process in which capital responds relatively quickly to

differentials in returns and costs and, therefore, tends to adjust over time and across regions.

The first conceptualization of investment is associated with the circular and cumulative causation theory of regional growth. The second is associated with two other theories whose interpretations of the adjustment process are entirely different. Equilibrium-based neoclassical theory argues that costs and returns differentials urge entrepreneurs to redeploy their capital investment to other areas, thereby leading to convergence in capital intensities, marginal productivities, etc. The Marxian theory (with which the restructuring school is generally associated) also argues that prospects of high profits motivate capitalists to shift their investments to 'less developed' regions. Although this theory maintains that investment is essentially a concentrated phenomenon, it also allows for tendencies towards dispersal and deconcentration and interprets them as means for enhancing or improving conditions of accumulation.

The resemblance between these two theories is also found in writings on restructuring and regional shifts of economic activity. Arguing from a basically neoclassical perspective, Casetti (1981: 572) has formulated a catastrophe theory of regional change to explain what he perceives as "unexpected reversal of long run trends." However, by emphasizing the dynamics of discontinuity Casetti departs from the neoclassical model and comes one step closer to the restructuring school which emphasizes the importance of specific time and space (see Clark et al., 1986).

Following the above description, this chapter is divided into four sections. Section 1.2 examines theories of equilibrium and convergence. Section 1.3 discusses the theories of disequilibrium and divergence. Section 1.4 deals with restructuring and the catastrophe theory of regional change. Finally, in section 1.5, I look at the related literature on regional growth and development in Canada.

1.2 Theories of convergence and equilibrium

Neoclassical growth models have permeated and dominated regional economic analysis since the turn of this century. Alfred Weber (1928) is considered the founding father of modern location theory, the oldest branch of regional economics. Hotelling (1929) also contributed to location theory using an imperfect (or quasi-monopolistic) competition framework.

Neoclassical growth models differ from other regional growth theories not only in their assumptions about production functions but also, and more importantly, in their assumptions about the characteristics of individual regions, that is, assumptions concerning resource endowments, distribution of the population, levels of technical knowledge, distribution of capital stocks, etc.

Neoclassical regional growth theory assumes a certain uniformity and homogeneity between regions, which leads to a neutralization of agglomeration effects. For example, as noted by Holland (1976:7) L6sch (1952) defines an economic region as an area with 1) uniform distribution of raw materials, 2) uniform

distribution of population, 3) uniform tastes and preferences, 4) uniform technical knowledge, and 5) uniform production possibilities.¹

This uniform distribution of all "essential elements of economic activity" within a given region is generalized to the entire space by further assuming a 'uniform transport surface'. This latter assumption allows factors of production and markets to move in all directions over space at no cost. This necessarily leads to an equilibrium situation in which no particular region can enjoy the benefits of agglomeration economies over others.

This even distribution of resources, factors of production and markets, although it is at odds with the observed patterns of concentration and oligopolistic behaviour of the firm, was still taken up by economists like Isard (1956), Borts and Stein (1964), and Isard and Smith (1969). It must be noted however that, in his later work, Isard admitted that the assumptions of uniformity rendered this theory inoperational and deficient since it could not account for real problems of industry location, the effect of agglomeration economies and of technical progress, etc.

Neoclassical theory of regional growth is based fundamentally on a state of equilibrium. It argues that interregional gaps, i.e., regional inequalities in factor endowments, incomes, industrial concentration, etc., are only transitory and their persistence is due to the slowness of the adjustment process.

¹ For a good review of the neoclassical approach to regional science, see Holland (1976).

Several models have been proposed to explain the tendency towards convergence and equalization in space. In these interregional convergence models, factor mobility plays an essential role.

The most complete version of the neoclassical model is that which combines regional growth with interregional factor movements. In this model (see Borts and Stein, 1964; Romans, 1965), wages and returns to capital are inversely related, so that high income regions import labour and export capital. Given the (initially) different interregional capital intensities, poor regions may offer higher yields to capital and will therefore end up importing capital and exporting labour. The equilibrating effects of interregional factor movements are associated with convergence in growth and incomes.

In this way the initial difference in factor proportions affects factor prices, and variation in factor prices affects factor supplies and therefore factor proportions. This simple causal relationship is at the heart of the neoclassical adjustment mechanism. Whenever there appears a disequilibrium situation because of a concentrated investment flow or concentrated impacts of an innovation, interregional factor movements will gradually reestablish equilibrium by dispersing over the entire space the benefits of innovation and industry.

This is in contrast with earlier work by Weber (1928) and Hotelling (1929) who admitted that the existence of scale economies may lead to spatial concentration. For example, Hotelling (1929: 43) criticized the spatial equilibrium theory for not taking into

account "the destabilizing effects of masses of consumers" and consequently argued that producers may locate close to the centre of all market areas so as to minimize transport cost and maximize market access.

Borts and Stein (1964) maintain that flows of capital and labour among regions reduce regional variation in factor proportions and consequently they argue that in equilibrium factor returns are equal in all regions. The problem with this analysis is that there are cases where evidence suggests, contrary to the neoclassical argument, that rich regions import both labour and capital, and that concentration and agglomeration economies are important characteristics affecting location of industry and economic activity.

More recent contributions have developed models which allow the production functions of prosperous regions to exhibit alternating decreasing and increasing returns to scale which leads to the existence of both stable and unstable equilibria. Thrall and Erol (1983) for example, show that, in an unstable equilibrium, regions may face either a rapid growth or depletion of their capital stocks depending upon the direction of change in the marginal productivity of their capital vis-a-vis that of others.

This result is based on the fact that Thrall and Erol assume that oscillating returns to scale are accompanied by oscillations in the marginal productivity of regional capital (MPRC).² Unlike

² It is assumed that MPRC is proportional to the size of capital stock and that capital migrates to the region with the greatest MPRC.

the neoclassical model and in line with Casetti (1981), when the MPRC is allowed to oscillate, multiple equilibria are possible. When equilibrium is unstable, like at point e_2 in Figure 1.1, the system will move to other equilibrium positions and, depending on whether the MPRC in the region concerned is higher or lower than that in the other regions (or as Casetti calls it the average marginal productivity of capital in the rest of the country MPC), capital will either flow in or out of that region. If MPRC in region 1 is less than MPRC in region 2, then equilibrium will be reached at e_1 , therefore increasing the capital stock of region 2 and lowering that of region 1. Similarly, if $MPRC_1$ exceeds $MPRC_2$, equilibrium moves to e_3 , and the capital stock of region 1 is increased at the expense of region 2. The MPRC is measured by the level of interest rate. Thrall and Erol (1983) use investment data from Canada and the U.S. to show that it was this situation that led to a rapid outflow of capital investment from Canada to the United States during the late 1970s and early 1980s.

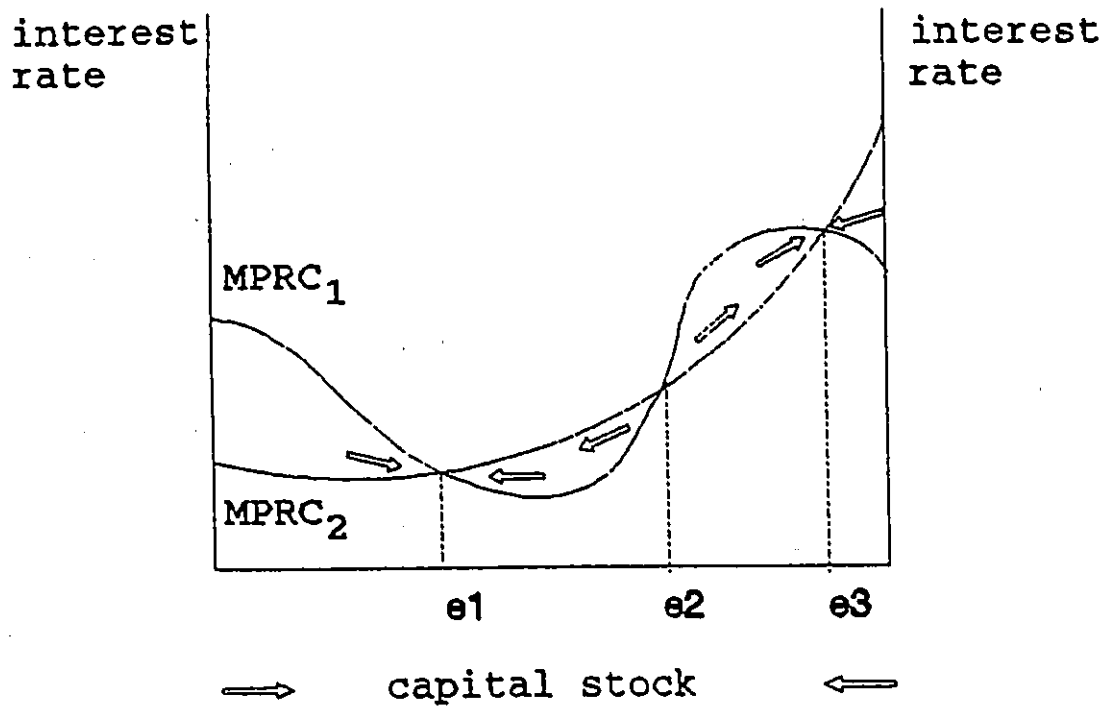


Figure 1.1

Capital flows in a two-region model

Source: (After Thrall and Erol, 1983)

In the neoclassical framework, the free functioning of the markets, i.e., free movement of factors of production and commodities define the parameters of the economic life of regions. In the theory of interregional trade, factor mobility and trade, together with different natural resource endowments determine the pattern of regional specializations in the sense that "each region has an advantage in the production of commodities into which enter

considerable amounts of factors abundant and cheap in that region" (Ohlin, 1967: 12).

Ohlin's general conclusion is that interregional trade and factor movements are factors which lead to commodity and factor price equalization. Factor price equalization obtains "as factors move from regions where their prices are relatively low to regions where they are dear, their scarcity, and therefore their rewards, in the former are increased, whereas their prices in the latter fall" (Ohlin, 1967: 116). But as Ohlin noted, this tendency towards factor price equalization reduces a given region's possibilities to develop a comparative advantage in the production of commodities requiring the use of factors that are abundant and cheap in that region. Interregional factor movements can be interpreted in this way as a substitute for interregional trade.

Concerning equilibrium in the goods market, equalization of goods prices is obtained only at a cost. That is, the assumption of perfect mobility cannot apply to both factors and commodities at the same time because it renders the system indeterminate and locations indifferent. In other words, with zero transportation costs and perfect factor mobility (of capital and labour), space will be reduced to one point and location becomes irrelevant. Neoclassical interregional trade models must therefore assume positive transportation costs given that factors of production are mobile.³

³This is symmetrical to international trade models where the assumption is reversed.

Goods price equalization in interregional trade models is only partial since it must take into account the positive transportation costs as can be seen from the diagram below.

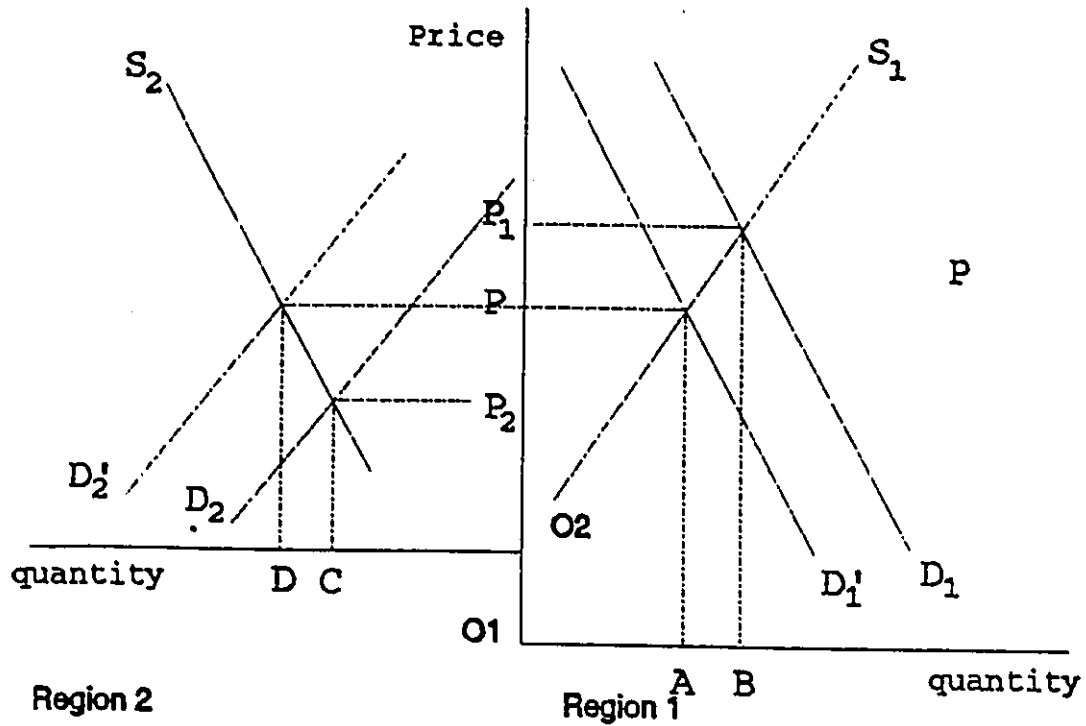


Figure 1.2

Goods price equalization in interregional trade models

If two regions are producing the same good, trade will take place only if the initial difference in prices between two regions ($O_1P_1 - O_2P_2$) exceeds transportation costs (O_1O_2). Initially equilibrium price in region 1 (P_1) is higher than that in region 2 (P_2) which induces consumers to shift their demand towards region

2. This increase in demand for region 2's output (from D_2 to D_2') drives prices up from P_2 to P . This is paralleled by a negative shift in demand for region 1's output which lowers prices from P_1 to P , the equilibrium price. It is particularly important here to note that region 2 experiences an expansion in its output through exports. The growth through foreign demand is the essence of the export base theory (to be discussed later).

This adjustment model is based on an important assumption, one which is often implicit in equilibrium-based neoclassical models, that is, the absence of agglomeration economies. This is reflected by assuming similar production functions in different economies and constant returns to scale. This is important for the equalization process for if regions had different production functions, factors of production as well as consumers could concentrate in the more productive region where expansion and growth could be sustained without necessarily having to trade with less productive regions or have only minimal trade.

In this context, it can also be the case that investment is attracted by the performance of firms in the more productive region, therefore, further increasing regional variations in capital-labour ratios, especially if the developed region is oriented towards more labour-saving production techniques (see Holland, 1976). This example shows that the assumption of identical production functions in different regions is essential for both interregional distribution of factors and trade as described in neoclassical models.

Neoclassical theory of regional growth views space only as a problem of distance; otherwise regions are considered identical in their production functions, consumption patterns and preferences, and above all function under the normal conditions of perfect competition. These restrictive assumptions are necessary for the results of equilibrium and convergence in factor proportions, prices and income. In this context, regional disparities arise only when the adjustment process is slow. This slowness is caused by frictions and market imperfections, in which case convergence and equilibrium are delayed.

When for example agglomeration economies are taken into account, not only are convergence and equilibrium delayed, but the tendency may be reversed. This would be the case if production functions of the more prosperous regions are allowed to exhibit increasing returns to scale. Firms operating under these conditions may cumulatively increase productivity and earnings over those in the less productive regions. Increasing divergence rather than equalization would be the more likely outcome of this scenario since firms will be attracted by the potential of higher profits in the rich regions. This is the view of the next group of theories to be discussed in the following sections.

1.3 Theories of disequilibrium and divergence

1.3.1 The cumulative causation model

A somewhat more general theory of the transmission of growth and development is found in the works of Myrdal (1957) and Hirschman (1958), among others. This analytical framework of regional economic inequality came as a reaction to the theory of convergent equilibrium and balanced growth. In his theory of circular and cumulative causation, Myrdal (1957) maintains that inequality is a situation of disequilibrium that leads to reactions from the system as is argued in the neoclassical theory, but these reactions are not corrective or equilibrating. They tend to intensify the initial inequalities. Once these regional economic inequalities emerge, they tend to be self-perpetuating.

As in the neoclassical theory, factor mobility and trade are the engine through which this process evolves, making the 'backwash' effects stronger. This would happen whenever the benefits of an innovation (e.g., increase in productivity) are confiscated by the innovator (located in the growth-centre). The gap is widened as there are further increases in productivity and more benefits accruing to the centre making it richer and richer. This is because factors of production are attracted by better opportunities. Capital is attracted by well-developed infrastructure and markets, and labour migrates to take advantage of the high wage rates. Growth becomes cumulative. But at the same time, the peripheral regions lose their prospects for development by losing their factors of production. Capital shuns regions where

investment opportunities are not promising, and out-migrants are often the younger, most dynamic and educated fractions of the population. Capital and labour movements therefore have pauperizing effects on the poor regions. The 'spread' effects that may benefit the periphery are largely offset by the dominant 'backwash' effects.

Hirschman (1958) contends that once economic growth occurs, it sets in motion 'trickling down' forces that transmit growth benefits to backward hinterlands through trade and transfer of capital. But these 'trickling down' effects may be outweighed by what he calls 'polarization' effects. This would be the case when the hinterland's economic base is shaken by competition from the growth centre. As a result, the centre grows stronger and richer whereas the hinterland's economy becomes depressed, dependent and generally in a much worse situation than before. Economic backwardness as it materializes over geographical space appears and coexists with a more industrially advanced state.

In the neoclassical theory, the assumption of factor mobility ensures the return to the state of equilibrium, but according to the cumulative causation theory it is an element of disequilibrium forcing factors to move towards more advanced regions. This process is cumulative because it repeats itself over time in such a way that the economic activity in the poor regions becomes disintegrated and unable to progress, which forces more industries and other activities to move to the already prosperous regions.

In "The Case for Regional Policies", Kaldor (1970) pointed out

that production was not equally profitable at all locations precisely because of the existence of a number of factors which disproportionately increase productivity of similar factors of production depending on their locations. He argued that firms in core regions enjoy a locational advantage which they derive from the existence of agglomeration (scale) economies. The existence of these internal and external scale economies leads to a cumulative growth in the productive capacities of those firms located in core areas. Kaldor (1970) used Verdoorn's law, which states that growth of productivity is positively affected by the rate of growth of output, to show that the rise in the return on investment in the rich regions will induce further investment, thus leading to a concentrated pattern of industrial location. By the same token, this argument also offers an explanation for the persistent depression of peripheral regions.

Kaldor's analysis is based on the fact that the spatial concentration of production and markets offers local firms a relatively higher level of efficiency. He argued that increasing returns to scale offer local producers the possibility to lower their unit production costs which enables them better to compete with those located in the peripheral regions. Prospects of growth and higher income exert an attraction effect on factors of production which move away from the depressed regions.

As mentioned before, this cumulative process had been noted earlier by Myrdal (1957) and Hirschman (1958) among others. Richardson (1969: 330) has also noted that:

unless investment opportunities are abundant in low income regions and are near exhaustion in the high income regions, [...] capital will not flow in the required direction. Indeed it may tend to flow in the opposite direction since investment opportunities may be greater in the high income region. In this case capital flows will be disequilibrating, accelerating the rate of growth in the richer region and slowing it down in the poorer one.

The resulting concentration of growth in some areas is reinforced by regional agglomeration economies which, according to Richardson (1973), play a critical multiple role: they attract industry and capital because they imply lower costs and higher profits; they promote technical progress and higher productivity; and they influence migration decisions.

Since the operative variable in the cumulative causation paradigm is capital investment, it is important to consider the question of accumulation more directly. In Richardson's work (1973) the pattern of the current and future investment depends on the previous distribution of capital in space. Myrdal (1957) and Hirschman (1958) have also stressed this positive feedback between existing and future patterns of capital accumulation and production.

The cumulative causation models are therefore based on a dynamic investment process in which the pre-existing stock of capital plays an important role. According to this model, regional allocation of investment is influenced by the existing distribution of fixed capital for three major reasons: (1) firms tend to replace their worn-out capital in situ, (2) it is easier to realize economies of scale through improvements and expansions rather than

starting from scratch, and (3) firms tend to locate near to each other in order to benefit from external increasing returns and agglomeration economies. As Hirschman (1958: 184) put it:

investors spend a long time mopping up all the opportunities around some 'growth pole' and neglect those that may have arisen or could be made to arise elsewhere.

Richardson (1973) stresses the fact that private investment decisions are greatly influenced by previously installed public infrastructure. His work, like that of Kaldor (1970), Myrdal (1957) and Hirschman (1958) rejects the neoclassical assumption of perfect factor markets and the implied spatial homogeneity. Indeed, Richardson (1973) sees this self-reinforcing nature of the investment process as a major cause of spatial differentiation, capital market imperfections and interregional disequilibrium.

1.3.2 The growth pole theory

Like Myrdal, François Perroux (1955, 1964) is also known to have stressed the fact that the free working of the market mechanism promotes concentration of growth in some areas and results in an imbalance in regional economies. He argued that development was essentially polarized leading to concentration of economic activities and imbalances between sectors and areas.

Perroux (1955) also emphasized the role played by agglomeration economies in promoting a 'polarization' process. This concept is similar to Myrdal's 'spread' and 'backwash' effects and includes both in the sense that it reinforces growth in areas which had established a growth pole by forcing factors of production and

trade to concentrate in those areas and move away from low-growth ones.

The growth poles theory ("pôles de croissance") was initially developed by Perroux in the early 1950s in order to explain the anatomy of economic development, but it quickly gained wide popularity and led to the establishment of several development programmes and policies. Policy makers thought they had found in it a means for solving problems of regional imbalances by establishing counter-poles in the less developed regions (Holland, 1976).

Perroux (1955: 309) contends that "a crude but solid observation is that growth does not appear everywhere and all at once; it appears in points or growth poles with variable intensities; and then spreads to the rest of the economy along diverse channels and has varying terminal effects." [my translation]

Growth poles are leading sectors with 'propulsive' industries ("industries motrices") that are 'innovative' and able to generate 'spread effects'. These spread effects are transmitted to other sectors and peripheral areas through inter-industry linkages. The leading 'propulsive' firms, according to Perroux, operate on a relatively large scale, generate significant growth in their environment, and have a high ability to innovate.

Because of their dimension and the nature of their operations (technically more advanced), these large-scale firms (macro-units) are able to *dominate* and exert a considerable influence on their environment. This last point, central in Perroux's analysis, shows

that the theoretical framework used by the author is at odds with the neoclassical theory for which economic activity is the result of isolated economic agents operating in a world of perfect competition. Growth is not a linear and balanced process. Perroux argues that it is rather a dynamic and complex process that spreads through diverse channels under the impact of dominant units and in a situation of disequilibrium.

The notion of economic dominance can be understood better by referring to the concept of industrial linkages. Using input-output analysis, Perroux (1964: Chapter 6) was able to find patterns of dominance in the economic system by emphasizing the hierarchical nature of industrial relations. In particular, he showed that, due to backward and forward linkages, any one industry would dominate those which depend on it for their growth and expansion and at the same time be dominated by others. These patterns of domination and hierarchy characterize the structure of the economy. Consequently, when macro-units and dynamic industries make investments and innovations, there will be a chain of reactions from the subordinated ones therefore giving rise to secondary effects, i.e., additional investments. This allows Perroux to show that growth is spatially polarized and unbalanced.

Secondary activities which are induced by those macro-units will not disperse over the entire space, but tend to cluster around the pole. One important reason is that dependent firms are (usually) of a small size and tend to avoid isolated locations because they need easy access to various markets and services and

look for opportunities to benefit from agglomeration economies. Subcontractors, for instance, are largely concentrated around the main firms. Growth poles have also negative and confiscating effects. They can concentrate all the growth effects leaving nothing to their peripheral areas. Theories of diffusion and location are therefore an important component of the growth pole framework.

The basic theoretical framework of the growth pole theory is similar to that of the cumulative causation theory. Growth appears in certain "leading sectors" or "growth poles" which dominate their periphery and are able to generate spread effects and transmit growth to other sectors or peripheral areas through inter-industry linkages. From this it follows that, for the development of an economically retarded region, policy makers need to create a system of growth poles which will generate and transmit growth to the rest of sectors and areas of the region. Thus, this theory encompasses the sectoral, the spatial and the intertemporal aspects of economic development.

1.4 The catastrophe theory of regional change

From what precedes, one can say that there are essentially two opposing views of capital accumulation. One view stresses the cumulative tendency and sees capital accumulation as an essentially concentrated phenomenon. The other approach perceives capital as a perfectly mobile factor adjusting relatively quickly to costs and returns differentials.

Clark et al. (1986) have pointed out that although these two views differ in their premises and conclusions they both conceive of regional change as a smooth and continuous process. It is this perspective, i.e., the regularity and continuity of regional change, which Casetti (1981) believes is unable to offer an adequate explanation of the recent regional economic experiences such as the rapid shift of economic activity from the US frostbelt to the sunbelt.

Casetti (1981: 572) proposes a catastrophe theory of regional change. He interprets the recent shifts as an unexpected reversal in the long run trends that have shaped the structure of regional economies of the U.S. As he notes, these events "cannot be explained in terms of cumulative causation and growth pole theories since these theories imply that the more developed areas will grow comparatively more, and will induce growth in the territories around them."

Casetti's point of departure is also capital accumulation. His analysis is based on the idea that capital formation is able to induce immigration of population and industry to regions experiencing net capital accumulation and to force workers out of those regions which are experiencing a net decline in their capital stocks.

In this framework (see also Thrall and Erol, 1983), the adjustment process is fuelled by the dynamics of discontinuous systems, which opens the possibility for sudden shifts and unexpected reversals in regional economic experiences. But

Casetti's catastrophe model is disappointingly simple in that it makes net regional capital formation depend on differences in marginal productivity of regional capital stocks.

Accordingly, Casetti (1981: 575) constructs a capital formation equation to show that there will be capital inflows if the marginal productivity of a region's capital (MPRC) is greater than the average marginal productivity of capital for the rest of the country (MPC). Capital flows out of the region if MPRC is less than MPC while there will be no capital flows if the two are equal.

The marginal productivity of the regional capital stock (MPRC) itself is assumed to be a function of the gross regional product (GRP). Casetti presumed that MPRC increases as the scale of regional production grows but beyond a certain level of maturity, this growth will induce a reversal in MPRC and therefore a sudden interregional shift in capital investment.

The main argument in Casetti's catastrophe theory is that MPRC, which is a function of GRP, may follow a trajectory of alternating increases and decreases. In fact, Casetti (1981: 574) argues that in the initial phase growth of GRP tends to be cumulative because of the existence of internal and external economies which has a positive impact on MPRC and therefore on capital flows. However, regional diseconomies may set in because of continued spatial concentration.

When looked at from a different perspective, the process described by Casetti could actually be interpreted as a Kaldorian growth model which breaks down as the regional economy reaches

maturity. But just how and why MPRC is lowered is not clear from Casetti's argument, although he seems to stress the negative consequences of concentration such as diseconomies, congestion, etc. (see Clark et al., 1986).

The possibility of sudden turnarounds and reversals in regional economic experiences has also caught the attention of Marxists. By emphasizing the role of capital mobility and ownership of means of production, Marxist writers (Storper and Walker, 1984; Massey, 1984) show that the recent period of restructuring has led to a series of relocations of economic activity which are similar to the shifts analyzed by Casetti (1981) and Bluestone and Harrison (1982) among others.

These writers have emphasized the power enjoyed by firms in creating and terminating employment (Clark et al., 1986). This allows them to show that location of economic activity depends on decisions taken by the firm. In light of the recent developments in transportation and communication technologies, new trends have emerged in the spatial organization of production and consumption in advanced industrialized countries (Aglietta, 1979). In particular, through a multilocal arrangement of production (Pred, 1977) capital reduces its dependency on a limited geographical set of locations (Walker, 1978). This further increases capital mobility and makes relocation an easy task.

The work of Bluestone and Harrison (1982) for the U.S. echoed the findings of Massey (1978) in her study on capital restructuring in Great Britain. Both studies suggest that restructuring has

important implications for regional changes. In particular, they show that the immediate consequences of relocation are a decline in local employment, out-migration of skilled workers and a devaluation of regional capital stocks. According to Clark (1981) and Storper and Walker (1984), these developments are motivated among other things by imperatives of accumulation, which include the control over labour characteristics (militancy, skills, unionization, etc.) and labour costs.

From this perspective, capital mobility is the central element leading to catastrophic shifts of productive activity between regions. It is important to note, however, that the studies referred to above have generally used shifts in employment as a proxy for measuring regional shifts. The limited availability of data on regional capital stocks has retarded the analysis of the direct implications of capital movements for regional change. As will be seen, in this thesis, I have been able to overcome this problem at least partially by using unpublished provincial capital stock time-series recently produced by the *Investment and Capital Stock Division of Statistics Canada* for the period 1961-1990.

The catastrophe theory of regional change differs from the neoclassical and the cumulative causation theories in the sense that it conceives of regional change as a discontinuous process rather than a smooth and continuous movement leading to some sort of steady state of equilibrium. The basic thinking behind this theory is that the dynamics of discontinuity open up the possibility for sudden shifts and unexpected reversals in regional

economic experiences. The nature of change that has characterized Canadian regions is the subject of the following chapters. Before we get to that, it is important to review briefly the Canadian literature on regional growth and development.

1.5 The Canadian literature on regional growth and development

The literature on regional growth and development in Canada has, to a large extent, been a reflection of the two established currents of regional economic analysis which were considered above. Theories of convergence and equilibrium have had their proponents in Canada, but so have the theory of imbalance and disequilibrium. These conflicting perspectives have each emphasized the role of different factors in Canada's development.

1.5.1 The staples approach

The classic works of Harold Innis, W.A. Mackintosh, and Vernon Fowke have had a profound impact on the development of the political economy and regional analysis in Canada. The staples approach, developed by Harold Innis (1933) and W.A. Mackintosh (1923) is now recognized as one of the most distinctive Canadian contributions to the general theory of growth. It emphasizes the importance of trade and production of staples such as fur, fish, timber, wheat, and minerals in the development of Canadian regions. As part of the British empire, Canadian regions functioned like any other colonies: they provided raw materials and served as a market for the centre's manufactured goods. The centre's need for these

raw materials (staples) greatly influenced the nature and pace of development of these regions. Brodie (1990:39) in reviewing Innis's work, notes that "The exploitation of a series of staples -- fish, fur, timber, wheat, and minerals -- meant that different areas of the country developed at different times and in different ways as the demands of the centre as well as technology and transportation made them accessible."

According to the staples approach, development of Canadian regions must be studied in relation with the changes in the pattern of demand and the state of technology in the metropolitan countries (Mackintosh, 1926, 1964; Innis, 1956b). The emphasis on the role of external demand is combined with internal factors like the availability of resources and their successful exploitation. This has led some to believe that natural resource endowments are the key to economic growth of a region. However, more recent writers (Watkins, 1982; Drache, 1982) inspired by the Innisian tradition have argued against a narrow focus on a staple-led growth and disagree that resources alone could be held responsible for a region's economic growth or decline.

Although regional analysis is not well developed and not explicit in Innis's work, his study of the historical development of Canada in its relationship with the imperial centres has clear implications for the study of the uneven development of Canadian regions. Innis (1956a: 371) argued that Canada's hinterland regions were dominated and exploited by metropolitan economies. Drache (1982: 43) maintain that for Innis "At the periphery labour,

capital, and resources were exploited by the centre in a trade arrangement which constituted normal market behaviour for the imperial economy, but had the effect of depriving the periphery of capital and resources to revolutionize its own mode of production." This relationship of dominance and exploitation is theoretically close to the general framework used later by Perroux (1955), Myrdal (1957) and writers of the dependency theory.

Others (Ray, 1985:49) maintain that this dependency is a two-way relationship and that the heartland or metropolitan economy is also dependent on the prosperity of the hinterland " ...hinterlands are generally defined as regional sub-systems that stand in a relationship of economic, political and cultural dependency to a heartland...But the definition is reversible: consider only the world heartland's need for OPEC oil. Thus, heartlands too could be defined as regional sub-systems existing in a relationship of dependency on their hinterlands... Heartlands and hinterlands are interdependent."

That the hinterlands play a major role as a supplier of raw materials, agricultural products and even some primary manufacturers to metropolitan areas (whether within Canada or outside of it) is apparent from the statistics and has been made clear by the pioneering work of Innis (1933, 1954, 1956a, 1956b), Mackintosh (1926, 1964), and others. However, as resource-based economies, these regions are sources of considerable wealth that is accumulated and reinvested in what is considered to be the most dynamic sectors of the economy. Those sectors are traditionally

located in the core or metropolitan regions which also become centres of banking, industry, and trade (see Matthews, 1982: 105). Phillips (1982: 3) goes as far as believing that "Regional disparities in Canada are inextricably bound up with an historic national economic policy that encouraged the concentration of industrial production...in the heartland of central Canada, while relegating to the hinterland regions the role of natural resource extraction for uncertain and volatile export markets."

On this account, the relationship between hinterland and heartland is not only a descriptive one since the focus is on more than simply the exchange of commodities. According to Watkins (1963:143) "the staples theory becomes a theory of capital accumulation", because it analyzes Canada's particular form of regional development by emphasizing the various linkages affecting capital flows, investment, and growth. Fowke (1946) has been more explicit than others in his emphasis on the role of capital formation. Brodie (1990: 46-47) suggests that there are three essential themes in Fowke's work:

- 1) his recognition that it was the overall process of capital accumulation and not simply the dominant staple that shapes and reshapes geography and social relations;
- 2) his emphasis on major state development strategies in the creation of different regions and regionalism;
- 3) and his ability to show how government development strategies, although essentially "national" and neutral in design, necessarily contained class and spatial biases.

Thus, it can be said that the staples approach is a dynamic approach attempting to explain uneven regional development by

internal factors such as the character of the staple, capital formation, class conflict, the level of technology and the significance of world market conditions.

1.5.2 Recent perspectives on regional development

Another approach, based on neoclassical assumptions, has developed within Canadian economic thought. This approach rejects the idea of domination and abstracts from exploitation and class conflict. It perceives uneven regional development as a result of impediments to the free functioning of the market. Canadian neoclassical economists argue that government intervention in the form of minimum wage legislation, unemployment insurance and other transfer payments has worked against the market-driven tendency towards equalization (Courchene, 1984, 1986; Polèse, 1981, 1987). They argue that transfer payments inhibit mobility (of labour in particular) and block adjustment in the form of restructuring that would eliminate conditions of inefficiency and low productivity (Royal Commission, 1985: 213).

According to Courchene (1986:32), the solution to unemployment and low growth and, therefore, to regional disparities is the removal of government intervention. He believes that the self-adjustment mechanism of the market will be such that "[a] fall in wages in the deficit region relative to the surplus regions should at the same time induce labour to flow out of the deficit area and capital to flow in." Regional disparities in this framework essentially refer to differences in per capita income and

unemployment rates and tend to ignore the significance of underlying economic and social conditions.

The role of the complex underlying economic and social structure has been emphasized by the Marxist school. Arguing from different angles, Marxist writers in Canada have all attempted to explain the causes of economic dependency and underdevelopment of the periphery by looking at the structures of economic and social life. For instance, Veltmeyer (1978:96) suggests that underdevelopment of Atlantic Canada is "a historical product of conditions created by the workings of capitalism on a world scale." He argues that "the process of capital accumulation creates ...regional conditions of an uneven polarized development" and that "the expanded reproduction of capital at one pole, creates on the other conditions for a mass of 'free' labour held in reserve." (Veltmeyer, 1979:19).

Others (Archibald, 1971; Sacouman, 1980) have argued that the core-periphery relations, based on domination and the transfer of surplus, have blocked industrial development in Atlantic Canada and resource-based economies in general. Fairley et al. (1990: 12) maintain that "capitalist expansion nationally and continentally has been accompanied by crisis and collapse in the Atlantic region's economy... The Atlantic region gradually became a dependency, to the point where economic, social and political stability now all depend on the flow of federal dollars."

More recently, Sitwell and Seifried (1984), Gertler (1986, 1987), and Anderson and Rigby (1989) have focused on the role of

capital formation and the implications of spatial distribution of investment in creating regional disparities. They argue that uneven rates of regional investment play an important role "in shaping the changing geography of capitalist production." (Anderson and Rigby, 1989: 117). Dow (1990: 23) on the other hand, has emphasized the role of financial variables and credit creation on regional economic development. "Financial concentration", she argues, "encourages concentration in production via the increasingly centralized process of credit creation."

The Canadian economic literature on the issue of regional growth, like economic thought in general, is rich with conflicting theories and explanations. These conflicting perspectives emphasize different factors to explain Canada's economic development. Some writers maintain that the availability of natural resources in certain regions and/or their geographical location have been crucial in the development of those regions. Others emphasize the role of economic and social structures in determining the patterns of growth and accumulation of wealth. The major controversy seems to be around the forces behind the creation of regional disparity. There is also disagreement on whether the gap of economic disparity among Canadian regions will ever be reduced. Those who believe in a free market economy maintain that government intervention has worked against the market-driven tendency towards equalization. Opponents of capitalism maintain that the process of capital accumulation leads to a concentrated and geographically uneven development. In order to correct and counteract these trends, they

argue for the necessity of a major state intervention which will have the responsibility to promote growth in the poor regions and create conditions similar to those prevailing in the rich regions.

Chapter Two

Capital Formation and Regional Disparities in Canada

2.1 Introduction

Economic theory has long considered the notion of capital formation and investment as central to the analysis of capitalist economies (Marx, 1967; Keynes, 1936; Kalecki, 1943). But the recent dramatic regional changes in many countries have been crucial in showing the significance of the sectoral and spatial allocation of investment in the creation of regional disparities. The conflicting theories of regional disparities reviewed in Chapter One are based on opposing views of the investment process and the regional dynamics underlying its spatial distribution. Most of these paradigms agree that regional capital accumulation constitutes a major component of the creation of jobs and economic growth in those regions. Among the various factors determining movements in space and the development of spatial structures are agglomeration economies, return differentials, the dispersing influence of transportation costs, and the development in communication and information systems.

Although they differ in their assumptions and hypotheses, most theories of regional growth and development have dealt with these interrelated factors. The conflicting predictions concerning the locational pattern of investment seem to be answers to questions like whether agglomeration economies are a minor factor influencing

return differentials or whether they are major complex forces inducing spatial concentration of firms and workers.

The equilibrium-based neoclassical theory of regional growth asserts that if the initial phase of industrialization is associated with concentration of population and economic activity in 'central' or 'core' regions, mature growth is associated with dispersion into different areas of the economy as entrepreneurs redeploy their capital to these locations. It argues that decreasing returns to scale might lower the marginal productivity of capital and, therefore, induce to relocate their capital away from areas of earlier industrialization which lowers the rate of investment.

The cumulative causation theory views investment as a self-reinforcing process and considers agglomeration economies as improved conditions of profitability, therefore, inducing more capital investment in the same direction as in earlier periods. It argues that the return on investment is an increasing function of growth in productive capacity. These higher capital yields attract more investment and deprive 'poor' areas of potential growth.

This polarized spatial structure of capital stock is also emphasized in other theories such as the growth poles theory or the Marxian theory of capital accumulation. However, the latter allows also for tendencies towards dispersal or deconcentration of production and interprets them as means for enhancing or improving conditions of accumulation. Prospects of high profits (availability of resources, labour, etc.) motivate capitalists to shift their

investments to 'less developed' areas.

In what follows, I will try to examine the validity of these competing conceptions of investment by analyzing the spatial structure of capital stocks in Canada between 1961 and 1990 and explore its implications for explaining uneven regional development. The remainder of the chapter is divided into three sections: Section 2.2 deals with the spatial structure of Canadian investment during the period 1961-1990 and outlines the implications of capital formation for regional growth in output, employment and migration. Section 2.3 examines the change that has occurred in the industrial structure of the Canadian regions over the past thirty years. Section 2.4 concludes the chapter.

2.2 The importance of capital formation

Economic analysis attempts to explain growth in aggregate output by the relative contributions of two main factors: capital and labour. Technological change is often implicit and is measured by the skill level of the labour force or the state of art of the machinery and equipment. Given that an expansion in the stock of capital is a major stimulus to regional economic growth, capital investment should be a central focus of regional economic analysis.

The centrality of capital formation in regional economic analysis has only recently been given the attention it deserves in empirical work. Much of this neglect has been attributed to the lack of data on regional capital stocks. *Statistics Canada* has recently produced unpublished provincial capital stock series which

represent an extremely useful resource for regional research in Canada. The availability of these data in Canada and elsewhere has spurred the development of many interesting regional studies.

McHugh and Widdows (1984) have found a quantitative relationship between the age of capital and unemployment rates in various regions (states) of the U.S.A. They show that the age of capital is an important factor in determining the order in which plants are shut down and when the worn-out capital would be replaced as well as the number of workers to be laid off. This obviously suggests that the direction of investment and, therefore, the rate of accumulation are important considerations for regional analysis.

In a somewhat similar study, Anderson and Rigby (1989: 121) show that there exist significant regional variations in the depreciation patterns which have led to "marked variations in the age structure of regional capital stocks" in Canada. They further argue that these differences have an important impact on regional output and employment since the latter depend on the age structure of capital which in turn determines the rate of investment and the direction of new capital.

Studies by Greenwood (1981) and Muth (1971) have established some strong interrelationships between labour (employment) and capital. Others (Massey, 1984; Bluestone and Harrison, 1982) have shown that regional in- and out-migration are closely related to regional growth and decline. In particular, Bluestone and Harrison (1982) argue that the recent period of restructuring has clearly

demonstrated that relocation of economic activity has been followed by a series of waves of labour migration. Capital mobility seems to induce labour migration and, in general, labour is found to be dependent on capital for jobs. Consequently, it can be maintained that migration is initiated and structured by the changes in the production process.⁴

All of the above theories suggest that the spatial distribution of capital is of key importance in determining regional growth in output, employment and interregional migration. The purpose of this section is to investigate these relationships in the Canadian context. The methods used here for examining the impact of capital formation on each of the three major variables referred to above (employment, output, migration) are conceptually simple and essentially aim at determining the level of significance of correlation between capital accumulation and the other variables.

In this section the discussion on regional performance is at two levels. First, more aggregated regions are considered in order to discern the general pattern of growth and concentration of economic activity. These regions are: Atlantic Canada (Newfoundland, Prince Edward Island, Nova Scotia and New Brunswick), Quebec and Ontario, The Prairies (Manitoba and Saskatchewan), Alberta, and British Columbia together with the Territories. The reason for grouping these provinces together is

⁴ For an interesting discussion on migration and capital, see Clark et al. (1986: Chapter 11).

twofold: (1) they present similar characteristics as to their industrial structure and economic performance, (2) some provinces (e.g. Prince Edward Island) have very small shares in the national aggregates (capital stock, employment, etc.) which makes them too insignificant to consider separately.

However, the second level of the discussion uses provincial information in order to identify and highlight the varying performance of each province.⁵ The discussion at this level is useful because it may provide some insight into the types of policy that a provincial government might adopt to improve economic performance and economic conditions (employment, etc.) within the territory over which it has jurisdiction.

Before examining the implications of the spatial patterns of capital formation, it is useful to look at the historical trends shown in the capital stock series. Table 2.1 shows the growth rates of total capital stock in the six major regions and their constituent subregions for different sub-periods between 1961 and 1990.

At the regional level, there seems to be a certain degree of stability in the rates of accumulation throughout the 1970s and the first half of the 1980s. This is shown by the high degree of correlation between the growth rate rankings at the regional level which only declined when the growth rates of the late 1980s were compared to those of the beginning of the decade. Indeed, the

⁵ Yukon and North-West Territories are included with British Columbia.

Table 2.1

Growth Rates of Regional Capital Stocks, 1961-90
Total Manufacturing and Non-Manufacturing

	1961-66	1966-71	1971-76	1976-81	1981-86	1986-90	1961-90
Atlantic	31.23 2*	31.87 1*	20.89 3*	13.99 4*	8.86 3*	10.58 4*	198.53 3*
NFLD	43.47	43.36	20.72	11.83	9.59	4.59	219.36
PEI	30.45	8.01	14.71	10.49	2.38	11.45	103.76
NS	24.63	33.33	19.60	12.47	12.55	12.64	183.38
NB	29.62	24.83	23.39	18.10	5.15	13.27	180.83
Quebec	32.57 1	15.73 6	21.22 2	14.90 3	5.08 5	15.89 2	170.34 5
Ontario	28.51 3	22.19 3	19.33 5	13.51 5	8.82 4	21.76 1	189.88 4
Prairies	25.61 6	17.29 5	14.76 6	11.97 6	-0.41 6	4.67 6	102.90 6
MAN	22.38	20.37	16.12	8.31	-0.95	6.34	95.15
SASK	28.55	14.61	13.53	15.38	0.07	3.22	99.33
Alberta	27.77 4	22.03 4	23.52 1	47.06 1	14.50 1	5.02 5	261.02 1
B.C.	26.81 5	27.00 2	20.24 4	24.60 2	9.33 2	10.87 3	209.24 2
CANADA	29.03	21.40	20.02	19.24	8.04	10.58	186.83
Coef.		-0.03	-0.086	0.83	0.83	-0.03	

* indicates the ranking
Coef. is the coefficient of correlation between successive growth rate periods.
Source: Statistics Canada, Investment and Capital Stock Division, Unpublished material

correlation between the first and last halves of the 1980s is negative, thus suggesting a relative shift in the direction of new investment. This reversal is reflected in the change of Ontario's position from fourth to first place and that of Quebec from fifth to second place. This was paralleled by a decline in Alberta and British Columbia who moved from first and second place respectively to fifth and third place.

In Central Canada, Quebec seems to have lost momentum in the 1980s after having taken the lead in early 1960s and during the 1970s. Growth rates in this region declined dramatically after 1981 and were largely surpassed by the performance of Ontario. The Prairie provinces of Manitoba and Saskatchewan were badly hit by the effects of the 1982 recession and have thus maintained a certain stability in their rankings throughout the study period 1961-1990. In Atlantic Canada, New Brunswick emerged as the dominant province (except for the recessionary period of 1982) and largely surpassed the high growth rates of the 1960s in Newfoundland. In the latter province, growth rates have shown a clear decline since the beginning of the 1970s. For the entire period considered, Alberta and British Columbia clearly dominate since capital stocks grew by 261 percent in Alberta and 209 percent in British Columbia. Growth rates in Alberta were higher than in any other region, suggesting that exploitation of natural resources in this region has necessitated important new investments.

Central Canada, which has been the dominant industrial core of the country, has recorded lower growth rates. This is perhaps due

to the fact that the aging capital stock of the region is being replaced at a slower rate. This seems to be supported by the fact that capital stocks in the manufacturing sector grew by 209 percent for the same period in Quebec, a less industrialized region and only by 188 percent in Ontario (see Table 2.2). However, growth rates of total capital stocks were faster in Ontario which might imply that the latter is developing a new competitive advantage in non-manufacturing industries.

The low growth rates in the Prairies suggest that this region has not presented any real advantage to motivate capital to invest in non-agricultural sectors and has therefore remained largely dominated by agriculture. However, if we consider the manufacturing sector, Saskatchewan seems to have attracted more capital, particularly in the last half of the 1980s (see Table 2.2).

In the manufacturing sector, the growing continuity between the experiences of the late 1970s and early 1980s seems to have come to an end with the 1982 recession. Alberta moved from first to fifth place and British Columbia from sixth to first place. In Atlantic Canada, growth rates have constantly declined since the beginning of the 1970s which marked the end of several publicly funded programmes (e.g., DREE).

Given that the growth rates of the total capital stock are generally high in Western (Alberta and British Columbia) and Central Canada (Quebec and Ontario) and low in the Prairies and Atlantic Canada, the overall picture would seem to suggest that

Table 2.2

Growth Rates of Regional Capital Stocks in Manufacturing Industries, 1961-1990

	1961-66	1966-71	1971-76	1976-81	1981-86	1986-90	1961-90							
Atlantic	35.23	3*	21.33	2*	10.03	5*	0.52	4*	33.49	4*	299.41	2*		
NFLD	31.42	68.66	16.84	8.83	-1.18	22.86					242.16			
PEI	27.69	21.69	21.78	26.42	30.23	21.73					279.23			
NS	30.79	87.89	21.67	6.95	-5.54	29.84					292.15			
NB	41.86	43.40	23.36	13.87	7.26	41.96					335.10			
Quebec	32.69	4	16.30	6	15.41	3	12.15	4	9.05	2	41.93	2	209.16	3
Ontario	37.01	1	17.74	5	14.85	4	20.90	2	4.05	3	23.74	6	188.39	4
Prairies	10.10	6	24.81	2	6.87	5	6.29	6	-1.84	5	36.39	3	108.98	6
MAN	11.99	22.43	2.76	3.45	-3.38	10.95					56.25			
SASK	5.94	30.36	15.85	11.80	0.91	80.13					225.15			
Alberta	10.56	5	24.68	3	42.87	1	53.25	1	10.02	1	27.99	5	325.01	1
B.C	36.11	2	23.93	4	2.43	6	17.34	3	-9.41	6	45.00	1	166.30	5
CANADA	33.09	21.49	14.67	18.76	3.48	31.74					200.11			
Coeff.		-0.37	0.20	0.30	0.54	-0.54								

* indicates the ranking
 Coeff. is the coefficient of correlation between successive growth rate periods
 Source: See Table 2.1

capital accumulation is concentrated in the first two regions; and since higher growth rates have characterized the economies of Alberta and British Columbia, there may be a beginning for the tendency towards a regional shift from central to western Canada, similar to that from the frostbelt to the sunbelt in the United States. However, given that the fast growth in capital stocks of the West is largely due to investments in resource-based industries, this possible shift is not likely to characterize the regional Canadian economies in the near future. Investment and capital accumulation would still be expected to be concentrated in Central Canada as can be seen from the rankings and the performance of Ontario and Quebec during the last half of the 1980s.

The issue of trends and patterns in the spatial distribution of capital accumulation is a central one in the competing theories of regional growth and decline. This disputed theoretical issue leads us to examine empirically the spatial and temporal dimensions of change in regional capital stocks in Canada. Table 2.3 shows the regional shares of the total national capital stock for the period 1961-1990.

The trends observed earlier in growth rates of regional capital stocks are largely reflected in the change in regional shares (see Table 2.3). The fast growth rates observed in the West translate into important increases in the percentage share of Alberta and British Columbia. The somewhat relatively lower rates of growth in the rest of the country resulted in a decline of the relative shares of all other regions except Ontario. The Prairie

Table 2.3
Regional Shares of National Capital Stock
1961-1990

	1961	1966	1971	1976	1981	1986	1990
Atlantic	7.29	7.42	8.06	8.11	7.76	7.81	7.58
Nfld	1.79	1.99	2.35	2.37	2.22	2.25	2.07
PEI	0.40	0.40	0.36	0.34	0.32	0.30	0.29
NS	2.68	2.59	2.85	2.84	2.68	2.79	2.75
NB	2.42	2.43	2.50	2.57	2.55	2.48	2.46
Quebec	23.29	23.93	22.81	23.04	22.20	21.59	21.96
Ontario	33.74	33.60	33.82	33.63	32.01	32.24	34.44
Prairies	11.18	10.89	10.52	10.06	9.44	8.71	7.99
Man	5.33	5.06	5.02	4.85	4.40	4.04	3.77
Sask	5.85	5.83	5.50	5.20	5.04	4.66	4.22
Alberta	11.91	11.80	11.86	12.20	15.05	15.95	14.70
B.C	12.58	12.36	12.93	12.95	13.54	13.70	13.33

Source: See Table 2.1

region suffered the largest decline (-3.19 percentage points), followed by Quebec (-0.48). In the case of Atlantic Canada, again it is clear that government intervention during the 1960s and early 1970s has helped to increase the region's share. But when these programmes were abandoned, the share of Atlantic Canada eroded back to the 1960s levels and all provinces have exhibited a continual decline throughout the 1970s and 1980s.

This change in the spatial distribution of capital stocks is important for two reasons. First, it tells us something about the direction of investment, therefore, providing empirical grounds for testing the various theories about investment location. Second, to the extent that productivity and incomes (which are important indicators of regional disparities) are affected by the intensity of fixed capital in production, this change gives us an indication of the performance of productive capacity in each region.

Concerning the validity of the various theoretical conceptions of investment, we must note that the trend towards decline in shares of capital stocks was smooth and continuous in the Prairies, and this was paralleled by a smooth increase in the shares of Alberta and British Columbia. In the other regions there was some degree of volatility in investment behaviour. Can it be argued then, as suggested by the cumulative causation theory, that investment tended to flow in the same direction of change established in earlier periods? This seems to be the case when one compares the Prairies to Alberta and British Columbia, but it does not apply in the case of Quebec, Ontario and Atlantic Canada which

have experienced important fluctuations in investment.

The neoclassical theory would interpret the disinvestment from Quebec and the rise in Alberta as a tendency towards convergence, but cannot explain the experiences of Atlantic Canada and the Prairies since it predicts that capital will flow to the regions where the capital-labour ratio is low, that is, areas characterized by low wages and high return on investment. The Marxian theory of accumulation which views investment as tending generally towards concentration, but also responding to changes in conditions of profitable accumulation, could apply here. The increase in oil prices experienced in the early 1970s seems to have diverted important funds of investment from other areas and drew them into Alberta, where oil resources were abundant.

Concerning the relative importance of capital formation in determining regional economic performance, one can start by looking at the change in regional output shares over the same period of study. Again, analysis at this aggregated level overlooks some important components of the structure of production such as changes in capital-labour ratios, the composition of the workforce, technological changes, etc. So in order to draw any conclusions concerning the role of capital accumulation in regional disparities one must necessarily account for these changes. This issue will be taken up in Chapter Four of this thesis. Nevertheless, it is useful at this level to establish at least the correlation between the spatial structure of capital stocks and the regional shares of output.

This information is provided by comparing Tables 2.3 and 2.4. First, note that output shares declined (increased) with the decline (increase) in capital stock shares in all regions except Atlantic Canada. This correspondence is quite strong in the Prairies where the correlation coefficient is 0.93. In the rest of the regions, this coefficient ranged between 0.77 and 0.87 (see Table 2.4). It is important here to note the shifting importance of the regional economies as Quebec and the Prairies saw their shares of total output produced decline by 3 and 1.9 percentage points respectively between 1961 and 1990. These declines were largely to the benefit of Alberta and British Columbia which increased their respective shares from 7.9 to 10.5 percent and from 10.2 to 12.4 percent during the same period.

The pattern of change in regional GDP as a measure of economic performance is useful and when combined with the change in the regional structure of population, it can be used to reflect the change in per capita GDP. While no province or region lost population between 1961 and 1990, the shift in the proportion of total population was significant⁶. Alberta and British Columbia increased their respective shares by 2 and 3 percentage points from 1961 to 1990. This increase was at the expense of all other provinces except Ontario which increased its own.

When we compare Table 2.5 with Table 2.3, one is struck by the similarity between the pattern of population and the spatial

⁶ Note, however, that population in the province of Saskatchewan declined between 1987 and 1990.

Table 2.4
Percentage of Total GDP Produced by Region, 1961-1990

	1961	1966	1971	1976	1981	1986	1990	r_{yk} *
Atlantic	6.16	5.86	5.99	5.76	5.33	6.23	6.01	-0.24
Nfld	1.26	1.30	1.35	1.34	1.31	1.35	1.29	
PEI	0.28	0.38	0.37	0.29	0.38	0.30	0.29	
NS	2.64	2.37	2.47	2.28	2.07	2.58	2.49	
NB	1.97	1.91	1.89	1.85	1.67	2.00	1.94	
Quebec	26.14	26.04	25.17	24.10	22.92	23.33	23.15	0.87
Ontario	41.08	40.97	42.08	39.51	37.07	40.15	41.42	0.77
Prairies	8.51	8.87	7.66	7.94	7.73	7.06	6.55	0.93
Man	4.55	4.18	4.08	3.97	3.70	3.65	3.53	
Sask	3.95	4.64	3.58	3.97	4.03	3.40	3.02	
Alberta	7.94	7.85	8.08	10.77	14.04	11.38	10.49	0.78
British	10.18	10.47	11.03	11.92	12.91	11.84	12.38	0.84

* indicates the coefficient of correlation between the spatial distribution of capital stocks and that of GDP.

Source: Statistics Canada, *Provincial Economic Accounts*, Catalogue no. 13-213

Table 2.5
Percentage Share of Population by Region, 1961-1990

	1961	1966	1971	1976	1981	1986	1990	r^*_{kp}
Atlantic	10.40	9.90	9.54	9.49	9.17	8.99	8.73	-0.58
NFLD	2.42	2.43	2.33	2.24	2.16	2.24	2.15	
PEI	0.52	0.51	0.50	0.50	0.49	0.50	0.48	
NS	3.66	3.60	3.48	3.44	3.35	3.44	3.56	
NB	2.94	2.95	2.86	2.80	2.72	2.60	2.71	
QUE	28.8	28.9	27.95	27.11	26.45	25.80	25.44	0.92
ONT	34.2	34.8	35.71	35.94	35.43	35.94	36.61	0.08
Prairies	10.2	9.6	8.88	8.45	8.19	8.21	7.86	0.89
MAN	5.1	4.8	4.58	4.44	4.22	4.23	4.10	
SASK	5.1	4.8	4.29	4.01	3.98	3.98	3.76	
ALTA	7.3	7.3	7.55	7.99	9.19	9.37	9.29	0.97
BC	9.10	9.60	10.38	11.01	11.55	11.70	12.08	0.89

r^*_{kp} indicates the correlation coefficient between capital stock shares and population shares

Source: See Table 2.4

distribution of capital. Shares of population have declined (increased) in most provinces and regions where shares of capital stock have declined (increased). The only minor exception would seem to be that of Atlantic Canada whose capital stock marginally increased at the end of the period but was not paralleled by an increase of the population share. The overall correlation coefficient between the change in population shares and capital stock shares is 0.87.

This result suggests that people (population) move to areas where economic growth is most promising; areas which also attract capital investment. This is consistent with other findings such as Aydalot (1984) for France and Garnick (1984) and Keinath (1982) for the United States. As suggested by these and other studies (see the discussion in Section 2.2 above) capital formation plays an important role in employment generation. Table 2.6 shows regional and provincial shares of employment for the same period of study. Here again the overall correlation between patterns of employment and capital stocks is very strong (0.89) and the correspondence is almost universal, that is, employment share increased (decreased) in all provinces/regions where capital stock share increased (decreased). The exceptional case of Atlantic Canada may be explained by the fact that the marginal increase in the share of the capital stock did not succeed in improving the general economic conditions which remained depressed and, therefore, could not influence potential out-migrants to stay.

Table 2.6
Regional Employment Shares, 1961-1990

	1961	1966	1971	1976	1981	1986	1990	r* _{ke}
Atlantic	8.37	8.05	7.59	7.56	7.28	7.22	7.37	-0.63
NFLD	1.67	1.70	1.54	1.66	1.63	1.55	1.60	
PEI	0.52	0.48	0.46	0.44	0.43	0.44	0.44	
NS	3.44	3.30	3.16	3.08	2.93	2.96	3.01	
NB	2.70	2.57	2.43	2.38	2.30	2.27	2.31	
Quebec	27.28	27.99	26.84	25.91	24.75	24.50	24.30	0.94
Ontario	37.47	37.48	38.42	38.44	37.91	39.23	39.27	0.03
Prairies	10.54	9.36	8.80	8.47	8.05	8.13	7.59	0.88
Man	5.33	4.35	4.68	4.48	4.19	4.21	4.02	
Sask	5.21	4.52	4.12	3.99	3.86	3.92	.57	
Alberta	7.63	7.66	7.94	8.84	10.46	9.90	9.79	0.92
B.C.	8.70	9.45	10.29	10.77	11.54	11.01	11.68	0.84

r*_{ke} indicates the correlation coefficient between capital stock shares and employment shares

Source: Statistics Canada, *Historical Labour Force Statistics*, Catalogue 71-201
 Statistics Canada, *Historical Statistics of Canada*, Second Edition, 1983

In this section, it was found that there is a strong relationship between regional capital stocks and growth in regional employment, output, and population. This is consistent with economic theory and other empirical studies. It was also found that Alberta and British Columbia emerged as strong regions which increased their shares of capital stock, employment, output and population by important proportions.

2.3 The changing industrial structure of regional economies

Concerning the sectoral composition of regional and provincial GDP, Table 2.7 shows that the goods-producing industries have declined in relative terms in all regions/provinces over the period 1961-1990. This decline, of course, is exactly offset by an increase in the service-producing industries for the same period. This shift towards the service-producing industries supports the commonly held perception of a general decline in the relative importance of manufacturing and other goods-producing industries. This commonly held perception usually refers to the decline of these sectors as a source of employment, but it is clear from Table 2.7 that their contribution to the output produced has also declined.

The most notable change reflected in the table is the decline in the relative importance of manufacturing output, especially in Quebec, Ontario and British Columbia where its share of GDP dropped to less than half of what it was in 1961. A similar trend was observed in construction industries which declined in every

Table 2.7

The Changing Composition of Regional Output, 1961-1990

		Service	Agric	Forests	Fish	Mining	Manuf	Const	Util	Total
Atlantic	1961	60.83	2.97	2.65	2.09	4.05	16.21	8.63	2.57	100.00
	1990	76.12	0.80	0.93	1.27	1.18	10.51	5.83	3.36	100.00
Nfld	1961	51.76	0.78	3.91	2.73	10.55	13.67	14.65	1.95	100.00
	1990	77.50	0.25	0.80	1.74	2.90	6.78	6.07	3.96	100.00
PEI	1961	61.95	11.86	0.88	3.94	0.00	8.08	11.50	1.78	100.00
	1990	79.90	3.01	0.20	2.28	0.00	5.77	6.42	2.41	100.00
NS	1961	64.79	2.90	1.03	2.53	3.75	15.45	7.02	2.53	100.00
	1990	77.41	0.90	0.46	1.64	0.79	10.90	5.67	2.53	100.00
NB	1961	61.20	3.25	4.26	0.88	0.88	20.15	6.51	2.88	100.00
	1990	72.97	0.69	1.75	0.46	1.12	13.17	5.78	4.05	100.00
Quebec	1961	53.58	2.51	1.64	0.05	2.40	31.24	6.25	2.33	100.00
	1990	75.26	1.21	0.34	0.05	0.69	14.78	4.92	2.75	100.00
Ontario	1961	51.87	3.34	0.69	0.03	3.29	33.31	5.57	1.90	100.00
	1990	74.77	1.07	0.22	0.02	0.95	16.90	4.05	2.00	100.00
Prairies	1961	57.62	11.76	0.20	0.12	7.70	11.94	8.28	2.38	100.00
	1990	72.89	6.76	0.17	0.06	4.83	7.65	5.38	2.86	100.00
Man	1961	62.65	7.20	0.22	0.18	4.47	15.96	7.29	2.03	100.00
	1990	77.12	3.95	0.15	0.09	1.62	9.84	4.87	2.36	100.00
Sask	1961	51.84	17.28	0.23	0.09	11.43	7.38	9.47	2.28	100.00
	1990	67.94	10.05	0.20	0.03	7.93	5.09	5.98	2.79	100.00
Alberta	1961	48.51	11.61	0.53	0.03	14.43	11.09	12.15	1.65	100.00
	1990	65.65	3.59	0.06	0.01	15.69	6.44	5.37	3.19	100.00
B.C	1961	55.53	2.27	6.88	0.97	2.76	21.57	7.58	2.44	100.00
	1990	76.74	0.80	1.41	0.32	2.82	9.40	6.30	2.21	100.00
Canada	1961	53.47	4.38	1.65	0.28	4.32	26.94	6.89	2.07	100.00
	1990	74.13	1.69	0.42	0.14	2.92	13.40	4.86	2.44	100.00

Source: Statistics Canada, Provincial Gross Domestic Product by Industry, Catalogue 15-203

province. Mining output also declined in Central Canada and the Prairies, but the biggest decline was recorded in Newfoundland (from 10.5 percent to 2.9 percent). Interestingly, the importance of mining in the GDP of Alberta has increased during this period: this reflected the rise in the importance of oil resources and the considerable investments in this sector during the 1970s and the first half of the 1980s. The output share of agriculture and the fisheries has also declined in all regions/provinces but particularly in Saskatchewan and Manitoba. Alberta and Prince Edward Island also saw the share of their agricultural output decline. The only industries which increased the relative importance of their output in the provincial GDP were those grouped under "other utilities", which include electric power and gas distribution.

The combined relative importance of the goods producing industries in the Canadian economy as a whole decreased from 46.5 percent in 1961 to just over 25 percent in 1990. This decline was offset by a 20 percentage points increase in the service-producing industries. Indeed, industries composing this sector⁷ have increased their relative shares in the GDP of all regions and in the Canadian economy as a whole. In Canada, the share of the

⁷ In addition to services to businesses, this sector also includes other services such as Finance, Insurance and Real Estate (FIRE), government (all levels) services, educational services, and health and social services. It would be very interesting to decompose this sector and see the relative importance of each of these components, but data at the regional (provincial) level are not always available for all categories and often suffer a great deal of inconsistency, especially for the 1960s.

service-producing industries increased from just over half (53.47 percent) in 1961 to almost three quarters (74.13 percent) of the total output in 1990. Thus there exists a certain degree of continuity to these patterns with each region experiencing, to varying levels, the same national trends.

How has this change in the industrial structure of regions affected their relative performance? In other words, to what extent has the relative decline (increase) of a particular industry in a region's economy affected its performance in comparison with other regions?

The question can be answered directly by looking at the change in the contribution of each region's sector in the national output of the same sector. Table 2.8 shows the change in the major sectors between 1961 and 1990. First, note the high degree of specialization among Canadian regions. Atlantic Canada provides over half of the total national output of fisheries with British Columbia supplying 28 percent in 1990. British Columbia is also the largest Canadian producer in the forestry and wood products and provides 42 percent of the output of this sector. Mining is essentially concentrated in Alberta where 56 percent of the mining output was produced in 1990 whereas manufacturing and services are highly concentrated in Ontario and Quebec.

Advanced manufacturing and financial and commercial services are located in what has traditionally been considered as the economic core of the country whereas production of primary (agriculture, forestry, fishing, and mining) commodities is

Table 2.8

The Regional Distribution of Economic Activity, 1961-1990

	Services		Agriculture		Forests		Fishing		Mining		Manufacturing		Construction		Utilities	
	1961	1990	1961	1990	1961	1990	1961	1990	1961	1990	1961	1990	1961	1990	1961	1990
Atlantic	6.99	6.16	4.18	2.83	9.95	13.31	48.60	55.08	5.78	2.44	3.70	4.71	7.70	7.19	6.83	7.93
NFLD	1.22	1.34	0.23	0.19	3.02	2.29	13.08	16.19	3.09	1.27	0.64	0.65	2.69	1.59	1.20	2.20
PEI	0.32	0.32	0.73	0.53	0.15	0.14	3.74	4.90	0.00	0.00	0.07	0.13	0.47	0.40	0.24	0.31
NS	3.19	2.59	1.75	1.32	1.66	2.72	25.23	27.49	2.29	0.42	1.51	2.02	2.69	2.89	2.87	2.09
NB	2.26	1.91	1.47	0.79	5.13	8.16	6.54	6.50	0.40	0.75	1.47	1.91	1.86	2.31	2.51	3.33
Quebec	26.21	23.51	15.04	16.55	26.24	18.99	4.67	7.67	14.60	5.49	30.32	25.55	23.74	23.40	28.98	26.22
Ontario	39.88	41.78	31.49	26.28	17.35	21.82	4.67	5.22	31.43	13.56	50.82	52.27	33.23	34.53	37.25	33.79
Prairies	9.15	6.44	22.89	26.17	1.06	2.72	3.74	2.98	15.17	10.17	3.76	3.87	10.20	7.25	8.74	6.84
Man	5.32	3.68	7.29	8.24	0.60	1.31	2.80	2.24	4.69	1.97	2.69	2.59	4.80	3.54	4.43	3.38
Sask	3.83	2.77	15.60	17.93	0.45	1.41	0.93	0.75	10.48	8.20	1.07	1.15	5.41	3.71	4.31	3.45
Alberta	7.20	9.29	21.14	22.29	2.56	1.41	0.93	0.75	26.56	56.39	3.27	5.17	13.96	11.58	6.23	13.86
British Columbia	10.57	12.82	5.26	5.88	42.84	41.75	37.38	28.30	6.47	11.95	8.14	8.69	11.17	16.05	11.98	11.37
Canada	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Statistics Canada, Provincial Gross Domestic Product by Industry, Catalogue 15-203

essentially the lot of the somewhat "peripheral" economies. This hierarchical structuration is an obvious characteristic of Canadian economic space and has been evident at least since the 1960s. Note for instance that Ontario's share of services and manufacturing has increased and that this was paralleled by important decreases in agriculture and mining. An opposite trend occurred in the Prairies where the share of mining has also declined. Atlantic Canada shares similar characteristics with the Prairies in that it increased its share of the primary production but suffered a decline in the share of services. Alberta and British Columbia have both increased their share of services with Alberta more than doubling its contribution to the mining output from 1961 to 1990 (see Table 2.8).

2.4 Conclusion

From the data presented above, it is clear that economic activity is spatially concentrated and heavily specialized. However, important changes have occurred in the regional structure of the Canadian economy over the past thirty years. Alberta and British Columbia emerged as important players on the Canadian economic scene. Location of economic activity in these regions seems to be competing against other Canadian regions and particularly Quebec. Although the Prairies and Atlantic Canada have experienced a relative industrialization, which was reflected in the expansion of their manufacturing sectors, the tendency towards concentration in "core" regions still characterizes the industrial landscape of the country.

Bearing this in mind and knowing that there exist substantial intraregional differences, I will try to show in the following chapters that the observed regional disparities in employment, unemployment, incomes, etc. find their root cause in investment decisions which resulted in a concentrated pattern such as the one described above.

Chapter Three

A Model and an Empirical Analysis of Canadian Regional Investment (1961-1990)

3.1 Introduction

In Chapters One and Two, I discussed the importance of capital formation as an explanatory variable in the observed trends and patterns in regional disparities. It was shown that capital formation was central in all theories dealing with regional growth and decline. The aim of this chapter is to show that, despite the frequent use of capital stocks and investment as an important variable in the theories reviewed in Chapter One, there has been no clear specification of the investment process from a regional perspective. A model of regional investment is then proposed and tested for the various Canadian regions.

If investment and, hence, capital stocks are a major element explaining the evolution of regional disparities, then a natural question is to find out what explains investment itself, that is, what makes investment grow faster (slower) in a given region as compared to the rest of the country. In other words, what are the regional dynamics of capital accumulation?

Most theories dealing with questions of regional growth and development have based their explanations on models of investment that are actually designed for the national economy. This "top-down" approach leaves an important gap between theories of

investment at the national level and the real determinants of capital formation at the regional level. This gap has also been noticed by Clark et al. (1986) and Gertler (1984, 1986) among others. There is therefore a need for a more explicit theory of investment that clearly specifies the determinants of investment and empirically tests their influence.

Alternative theories of investment behaviour differ greatly as to what variables should be included as determinants in the investment function. Some studies emphasize the role of expected profits, others give a central role to the cost of capital and the growth of demand (and output). However, most of these studies can be said to have generally been based on the (partial) capital stock adjustment model (Chenery, 1952; Koyck, 1954) where the gap between actual and desired capital stock is only gradually eliminated:

$$\Delta K_t = I_t = (1-\alpha)(K_t^* - K_{t-1}) \quad (3.1)$$

$$0 < \alpha < 1$$

where K_{t-1} is actual capital stock, K_t^* is desired capital, and $(1-\alpha)$ measures the rate of speed with which the actual capital stock adjusts to its desired level.⁸ If $\alpha=0$, the adjustment is completed within the current time period and if $\alpha=1$, then net investment is zero and no adjustment is implied.

According to this general basic framework, investment is determined by the existing level of capital stock, K_{t-1} , and the

⁸ Capital refers here to fixed capital stock, i.e., the accumulated business investment.

desired level of capital, K^* . One might ask in turn what are the determinants of the desired level of capital? Two broad categories of determinants can be identified.

The first set of determinants is derived from theories of profit maximizing behaviour. This is usually expressed in terms of the accelerator model of investment according to which there is a close and systematic relationship between the level of output and the stock of capital. In neoclassical models where markets are competitive and the production function exhibits variable (rather than fixed) coefficients, investment is assumed to be proportional to the scale of production, to the capital-output ratio, and to relative prices. The second set of determinants relates to financial considerations. The rate of investment may be constrained (stimulated) by the availability of investment funds. Desired capital may depend on the sources of financial resources (internal or external) and the conditions under which these are made available to firms, i.e, the cost of capital, terms of repayment, etc.⁹

A regional theory of investment must obviously take into account the empirical significance of the above determinants. This makes it important to evaluate the arguments and hypotheses concerning the complex relationship between capital accumulation

⁹ Note that (other) political and social determinants of investment such as the attitude of the government towards the private sector, the militancy of the labour force, etc. are not considered here. For a useful discussion see Sawyer (1989: 379-380). See also Gertler (1987) for an analysis of the impact of these determinants on provincial capital accumulation in Canada.

and the various factors that influence it. In this chapter, two basic questions are answered by looking at the evidence from time-series data on regional investment in Canada. The first question deals with the determinants of the level of capital accumulation in a given region over time. The second question deals with the allocation of capital between regions and the factors that make some regions attract (and accumulate) more capital than others.

In section 3.2, I review the existing regional applications and show that they rely on national rather than regional perspectives in order to derive their investment functions. In section 3.3, I propose a model of investment that takes into account the relative size of a region's previous capital stocks, its profit levels, the cost of labour, and prices of the major commodities. The relative growth rate and capacity utilization as well as the cost of capital are also considered as major determinants of regional investment. Section 3.4 explains the data sources. Time-series data are used to test the model and evaluate the significance of these determinants. The underlying elements of investment behaviour at the regional level are then brought out and their impact on regional disparities discussed in Section 3.5. Section 3.6 summarizes the findings of the chapter.

3.2 Theories of investment and their regional applications

It was noted in Chapter One that most theories that have dealt with the regional question are based on differing conceptions of the investment process. Although investment and, therefore,

capital accumulation has loomed large in explanations of regional growth and decline, there has not been any clear formulation of a regional investment theory that specifically identifies the regional dynamics of capital accumulation. As mentioned by Clark et al. (1986), the regional dimensions of investment have not been examined in enough detail since most theories have often relied on national rather than local accelerators to derive their investment models.

For instance, as mentioned above, it is generally assumed that investment is a linear function of output, with every change in production leading to a direct change in investment (the accelerator model). Among the second set of determinants there is also the assumption that investment capital is perfectly mobile and equally available to all regions of a given country, that cost differentials are minimal, and that investment is affected by the rate of return to capital.

Before I show that these assumptions do not always hold at the regional level, it is important to note that the theories referred to above have not included in their models some other important determinants which may be more relevant to consider at a regional level. For instance, conclusions based on the accelerator model, which assert that an increase in output calls for an increase in investment, clearly need to be qualified when we include the degree of capacity utilization (DCU). Indeed, if capacity utilization is less than 100 percent, an increase in production might not lead to an increase in investment but only to an increase in the DCU and

firms could increase their output without making new investments.

Also, other factors such as the magnitude of past profits realized in a region, levels of its existing capital stocks and the change in prices of its major commodities seem to be important considerations, at least from the investor's point of view. Yet they have not been explicitly considered by these theories in their investment models. Further, assumptions concerning the availability of investment funds and the mobility of capital between regions refer to *financial* capital and ignore the role *fixed* capital may play in the spatial distribution of capital and its accumulation.

The distinction between financial and fixed capital is important for two reasons. First, fixed capital, which represents an important component of capital, lacks the kind of mobility enjoyed by financial capital and is therefore characterized by a certain degree of rigidity in space. It is also this form of capital that is used in empirical studies to measure the impact on regional growth, productivity, employment, etc. Second, and no less important, the distinction raises the question of the meaning of capital and its measurement. As Joan Robinson (1974: 38) put it: "does a quantity of capital mean a number of dollars or a list of machine tools?"

Although growth theories are production-based and attempt to explain regional disparities by looking at the relative contributions of the various inputs (particularly capital and labour) and the effect of industrial structure, most of them have systematically referred to capital in its fluid, financial form.

The neoclassical theory of investment reviewed in Chapter One assumes that capital and labour are substitutable and that entrepreneurs can adjust their levels according to relative prices and marginal productivities. Regional cost and return differentials induce entrepreneurs to redeploy their capital towards locations where the capital-labour ratio (K/L) is low and away from regions where it is high. The theory predicts that over time these ratios (and consequently marginal products and factor prices) are equalized. This capital mobility clearly refers to investment capital (financial) and not to the actual redeployment of physical capital but it is implicitly assumed to hold for capital in general.

Although it is true that investment capital now enjoys a considerable degree of mobility with the advance in technology and information diffusion, it remains equally true that the assumed equal availability of capital to all regions is inhibited by tendencies towards concentration and economies of agglomeration, which are common characteristics of modern economies. For instance, Martin et al. (1979) found that there exist significant and systematic lags between Canadian regions in the adoption and diffusion of technology and industrial innovations. The authors concluded that this situation may have contributed to the persistent productivity differences between Canadian regions.

In an empirical study using Canadian data, Guccione and Gillen (1972) attempted to explain gross investment in Canadian regions over the period 1947-1968. They used a model based on the

accelerator mechanism but modified to account for the real cost of capital services. The main determinants of regional investment were the change in output and lagged values of investment. The authors assumed that output and the price of capital services were constant over time and used national rather than regional values. They derived regional coefficients to assess the regional sensitivity to national fluctuations. Their conclusion was that regional investment was driven by national output.

This method of regionalizing the effects of national variables through regional coefficients is clearly a limited one (as admitted by the authors themselves) since it fails to consider directly the regional determinants of investment (see Guccione and Gillen, 1972: 293). Moreover, if the aim is to study problems of regional capital accumulation, the use of gross investment as the dependent variable seriously curtails both the explanatory power of the model and its predictions since it ignores the effect of physical depreciation and therefore gives a false impression of the productive capacity of a region as embodied in its stock of capital.

The use of output as an explanatory variable of investment behaviour is derived from the accelerator concept, which states that net investment is a function of past changes in output (Jorgenson, 1971; Clark, 1979; Allen, 1982). The accelerator model has been used mainly to explain investment at the national level, but it is implicit in most theories that have attempted to describe this process at the regional level. Neoclassical regional models are generally explicit about their use of the accelerator principle

since they are essentially adapted versions of national models. Other regional models like the cumulative causation models proposed by Myrdal (1957), Hirschman (1958), and Kaldor (1970), have also in some way or the other made (implicit) use of the accelerator principle.

Indeed, it is a well known point in the regional growth literature that the cumulative causation model as formulated by Kaldor (1970) largely relies on the working of Verdoorn's law (Verdoorn, 1949; 1980; see also Bairam, 1987), which states that productivity is an increasing function of the rate of growth of output. It is then argued that higher capital returns attract more investment to high-growth regions and deprive the 'poor' areas of potential growth, thus leading to a cumulative process of growth.

As it is generally specified, the accelerator model relating investment to changes in output not only fails to take into account the changes in the utilization of productive capacity, but also leaves out of account any impact a *change in output in other regions* might have on investment in the region under study. For example, trying to explain regional investment by *regional* demand may not be entirely appropriate since if we consider regional imports and exports, demand within a region and therefore investment become relatively independent of local output. If output changes are believed to be major determinants of investment, the accelerator model must be at least adapted to account for the above factors.

In a recent study, Anderson and Rigby (1989) estimated

regional capital stocks in Canada and their age structure for the period 1961-1981. They found important variations in regional patterns of depreciation and suggested that the resulting differences in regional capital stocks have important implications for investment. In particular, it was found that depreciation was faster in Ontario, thus contributing to a more rapid turnover of capital, which leads to the introduction of new technologies that in turn make the existing capital obsolete more quickly. Here the rate of investment seems to follow the rate of depreciation of capital stocks.

Another interesting observation of Anderson and Rigby is that the rate of investment has markedly increased in Alberta during the second half of the 1970s and the early 1980s. The high profits realized in the energy sector and related industries must have exercised an attraction effect on investment in this region. Investment in this case is influenced by profits as well as the change in prices of the region's major commodities.

In their study of the U.S. regions, Varaiya and Wiseman (1981) have noted that capital was aging more rapidly in the northeast and north central regions, and that much of the considerable investment occurring in the northeast was due to the replacement of worn-out stock. This empirical evidence lends little support to the accelerator theory which ties investment directly to changes in output levels. Varaiya and Wiseman (1981) also pointed out that the new investment was labour-saving, which meant an increase in capital-labour ratios and a decline in manufacturing employment.

This latter interpretation is more emphasized in Marxian theories that seek to analyze the social impact of production restructuring (see Walker and Storper, 1981; Massey and Meegan, 1982; Bluestone and Harrison, 1982). The restructuring school (see also Holmes, 1983; Leborgne and Lipietz, 1988) argues that the advance in technology and information handling has increased capital mobility which induced a wave of locational investment shifts in the last twenty years. These locational shifts, as in the neoclassical theory, are motivated by the search for higher profits. The investment (disinvestment) process in this approach refers not only to new capital but also to actual plant shutdowns and relocations. According to this approach, the impact of the spatial rigidity of fixed capital is limited since firms are able to disinvest from a given plant by choosing not to replace the worn-out or obsolete capital and by using capital consumption allowances and retained earnings from less profitable locations to increase investment in more profitable ones (see Clark et al., 1986).

This corresponds to the Marxian conception of investment which states that capitalists are continuously checking their investment in local production plants against the more profitable employment of capital elsewhere. Although this approach emphasizes the social and economic implications of plant closures and relocation of their activities (restructuring), and despite its other differences, it ironically resembles the neoclassical approach in many respects.

Both theories assume that capital enjoys a good degree of

mobility and adjusts fairly rapidly to return differentials (profits). For both theories, investment responds to changes in local demand and local wage rates. But as Clark et al. (1986) have noted, and as shown in Chapter One, the two approaches differ greatly in their analysis of the implications of the adjustment process described above. The Marxian approach argues that capital mobility leads not to equilibrium but to an increased spatial flexibility that facilitates or enhances capital accumulation by allowing the firm to move its activities to the more profitable sites. In particular, it points to the uneven spatial distribution of investment opportunities and the presence of concentrated large scale economies as elements of disequilibrium.

In this section, I have shown how the various theories of regional growth conceptualize capital dynamics. In particular, I have reviewed the models of local investment based on the simple accelerator and the more complex theories of restructuring. It appears that the existing literature on regional investment is somewhat underdeveloped. Most theories of regional growth (or change) tend to be conceived in the long run and have therefore emphasized the role of tendencies towards equilibrium and the resulting stability and/or regularity of spatial distribution of capital stocks over time. However, as some have pointed out, the existence of dynamic economies of scale (Storper, 1988), the recent 'catastrophic' shifts (Casetti, 1981), and regional restructuring throw doubt on the explanations offered by long run or equilibrium theories of the process of capital accumulation. By emphasizing the

volatile nature of investment and the specificity of its regional determinants, it is hoped that the present study will give another (more detailed) perspective to regional capital formation.

3.3 A model of regional investment

National models of investment behaviour have focused on the role demand exerts on investment decisions. This relationship between net investment and changes in output has been formalized by the accelerator model (Jorgenson, 1971). Most regional models of investment are direct applications of this theory. (See, for instance, Guccione and Gillen, 1972.)

In contrast to other models and in line with Kalecki (1971), it can be argued here that investment expenditure is intimately connected with growth and business cycle fluctuations. If firms initially respond to increases in demand by collectively expanding their productive capacity, in the next phase they will be induced to restrict their investment expenditures until excess capacity has been reduced. Similarly, a downturn in demand and the expectation of slower growth may force firms to reduce collectively their investment expenditure, which will lower their productive capacity in comparison to the existing demand. This constitutes an incentive to increase investment in the next period in order to meet the increased demand. In other words the business cycle in investment may not follow the business cycle in demand for output.¹⁰ This

¹⁰ For useful discussions of the role of business cycle in investment see Clark et al. (1986) and Sawyer (1989).

volatile and unsteady nature of local investment suggests that it is important to include the degree of capacity utilization (DCU) as an explanatory variable in the investment equation.

When production is at or near the technical capacity, the stimulating effect that increasing demand¹¹ exerts on the decision to invest can also be captured by the relative growth of the region as compared to the rest of the country. This relative growth rate can be defined as:

$$(\Delta Y/Y)_i - (\Delta Y/Y)_t$$

where $(\Delta Y/Y)_i$ is the growth rate of region i and $(\Delta Y/Y)_t$ is the national growth rate at time t .

One might also consider the effect of change in prices of the major commodities produced in (and perhaps exported by) the region. Price changes have a direct impact on profits; and it was shown that most economic theories agree that investment adjusts with changes in profitability. In particular, it was indicated that regional investment might be greater in locations characterized by higher rates of profitability relative to other regions.

Another hypothesis to be tested here is that local investment will increase when the past surplus (profits) generated from local production is high. Webber and Tonkin (1990: 1057) have attempted to measure the impact of this variable on capital accumulation at the industry level in the Canadian context and found that in nine of the twenty industries examined "the availability of surplus for

¹¹ Demand here is defined to include regional demand (demand from within the region) and demand from outside the region.

reinvestment is a significant determinant of the accumulation of capital." At the firm level, this can be measured by retained earnings, that is, the available funds after rent, interest, taxes and dividends are paid. At the regional level however, it can be assumed that these payments (rent, interest, dividends, etc.) represent a constant proportion of total costs in all regions so that their inclusion will overestimate regional profit levels but in a consistent manner. Webber and Tonkin (1990) have used such a procedure to evaluate regional profit levels. This procedure was also used by Clark et al. (1986) in their study of the US regions. Gross profit levels can therefore be used as a proxy to get an indication on the profitability as well as the supply of available finance in a given region.

The coefficient of profit levels is expected to be positive and it is expected to be higher in the poor regions since these have a limited access to foreign funds as compared to rich regions. In his early writings, Kalecki (1937) showed that firm size is a key determinant of access to capital. He maintained that larger firms (usually more profitable and often located in rich regions) are likely to have easy access to investment funds either because of their capacity of generating internal funds (retained earnings) or because of the importance of their assets on external capital markets. Also, high profitability is likely to affect the availability and cost of external funds. When taken from a regional perspective, the Kaleckian approach suggests that regional surplus (regional profits) are an important source of investment and

therefore are likely to influence regional investment decisions.¹²

The idea that the regional surplus may influence regional investment decisions is also consistent with the more recent "credit view" of investment.¹³ This view asserts that entrepreneurs may not have the necessary funds to finance their investment projects (which may be the case of those located in poor regions). Investors with financial resources may not have good information about these investment projects and, consequently, will incur costs in trying to monitor their performance and to gather information on the creditworthiness of the borrowers. In order to compensate for these costs, investors may ask for higher interest rates or collateral requirements. Possibilities of meeting these requirements may be low in poor regions, which will force local entrepreneurs to rely heavily on the locally available supply of finance.

Another important variable that influences current and future investment decisions is the existing level of the capital stock. Regional theories of growth have opposing views concerning the impact of previous capital stocks on regional investment plans. For example, as we have seen, the cumulative causation theory views investment as a self-reinforcing process (Myrdal, 1957; Kaldor, 1970; Richardson, 1973). Through agglomeration economies, growth

¹² Note, however, that in a world of multilocational firms, interregional transfer of profits and savings has freed the firm from these 'spatial rigidities'.

¹³ For a recent review and a regional application, see Samolyk, 1991.

of capital in one region leads to more capital accumulation. According to this theory, the existing capital stock exerts a positive impact on future investment so that investment continues to flow in the same direction as in earlier periods. Richardson (1973) argues that it is this dynamic of the investment process that leads to interregional disparities.

On the other hand, Kalecki (1971: 112) has argued that the rate of change in the stock of capital has a negative effect on the rate of investment decisions. He pointed out that high profits attract new firms which enter the industry by bringing in new investments. The net increment of the capital stock renders "investment plans of the established firms less attractive" since "an increase in the volume of capital equipment if profits, P , are constant means a reduction in the rate of profit." This will force competitors to cut back on their investment spending in the next period, while waiting for demand to pick up and increase to a level that would use their productive capacity. Conversely, if previous additions to the capital equipment have been low and have resulted in a reduction in the productive capacity of the sector, firms will react in the next period by significantly increasing their investment. Although this mechanism explains investment behaviour using past changes in capital stock, it is very similar to the accelerator model which relates investment directly to changes in output.

Both the Marxian and neoclassical theories argue that capital moves to low-wage areas in order to maximize its return. Assuming

equal or similar productivity in two distinct regions, capital will flow to the region with the lowest wage rate. One should then expect a negative relationship between the labour cost and investment.

Finally, the cost of capital¹⁴ must also be included as explanatory variable since variations in the rate of interest have direct implications for borrowing necessary funds for investment. It is usually argued that financial capital is perfectly mobile between regions in Canada. The Canadian financial system with its branch network across provinces allows rapid financial flows throughout the country. In this context, regional differentials in interest rates are minimal¹⁵ and the national rate of interest can be used as the explanatory variable. Since this is the only variable with a national value, it will be interesting to see its impact and significance as an explanatory variable of regional investment.

These hypotheses can be summarized in the following model, which explicitly states that regional (private) investment will increase as:

- 1) the relative regional growth rate increases (the role of

¹⁴ The cost of capital is usually defined as a weighted average of (reinvested) internal funds, equity capital and borrowed capital on external markets (see, Chirinko, 1986). Given that the first component is accounted for by the profit variable and that we do not have information on equity capital at the regional level, the rate of interest could be taken as a proxy for the cost of capital, although it is an imperfect one.

¹⁵ In a recent statement on Canadian Federalism and Economic Union, Minister of Supply and Services, 1991, p.9, it is maintained that interest rates are equal in all provinces.

- demand),
- 2) the degree of capacity utilization increases,
 - 3) the relative size of the region's previous capital stock increases (cumulative causation) or decreases (Kalecki),
 - 4) the past level of profits (in the region) increases,
 - 5) the unit labour cost declines,
 - 6) the cost of capital decreases, and
 - 7) the price of the major commodity increases.

Since both the relative regional growth rate and the degree of capacity utilization capture the effect of demand, only one variable at a time was included in the estimation. Also, since the unit labour cost (ULC) is at least partly accounted for by the profit level variable, estimation was first done without including it in the regression equation. It was observed that commodity prices (also reflected in the profit variable) did not perform well as an explanatory variable of the regional investment. They were then replaced by the unit labour cost (ULC) in an attempt to capture the direct impact of the labour cost. The unit labour cost variable was chosen after experimentation with other indicators, such as the wage rate which produced some poor results (positive coefficients in certain regions), perhaps due to the fact that productivity impact was not controlled for. This gives us the following four equations:

$$\Delta K_{it} = \alpha_0 + \alpha_1 DCU_{it} + \alpha_2 \frac{K_{it-1}}{K_{t-1}} + \alpha_3 P_{it-1} + \alpha_4 CP_{it} + \alpha_5 R_t + \epsilon_{it} \quad (3.2)$$

$$\Delta K_{it} = \alpha_0 + \alpha_1 DCU_{it} + \alpha_2 \frac{K_{it-1}}{K_{it}} + \alpha_3 P_{it-1} + \alpha_4 ULC_{it} + \alpha_5 R_t + \epsilon_{it} \quad (3.3)$$

$$\Delta K_{it} = \alpha_0 + \alpha_1 \left(\frac{\Delta Y_{it}}{Y_{it}} - \frac{\Delta Y_t}{Y_t} \right) + \alpha_2 \frac{K_{it-1}}{K_{t-1}} + \alpha_3 P_{it-1} + \alpha_4 CP_{it} + \alpha_5 R_t + \epsilon_{it} \quad (3.4)$$

$$\Delta K_{it} = \alpha_0 + \alpha_1 \left(\frac{\Delta Y_{it}}{Y_{it}} - \frac{\Delta Y_t}{Y_t} \right) + \alpha_2 \frac{K_{it-1}}{K_{t-1}} + \alpha_3 P_{it-1} + \alpha_4 ULC_{it} + \alpha_5 R_t + \epsilon_{it} \quad (3.5)$$

where ΔK_{it} is the net private investment, $(\Delta Y_{it}/Y_{it} - \Delta Y_t/Y_t)$ is the relative growth rate, K_{it-1}/K_{t-1} is the relative size of the region's capital stock, private and public, which is intended to capture the impact of interregional capital flows, P_{it-1} are the profits generated from past production, CP_{it} are prices of the major commodity produced (exported) by the region, and R_t is the national rate of interest. DCU_{it} is the capacity utilization of production in the region, ULC_{it} is unit labour cost and ϵ_{it} is the error of estimation. The α_i 's are the parameters to be estimated.

Each of these four equations was estimated for each of the six Canadian regions. It was found that the last equation (equation 3.5) describes best the regional investment behaviour in Canada. The regression results which follow were estimated using the seemingly unrelated regressions estimation (SURE) method.

3.4 The data sources

The capital stock data were taken from unpublished material by *Investment and Capital Stock Division, Statistics Canada* and cover the period 1961-1990. Regional capital stocks are expressed in constant 1986 dollars and are net of depreciation which was subtracted following the geometric method of depreciation used by the *Statistics Canada's Investment and Capital Stock Division*. These series are available for both the private and public sectors. ΔK_{it} therefore represents net investment since it was found by taking the first difference of the private capital stock series for each region.

The degree of capacity utilization is not directly observable and no data exist for it at the regional level. It was calculated using the output/capital ratio method (see Klein and Preston, 1967). This method is also similar to that used by *Statistics Canada* to construct national capacity utilization measures (see *Statistics Canada, 1984*):

$$DCU_{it} = (Q_i/K_i)_{\text{observed}} / (Q_i/K_i)^*_{\text{adjusted}} \quad (3.6)$$

where $(Q_i/K_i)^*_{\text{adjusted}}$ is found by estimating the equation:

$(Q_i/K_i) = \beta_0 + \beta_1 t$ for each region over the period of study. The output data are available from *Provincial Economic Accounts* (Catalogue no. 13-213) published by *Statistics Canada* and were converted in 1986 prices using the national GDP deflator.

Regional profits are corporation profits before taxes and were

also taken from *Provincial Economic Accounts*. They include taxes and rental payments and may therefore be interpreted as the income accrued to producers. They were deflated by the capital price index (1986 = 100). Their previous levels (restricted to one time lag) are expected to have a positive feedback influence on current investment. The same source gives regional wages and salaries. Regional wages and outputs were used to calculate the unit labour cost (ULC). Commodity prices (CP) are available from the *Consumer Prices Section of Statistics Canada* (Cansim data base). For Ontario and Quebec, I used industrial product price indexes for all manufacturing industries. For Atlantic Canada, I used the price index for fish products industries. The price index for wood industries was used for British Columbia and the price index for refined petroleum and coal products industries for Alberta. Finally, the raw materials price index was used for the Prairie region of Manitoba and Saskatchewan. All prices are in constant 1986 dollars. The interest rate variable is the chartered banks' rate on prime business loans taken from the *Bank of Canada Review*.

3.5 Estimation results

The estimation results for the regional investment models specified in Equations 3.2-3.5 are summarized in Tables 3.1-3.4. Given the nature of the model which attempts to capture the impact of interregional flows of capital and the role of relative growth rates, it is suspected that using ordinary least squares (OLS) to

estimate each equation separately may be less efficient than estimating all equations jointly. For this reason and due to the existence of contemporaneous correlation, all specifications were estimated using seemingly unrelated regressions estimation (SURE) technique after having applied the Cochrane-Orcutt correction for serial correlation.¹⁶ Insignificant variables were removed and replaced by more pertinent ones to produce individual investment functions for each of the regions considered over the period 1961-1990.

The first important observation concerns the explanatory power of the model. Among the four different specifications, the last one (equation 3.5) seems to fit the data best. The first two equations (3.2 and 3.3), whose results are reported respectively in Table 3.1 and Table 3.2, are basically the same. The only difference is that commodity prices (CP) were replaced by unit labour cost in the second specification. The results improved significantly. In both equations the degree of capacity utilization was used in an attempt to capture the effect of demand on investment. The low performance of this variable (judging by the t-statistics) suggested that perhaps the regional relative growth rate would be a better measure. As it turned out, the last two equations (3.4 and 3.5), whose results are found respectively in Table 3.3 and Table 3.4, showed that indeed the relative regional

¹⁶ Note that, after having adjusted the data for autocorrelation, the Durbin-Watson statistic is not considered as a valid test for serial correlation. Instead, the runs test was used and the problem of serial correlation was eliminated although the D.W. statistic was low (see Gujarati, 1988: 388-89).

Table 3.1
 Estimation results of Equation 3.2

	α_0	DCU _{it}	$\frac{K_{it-1}}{K_{t-1}}$	P_{it-1}	CP _{it}	R_t	\bar{R}^2	ρ	Runs Test
Atlantic	-5353.5 (-4.11)	-10.02 (-0.97)	-603.93 (-2.48)	0.08 (1.98)	2.72 (1.45)	-48.95 (-0.97)	0.38	0.29	n, (+), (-) {10, 12, 18}
Quebec	-18727.0 (-3.40)	41.97 (1.58)	636.82 (1.84)	0.04 (2.64)	24.23 (1.12)	-71.84 (-1.25)	0.43	0.22	{11, 14, 16}
Ontario	-18441.1 (-2.46)	123.18 (1.68)	178.38 (4.45)	0.08 (3.97)	33.82 (1.28)	-98.33 (-1.81)	0.67	0.21	{11, 15, 15}
Prairie	-4135.8 (-3.12)	-7.19 (-0.94)	430.15 (1.14)	0.09 (1.48)	1.50 (0.97)	74.76 (0.89)	0.28	0.26	{10, 18, 12}
Alberta	-13099.2 (-2.42)	73.82 (1.45)	-473.78 (-2.28)	0.09 (1.21)	22.43 (1.56)	147.49 (1.85)	0.69	0.22	{11, 17, 13}
B.C.	-26692.7 (-4.21)	55.09 (1.94)	-175.6 (-1.75)	0.02 (1.73)	-6.05 (-1.21)	-113.96 (-1.48)	0.47	0.27	{10, 11, 19}

Note: Values in parentheses are t-statistics.
 n is the number of runs, (+) and (-) are the numbers
 of positive and negative runs respectively.

Table 3.2
 Estimation results of Equation 3.3

	α_0	DCU _{it}	$\frac{K_{it-1}}{K_{t-1}}$	P_{it-1}	ULC _{it}	R_t	\bar{R}^2	ρ	Runs Test $n, (+), (-)$
Atlantic	-3789.56 (-2.76)	-7.26 (-3.65)	-468.23 (-4.65)	0.21 (2.76)	-9.43 (-3.58)	123.21 (1.25)	0.64	0.23	{11, 14, 16}
Quebec	-16405.23 (-2.56)	29.78 (1.12)	645.63 (2.34)	0.16 (1.67)	-18.37 (-2.16)	-127.54 (-2.76)	0.52	0.21	{10, 12, 18}
Ontario	-15900.21 (-2.54)	98.12 (2.89)	278.76 (3.87)	0.17 (2.69)	14.37 (1.01)	-123.97 (-4.48)	0.73	0.19	{11, 19, 11}
Prairie	-8224.76 (-3.34)	21.23 (1.18)	554.43 (1.49)	-0.22 (-1.98)	-18.45 (-1.67)	-76.65 (1.05)	0.60	0.22	{11, 13, 17}
Alberta	-5978.34 (-1.78)	67.43 (1.16)	-149.37 (-2.34)	0.12 (1.89)	-63.54 (-1.45)	165.63 (1.24)	0.66	0.23	{10, 10, 20}
B.C.	-21276.46 (-3.45)	45.57 (1.27)	-134.94 (-1.23)	0.15 (1.98)	12.32 (1.12)	-129.76 (-3.65)	0.67	0.24	{11, 16, 14}

Note: Values in parentheses are t-statistics.
 n is the number of runs, (+) and (-) are
 the numbers of positive and negative runs respectively

Table 3.3
 Estimation results of Equation 3.4

	α_0	$\frac{(\Delta Y_{it} - \Delta Y_{it-1})}{Y_{it} - Y_{it-1}}$	$\frac{K_{it-1}}{K_{it}}$	P_{it-1}	CP_{it}	R_t	\bar{R}^2	ρ	Runs Test $n, (+), (-)$
Atlantic	-1080.5 (-1.85)	-12.86 (-2.06)	181.40 (2.19)	0.18 (1.86)	2.35 (0.86)	-48.86 (-0.92)	0.57	0.21	{11, 14, 16}
Quebec	-17163.02 (-5.64)	17.99 (1.85)	733.11 (1.85)	0.04 (2.65)	-19.27 (-1.14)	-69.80 (-1.74)	0.46	0.20	{10, 16, 14}
Ontario	-3168.20 (-0.71)	304.07 (2.89)	94.83 (3.57)	0.06 (1.87)	9.49 (1.05)	-157.67 (-1.29)	0.81	0.17	{11, 14, 16}
Prairie	-5561.10 (-4.72)	19.76 (1.36)	485.15 (1.58)	-0.15 (-2.68)	0.29 (0.93)	-92.41 (-0.16)	0.49	0.21	{11, 16, 14}
Alberta	-8465.90 (-1.44)	26.52 (1.85)	-596.75 (-2.01)	0.06 (3.32)	62.70 (1.46)	427.60 (0.88)	0.67	0.19	{14, 15, 15}
B.C.	-5298.21 (-1.17)	101.32 (3.12)	-420.71 (-2.54)	0.07 (2.38)	11.97 (1.25)	-202.03 (-1.12)	0.49	0.20	{10, 12, 18}

Note: Values in parentheses are t-statistics.
 n is the number of runs, (+) and (-) are the numbers of positive and negative runs respectively

Table 3.4
 Estimation results of Equation 3.5

	α_0	$\frac{(\Delta Y_{it} - \Delta Y_{it-1})}{Y_{it} - Y_{it-1}}$	$\frac{K_{it-1}}{K_{t-1}}$	P_{it-1}	ULC _{it}	R_t	\bar{R}^2	ρ	Runs Test n, (+), (-)
Atlantic	-1589.67 (-1.67)	17.43 (2.35)	-341.52 (-3.69)	0.17 (2.59)	-8.43 (-2.56)	-43.61 (-1.75)	0.69	0.19	{11, 15, 15}
Quebec	-10812.32 (-3.76)	-57.42 (-1.12)	445.36 (2.67)	0.15 (5.46)	-35.72 (-2.17)	-121.46 (-3.76)	0.74	0.21	{12, 13, 17}
Ontario	-15675.29 (-3.57)	298.89 (3.76)	517.56 (3.87)	0.12 (3.19)	-46.11 (-3.78)	-221.42 (-6.72)	0.83	0.18	{13, 16, 14}
Prairie	-6216.32 (-4.85)	-24.51 (-0.79)	426.58 (2.17)	0.25 (2.87)	6.43 (1.01)	-87.95 (-1.02)	0.68	0.20	{13, 15, 15}
Alberta	9892.48 (4.52)	62.25 (5.34)	-698.73 (-3.65)	0.16 (4.02)	-65.57 (-1.16)	312.34 (1.12)	0.75	0.17	{14, 16, 14}
B.C.	-6502.65 (-2.45)	82.54 (2.71)	496.45 (3.14)	0.13 (4.42)	-6.62 (-3.04)	-147.76 (-3.98)	0.67	0.18	{12, 13, 17}

Note: Values in parentheses are t-statistics.
 n is the number of runs, (+) and (-) are the numbers of positive and negative runs respectively

rate of growth was more significant and, when combined with the unit labour cost, it produced the best results (see Table 3.4).

Considering the first specification of the regional investment model, equation 3.2, it can be said that the proportion of the variance in the level of capital accumulation accounted for by the independent variables is generally low since it exceeds 0.6 in only two regions. Commodity prices were not significant as a determinant variable of investment in any of the six regions. This was consistently the case in both specifications that included commodity prices as an independent variable (equations 3.2 and 3.4). Prices are apparently not an important consideration for investors. This suggests that costs rather than prices may be the relevant variable to consider.

Labour costs have been emphasized as an important component of production costs by most theories examined above. Earlier regressions (not reported here) using the wage rate as a proxy to capture the impact of labour cost on investment produced some poor results. The coefficient of the wage rate was either positive or zero (t-statistics not significant) in four of the six regions studied. The fact that productivity was not accounted for proved to be an important source of this problem. This was circumvented by choosing the unit labour cost as the explanatory variable which had the expected sign in all six regions except the Prairie region where it was not significantly different from zero (see Table 3.4).

Two other variables, the relative regional growth rate and the degree of capacity utilization were used in an attempt to capture

the impact of demand changes. The degree of capacity utilization (DCU) did not perform well as an explanatory variable of regional investment. The relative regional growth rate, however, had significant parameters in all regions except for Quebec and the Prairies (see Table 3.4).

The above comparison shows that the last specification showing the relative growth rate, the relative size of the capital stock, profit levels, the unit labour cost and interest rate as explanatory variables of the regional investment is most appropriate. The performance of the other three specifications (equations 3.2-3.4) was generally poor. It is therefore possible to shift our attention to this equation and focus on the results shown in Table 3.4.

The first important variable affecting regional investment is the differential growth rate. This variable produced some interesting results in that its coefficients were significantly positive in Atlantic Canada, Ontario, Alberta and British Columbia, but negative although not significant in the case of Quebec and the Prairies. The magnitude of the coefficient in Atlantic Canada suggests that low growth rates in the Atlantic region have apparently not been successful in attracting investment from other regions. The variable was not operative in the Prairies and Quebec perhaps because the overall growth rates in these two regions have not been very different from the national average.

The relative size of the existing capital stock ($K_{i,t}/K_{i,t-1}$) is another important determinant of the amount of capital invested in

all six regions. In the three large manufacturing regions (Ontario, Quebec and British Columbia), the sign was positive and the parameters were highly significant, perhaps indicating the strong effect of agglomeration benefits. This result is consistent with another Canadian study, by Webber and Tonkin (1990: 1058), who found that, over the period 1952-1981, "industries in which the capital stock is larger are also industries in which accumulation is large." Since the capital stock share variable includes also the government sector and, therefore, the publicly funded infrastructure, it can be said that private investment is highly influenced by the regional dimension of the material infrastructure.

Private investment decisions in a given region are largely influenced by the existing levels of capital stocks because, as Webber and Tonkin (1990: 1055) argue, larger capital stocks represent a larger basis upon which profits can be made and, therefore, funds reinvested. In this sense, the capital stock variable which includes public infrastructure also influences the level of capital that can be accumulated (invested) from local funds. The significant and positive effect reflected in the coefficients of this variable in Ontario, Quebec, and British Columbia indicate that the greater the existing capital stock, the faster it grows. This means that as the capital stock (including public infrastructure) of a region grows, the additions and the level of accumulation to that stock will also grow.

The above scenario corresponds to the description of the

investment process by theories of cumulative causation as developed by Myrdal (1957), Hirschman (1958) and later reinterpreted by Kaldor (1970), Richardson (1973), and Thirlwall (1986). As indicated earlier, these theories postulate a positive, self-reinforcing process whereby growth in capital leads to more concentrated growth. Although this relationship was not as strong in the Prairies, the sign was still positive.

By contrast, the relationship between net private investment and the total capital stock was negative in Alberta and Atlantic Canada. This result might lead us to conclude that capital accumulation in these two regions has been decreasing over time but, in view of the actual firm investment decision-making (see Llewellyn et al., 1977), this negative sign might reflect the tendency of individual investors to overreact collectively to local or national business cycle signals (see Klein, 1950; Kalecki, 1971; and more recently Massey and Meegan, 1982). As mentioned earlier, Kalecki's model (1971) suggests a negative relationship between current capital formation (net of depreciation) and the existing stock of capital.

Based on Kalecki's short run framework, more recent analyses (see, among others, Nadji and Harris, 1984; Clark et al., 1986) have suggested that investment decisions are made in response to changes in regional profit conditions. Profit conditions are known to have been volatile in Alberta partly due to rapid changes in the prices of oil, which is the dominant industry in that region. Alternatively, the various regional investment incentives

introduced by the government during the 1960s and 1970s in Atlantic Canada, which were largely abandoned later, might have contributed to swings in private investment similar to those observed in Alberta.¹⁷

Capital 'flows' from one region to another are interpreted as reflecting differences in profitability. If profits are themselves a source of investment, then the profit variable (lagged to its previous level) affects investment in two ways: the more profit that is available, the greater the accumulation of capital both because it attracts investment and because it is a source of funds for (local) investment. Indeed, this variable had a significant positive effect on private investment in all regions.

The assumptions about the availability of funds that firms need to invest can also be tested by this model. It is generally assumed that the rate of investment may be constrained by the availability of investment funds. Also, entrepreneurs in 'poor' regions may not have the same access to capital on external markets. External funds are usually considered to be more costly than internally generated funds. The coefficients of the independent variable (profit) are expected to be high in the poor regions since entrepreneurs there will rely heavily on local supply

¹⁷ These swings in the share of Atlantic Canada in the national capital stock coincide with the implementation and the abandonment of the Regional Development Incentives Programme by the DREE: Department of Regional Economic Expansion. (see Table 2.3 in chapter Two above). Economic Council of Canada (1977) reports that during its first six years of existence since 1969, DREE had spent about 45% of its expenditures on investment projects in the Atlantic region.

of funds. This 'credit view' to investment seems to be supported by the evidence presented here and in a related work by Webber and Tonkin (1990). The parameter estimates were high in Atlantic Canada and the Prairies compared to the rest of the country.

The influence of labour costs was also significant. Except in the Prairies where the coefficient (positive) was not significantly different from zero, all other regions had the expected negative sign. However, in the case of Alberta, although the sign was negative as expected, the parameter was not significantly different from zero. Given the poor performance of the unit labour cost variable for the Prairies and Alberta it can be said that apparently labour costs are not a deterrent to private investment in these two regions, perhaps due to the relatively weak importance of the manufacturing sector there.

Finally, the indicator of capital cost, the national interest rate, had significant coefficients in Ontario, Quebec, Alberta, and British Columbia. The influence of capital cost in the Prairies and Atlantic Canada was not significant. Note, however, that it was found earlier that investors in these regions do rely more heavily on local funds. Gertler (1987: 36) found similar results and concluded that maybe "capital markets in the more peripheral regional economies move independently from those in the major financial centers."

3.6 Conclusion

In this chapter, I have reviewed the existing applications of

regional investment models. It was noted that the existing literature on regional growth has somewhat neglected the analysis of regional disparities from the perspective of capital formation. Explanations of regional growth and development which do refer to the role of capital accumulation, have generally failed to offer a clear formulation of a regional investment theory that specifically identifies the regional dynamics of capital accumulation.

The model proposed here is an attempt to shed light on the spatial dimension of regional investment. According to the last specification of the model, regional capital accumulation in Canada is apparently a process that is strongly structured by the variables examined here. The results show some support for the traditional assumptions about the relationship between capital accumulation, on one hand, and profits, wages and other costs, on the other hand. They also indicate that regional capital accumulation can be successfully predicted by a regression equation that contains the relative growth rate of a region, the relative size of its capital stock, profit levels and a measure of labour cost that takes into account changes in local productivity.

The major finding of this chapter is that finance capital plays a central role in regional capital accumulation. The availability of investment funds seems to exert a considerable influence on regional growth. This is consistent with other regional studies (e.g. Clark et al., 1986) and with Kalecki's (1971: 109) argument that ownership of capital is the most important prerequisite for the accumulation of capital.

Chapter Four
Capital Intensity, Output Growth and Regional
Disparities in Labour Productivity

4.1 Introduction

Regional disparities in income and growth of output are determined by a number of factors which include output per worker, the average number of hours worked per week and the share of the working age population employed. In turn these factors depend on several other variables such as the industrial structure of a region, its capital formation and education levels of its labour force. It is well known that Canadian regions differ greatly in their industrial structure and the quantity and quality of their capital stock and labour force (Brewis, 1969; Economic Council of Canada, 1977; Auer, 1979; Martin et al., 1979; Sitwell and Seifried, 1984; Sharpe, 1990).

In market economies, the wage rate is usually taken as an indicator of labour productivity, which is considered as an important indicator of economic efficiency. Labour productivity is thought to be a major cause behind regional disparities. Several studies have suggested that regional variations in labour productivity may be an important factor contributing to regional differences in income and growth (Economic Council of Canada, 1977; Auer, 1979). The study of regional differences in labour productivity seems of particular importance in Canada where a

number of programmes have been introduced in an attempt to reduce the large income differences which have persisted for a long time (Savoie, 1986; Bradfield, 1988).

In addition to transfer payments, governments in Canada have also pursued a policy of promoting investment and growth of capital-intensive activities in low-income regions (Anderson, 1987). These actions will have contributed to a change in the industrial structure of the regions concerned and may have caused variations in incomes and growth rates. The role of agglomeration economies has been emphasized in economic theory as an important factor affecting investment decisions. As it was argued in the previous chapters, several factors attracting and repelling investment have resulted in a change in the industrial structure of the Canadian regions. The important question, of course, is to find out to what extent these changes have affected the trends in regional disparities.

In a recent study, Anderson (1990) has attempted to decompose growth in labour productivity into three different factors: growth in capital-labour ratio, scale economies, and technical progress.¹⁸ To evaluate the relative contributions of each of these factors, Anderson estimated the parameters of a Cobb-Douglas production function which he allowed to exhibit increasing returns to scale. His results indicate that although growth in capital-labour ratio and scale economies have contributed to growth in low-productivity

¹⁸ Others have attempted to estimate directly the impact of the number of hours worked on productivity growth (see Chatterji and Wickens, 1982).

regions, this was not enough to reduce regional differences in labour productivity.

The aim of this chapter is also to measure the extent to which changes in capital-labour ratios and the industrial structure have contributed to a reduction in labour productivity differences and therefore, to a convergence in regional disparities in incomes and other indicators. But the approach differs from that used by Anderson (1990). The model proposed here is based on Verdoorn's law which is extended to include the effect of capital accumulation on productivity growth. The approach adopted is to estimate the parameters of the productivity equation relating growth in productivity on the one hand, to growth in output, growth in capital-labour ratio, and technical progress, on the other hand. Using time-series data spanning the period 1960-1990 for each of the Canadian regions, I will be able to estimate the effects of each of these factors on labour productivity.

The approach adopted in this chapter follows that used by Michl (1985) and partly draws on Anderson (1990) and Uri (1984). In the literature on Verdoorn's law, all studies have used data from the manufacturing sector to do their estimations. Three types of data have been used so far:

- 1) time-series data for manufacturing industries from a single country.
- 2) cross-section data for manufacturing industries from several countries.
- 3) data for manufacturing industries from different regions within a single country.

The present study is different from the previous ones in that it includes the role of capital formation on productivity and uses

data from regional *gross domestic product* rather than *manufacturing industries*. It resembles the study by McCombie and De Ridder (1983, 1984) carried for the U.S using *manufacturing state data*. In this study, I use data for total output, capital, and labour from Canadian regions to obtain estimates of the parameters of regional productivity equations. These parameter estimates are used to identify the differences in regional growth rates of labour productivity which are attributable to capital-labour ratio and scale economies. Section 4.2 briefly reviews the literature that deals with labour productivity and regional disparities. Section 4.3 deals with Verdoorn's law and its various interpretations. The empirical results from estimating the productivity equation are presented in section 4.4. Section 4.5 summarizes the major findings and concludes the chapter.

4.2 Methods of analyzing labour productivity

The most commonly used method of analyzing productivity is by means of a Cobb-Douglas production function.¹⁹ Models generally assume that factor inputs are paid according to their respective marginal products. This leads them to assume further a perfectly competitive economy and constant returns to scale, which precludes the analysis of the effects of agglomeration economies. However, as Kaldor (1967:12-13) noted, economists since Adam Smith (1776), Alfred Marshall (1920), Allyn Young (1928), and Kenneth Arrow

¹⁹ Denny et al. (1981) use a cost function to compare differences in *total factor productivity* among Canadian regions.

(1962) have all stressed the importance of increases "in the scale of industrial activities in causing returns to increase" and that "productivity increases in response to increases in total output because of economies of scale or increasing returns."

In the context of multiregional economies, various models have been used to study spatial variations in labour productivity. The neoclassical model emphasizes the role of supply and makes the growth of output a function of labour supply, growth of capital stock, and technical progress. Borts and Stein (1964) argue that capital and labour mobility between regions reduces regional variations in the capital-labour ratio over time, and that in equilibrium, labour productivity is the same in all regions. In this model, regional growth rates are predicted to converge over time.

The neoclassical model does not explicitly recognize the role of demand factors in regional economic growth (see, for example, Solow, 1956; Romer, 1986, 1990). It also ignores differences in techniques of production and the differential impact of agglomeration economies. Kaldor (1970) pointed out that such economies disproportionately increase the productivity of similar factors of production depending on their locations. In particular, he showed that external increasing returns and agglomeration economies positively affect the growth rate of output. He then used Verdoorn's law, which stipulates that productivity is an increasing function of the rate of growth of output, to show that an increase in the efficiency of capital in the capital-rich regions will

induce further investment, thus leading to a concentrated pattern of industrial location. This model therefore contains a mechanism which, contrary to the neoclassical model, may result in a situation where regions can grow at different growth rates indefinitely. Drawing on Kaldor, Dixon and Thirlwall (1975) developed a model where regional growth rates are a function of a region's output and its industrial structure.

Most studies on productivity growth emphasize the close relationship between capital accumulation and labour productivity.²⁰ Many economic theories interpret the flows of capital from one region (industry) to another as reflecting differences in profitability. The causes of these differences in profitability are used to explain the observed patterns in capital flows. Labour costs are also used to explain changes in regional investment. The same variable can be used to explain the changes in regional technology. Pasinetti (1977) has explained that when local labour becomes expensive, entrepreneurs tend to replace it with capital. He has argued that the secular trend in technological change leads to an increase in the capital-labour ratio, although this tendency is somewhat slowed down by simultaneous increases in labour productivity.

Kaldor (1961; see also Kaldor, 1957) has stated in his "technical progress function" that productivity growth is an increasing function of the rate of increase in the capital-labour

²⁰ For Canadian reviews of the literature on productivity, see Stuber (1986), Sharpe (1982) and Denny and Fuss (1982).

ratio. The imperatives of competition to reduce costs and improve labour productivity lead firms to invest in labour-saving technologies and, through capital deepening, this results in an increase in the capital-labour ratio. This ratio carries the idea that engineers and managers consider technical change as "a natural way to reduce costs, increase reliability and precision of production, gain more reliable control over operations, and so on" (Nelson and Winter, 1982: 260). Technical change is likely to alter the organization of production (Braverman, 1974) and help firms to implement specialization and division of labour. This has the advantage of reducing costs not only at the firm level but for the entire industry or the whole economy, which is a source of economies of scale for firms operating in that industry or region. From a regional point of view, one should then expect that capital intensity in regional production plays an important role in determining growth rates and levels of labour productivity and therefore of regional growth.

Traditionally, economic theory has assumed a positive relationship between labour productivity and the capital-labour ratio. For example, the Marxian school holds that the capital-labour ratio tends to rise in the long run. The tendency of the capital intensity of production to increase over time is motivated by the desire of capitalists to increase profitability (by reducing labour costs) and to insure a greater control over the labour process (Clark, 1981; Storper and Walker, 1984). However, the continued decline of the share of labour in total output will

result in a decline of effective demand as noted by Keynes (1936) and Kalecki (1971), and may therefore result in a crisis of underconsumption unless real wages are allowed to increase as Robinson (1971) pointed out.

Capital intensity in regional production, i.e., the degree of mechanization of production, is synonymous with a certain industrial structure of the region. Infrastructure, such as transport and telecommunication networks, universities, hospitals, etc. facilitate urban development and spatial concentration, which in turn allow the constitution of large markets. High levels of effective demand are a source of agglomeration (scale) economies for local firms.

In this context, one should recall the work of Joseph Schumpeter which stresses the relationship between market structure and technological change. Schumpeter (1950: 106) asserted that, by virtue of its size, the monopolistic, large-scale firm "has come to be the most powerful engine of progress...In this respect, perfect competition is not only impossible but inferior, and has no title to being set up as a model of ideal efficiency." In the same vein, Galbraith (1956: 87) has maintained that "... because development is costly, it follows that it can be carried on only by a firm that has the resources which are associated with considerable size."

A rapid growth of demand will help to stimulate investment (along with other inputs) and, therefore, will lead to a faster rate of technical change. Conversely technical change may be seen as a stimulus for investment expenditure since it represents an

important source of cost-reduction (e.g., of labour) and therefore opens up the prospects of higher profits. This two-way relationship is summarized by Sawyer (1989: 387) as follows: "In one direction, the demand for investment expenditure is stimulated by technical change, and net investment would come to a halt in the absence of technical change. In the other direction, the implementation of technical change is seen to require gross investment so that the new capital equipment is available to apply new technology and/or to produce a new range of products."

Hazledine (1974) has suggested that changes in productivity are influenced by changes in the vintage composition of capital. In an expansionary period, productivity growth may be slowed down because when factor utilization is close to full capacity, firms may resort to the use of older vintages. Conversely, during a recession much of the idle capital is composed of older vintages and only the best equipment is used which causes productivity to increase.

The newly acquired capital equipment will incorporate the most recent technology and help to improve labour productivity. And, as hinted above, "the more new capital equipment installed, the faster will be the growth of productivity" (Sawyer, 1989: 402). The increasing capital-labour ratio also carries the idea that technical change needed for improvement in labour productivity (and the general knowledge) is partly embodied in capital. "Rapid capital accumulation is traditionally associated with both increased amounts of capital stock per worker and the introduction

of the latest vintage of technology. Weak capital accumulation, on the other hand, sees small increases in the capital stock per worker and a slower introduction of best practice techniques" (Seccareccia and Sharpe, 1991: 26).

All these three factors (capital deepening, scale economies, and technical progress) are interrelated. As Thirlwall (1987: 175) put it, "there cannot be capital deepening without some technical progress embodied in the new capital, and some new ideas need capital accumulation for their embodiment." And Arrow (1962) pointed out that increasing returns to scale arise because new knowledge is discovered as investment and production take place.

Firms operating under conditions that are conducive to faster technical change and capital accumulation are likely to benefit from higher opportunities for expansion. A region facing favourable demand conditions will experience higher rates of investment (and capital accumulation and technical progress) and, through the Verdoorn law, will also experience higher rates of productivity growth. It is therefore of particular importance in the context of Canadian regions to find the relative contribution and the differential impact of capital-labour ratio, agglomeration (scale) economies, and technical progress on growth rates of labour productivity in each region.

4.3 Verdoorn's Law, agglomeration economies, and regional labour productivity:

It was argued in the previous chapters that, even though

regional growth, and particularly regional disparities in growth rates, have attracted the attention of economists for a long time, there still does not exist any general agreement about the underlying causes of growth. Several models have been proposed to explain the determinants of regional economic growth and decline. These competing models have attempted to study the implications of regional variations in labour productivity for economic growth and disparities.

Empirical studies concerned with declining productivity growth at the national level and the divergent growth patterns among regions, have often used a 'growth accounting' model to measure the impact of the causal forces behind such phenomena (Denison, 1979; Nadiri, 1970). Hulten and Schwab (1984) apply this model to US regions and show that the shift in economic activity from North to South was due to variations in input growth among these regions.

The growth-accounting model decomposes growth in labour productivity into growth in capital-labour ratio and a residual component which is due to 'total factor productivity'. The decomposition assumes that capital and labour are paid at their marginal revenue products. This often leads to the assumption of constant returns to scale, which obviously precludes the analysis of the impact of agglomeration economies on labour productivity (see for example the more recent studies of Moomaw and Williams, 1991; Mullen and Williams, 1990; and Williams and Moomaw, 1989).

Alternatives to standard neoclassical growth models do not generally assume constant returns to scale and, hence, are able to

focus on the advantages of spatial concentration. The existence of agglomeration economies implies that the same capital and labour will be more productive in an environment with a well-developed infrastructure. Agglomeration economies attract capital and labour, and promote technical progress through higher rates of innovation and higher productivity by attracting more skilled workers (Richardson, 1978). Kaldor (1970: 340) notes that agglomeration economies "... are not just the economies of large scale production, commonly considered, but the cumulative advantages accruing from the growth of industry itself -- the development of skill and know-how, the opportunities for easy communication of ideas and experience, the opportunity of ever-increasing differentiation of processes and of specialization in human activities."

When one considers the existence of agglomeration economies, it is easy to give a regional dimension to the whole process of growth and technical change. As argued elsewhere (Kaldor, 1970; Richardson, 1978; Beeson, 1987), agglomeration of economic activity can influence productivity growth by influencing the rate of investment. And "the greater the investment, the more workers learn, the greater their productivity, the more the output, the greater the investment" (Malecki and Varaiya, 1986: 634). This leads Thirlwall (1974: 6) to conclude that cumulative causation "is nothing more than the phenomenon of increasing returns in the broadest sense."

Studies by Anderson (1990) and Beeson (1987) have attempted to

decompose productivity growth into scale economies and technical change. Beeson (1987: 183) emphasizes the role of agglomeration economies as a determinant of growth in 'total factor productivity'²¹ and points out that "despite the theoretical discussion of these economies no empirical tests have been conducted." In Canada, such empirical tests have been attempted by Anderson (1990) for labour productivity in the *manufacturing* sector. Dickson (1990) has also established a relationship between scale economies and the low productivity at the *industry* level in Atlantic Canada.

The Kaldorian model for regional economies (Kaldor, 1970, 1978; see also Dixon and Thirlwall, 1975), which emphasizes the importance of external demand, relates growth in labour productivity to growth in output. The self-reinforcing process of 'cumulative causation' contains a feedback mechanism whereby an increase in regional economic growth results in the growth of labour productivity. An increase in labour productivity reduces the unit costs of production and consequently the relative prices of regional exports, which stimulates the growth of regional exports. This leads to a further increase in output and, via the Verdoorn law, to an increase in productivity. According to the cumulative causation hypothesis, growth of productivity and that of output are not independent of each other.

Verdoorn's law, therefore, forms the basis of the cumulative

²¹ For a useful discussion of the concept of 'total factor' and 'total factor productivity' see, among others, Daly (1972); Rymes (1972); and Nadiri (1972).

causation model as developed by Kaldor (1970) and Richardson (1973) among others. It provides an opportunity for an empirical test of how regional growth affects labour productivity. Following Kaldor (1966), Chatterji and Wickens (1981, 1982) and McCombie and De Ridder (1984) have used time-series data and cross-section data to estimate the Verdoorn equation and have found significant "dynamic and static economies of scale."

Verdoorn's law, apparently a simple statistical relationship between the growth of manufacturing productivity and that of output, has caused a great deal of confusion and controversy in the literature. Kaldor's (1966) interpretation of the law seems to be the source of the ambiguity because it implies that growth rates of productivity are endogenous and determined by the growth rate of output. This interpretation is different from that found in Verdoorn's (1949) original model.

As specified by Kaldor (1966), the Verdoorn equation takes the following form:

$$p = \alpha + \beta q \quad (4.1)$$

or

$$l = -\alpha + (1-\beta)q \quad (4.2) \quad \text{since by definition } p = q-l$$

where p , q , l are growth rates of productivity, output and employment, respectively, in manufacturing. Empirical estimation of this relationship, using cross-section data from twelve O.E.C.D

countries over the period 1953-54 to 1963-64, shows that there exist substantial increasing returns to scale. The value of the Verdoorn coefficient (β) is approximately one-half, which implies that the growth of output is considered as an important determinant of productivity growth due to the existence of large scale economies.

Kaldor's hypothesis about the relationship between p and q means "...that productivity tends to grow the faster, the faster output expands; it also means that the level of productivity is a function of cumulative output (from the beginning) rather than of the rate of production per unit of time" (Kaldor, 1966: 106). The above statement shows that Kaldor implicitly assumes that the law reflects a production relationship. Indeed, the Verdoorn equation (4.1) could be easily interpreted as a linear technical progress function. Kaldor (1966: 107) had argued that "it [the Verdoorn Law] is a dynamic rather than static relationship between the rates of change of productivity and of output rather than between the levels of productivity and the scale of output -- *primarily because technological progress enters into it* [last emphasis mine], and it is not just a reflection of economies of large scale production."

Various criticisms have been levelled against Kaldor's specification of the law. Rowthorn (1975a) argued that if one wishes to measure the impact of employment on productivity, then employment should appear as an independent variable and one should regress growth of output (q) and of productivity (p) on growth of employment (l) rather than the other way round (for a useful

discussion see Thirlwall, 1983; McCombie, 1982; and Bairam, 1987). Given the nature of the problem, Rowthorn (1975b) pointed out that output and employment growth must be jointly determined because the single equation model may suffer from the simultaneous equation bias caused by the reciprocal influence of growth in productivity and output. Moreover, "statistical estimates of the parameters of any single equation will be liable to serious errors if that equation is considered in isolation" (Rowthorn 1975b: 898).

In his attempt to reformulate the Verdoorn law, Rowthorn (1979) has also questioned the underlying theoretical structure of the law. He showed that if Verdoorn's (1949) original model is accepted as the underlying structure of the Verdoorn law, then Kaldor's specification ought to include capital as an explanatory variable since Verdoorn's (1949) simultaneous model can be collapsed into a production function using capital and labour as factor inputs.

Kaldor's assumption of the existence of surplus labour in a dual economy releases growth in the industrial sector from being constrained by the scarcity of resources. The model assumes that an increase in labour demand will have no significant effect on the wage rate and consequently may not have any adverse consequences on the growth of output. This possibility existed in Verdoorn's (1949) original model which contained explicit labour demand and supply equations. It is this possibility that leads to 'the identification problem' pointed out by Rowthorn (1979).

The identification problem arises because in Verdoorn's (1949)

model, growth of labour (supply) is a function of the growth of wages which is in turn determined by growth of productivity. This leads to two relationships between productivity growth and output growth (see Appendix A of chapter 4 for details).

If the assumption of surplus labour is accepted, then Verdoorn's (1949) simultaneous model can be replaced by a single equation model based on a production function without a need for labour demand and supply equations. In fact, this is exactly what Verdoorn himself did in his later paper when he suggested that "a correct and at the same time more elegant and readily interpretable form for the elasticity [of productivity growth to output] is obtained... by studying the asymptotic growth rates, and replacing the labour demand and supply equations by one single relation for effective labour demand." (Verdoorn, 1980: 382).

To respecify his model, Verdoorn adopted a Cobb-Douglas functional form:

$$Q = K^{\alpha} L^{\beta} A e^{\lambda t} \quad (4.3)$$

where Q , K , L are output, capital, and labour respectively. α and β are the output elasticities; their sum ($\alpha+\beta$) gives the degree of returns to scale. A is a positive constant, λ is the growth rate of exogenous technical progress and t is time.

Concerning the role of capital accumulation in the process of growth, Kaldor (1968:138) does not consider long-term growth to be constrained by capital "...because savings and capital accumulation

in a capitalist economy do not represent an independent variable -- a faster rate of growth induces a higher rate of investment; it also brings about a higher share of savings to finance investment, through its effect on the share of profits. It is therefore, more correct to say that a fast rate of growth of capital accumulation is a *symptom* of the fast rate of growth than a cause of it."

This is perhaps why Kaldor (1966) did not include the effect of the growth of capital on the growth of productivity in his original specification of the Verdoorn law. However, Kaldor (1978: 178; see also Kaldor, 1967: 81) used the gross investment-output ratio as a proxy to capture the effect of capital growth. Kaldor's (1966) specification of the Verdoorn law can be interpreted as a production function whose parameter (the Verdoorn coefficient) reflects the relationship between the growth of output and factors responsible for this growth. On this account it can be said that the law is misspecified since it does not allow for the impact of capital growth to be taken into account.

Michl (1985) incorporated the capital-labour ratio into the Verdoorn equation in order to account for the effect of the rate of mechanization on productivity growth. His "augmented technical progress function" was estimated using pooled cross section data from twelve O.E.C.D countries. The estimation results indicate the presence of substantial economies of scale. The results are used to examine the decline in productivity growth since 1973, and to decompose the relative impact of each of the factors contributing to this decline. Michl's conclusion was that the decline in the

rate of capital accumulation and in the growth of output played a significant role in the slow growth of productivity.

4.4 Estimation of the productivity equation using Canadian regional data

Given that the purpose of this study is to analyze (i) the impact of capital deepening on labour productivity, (ii) the impact of agglomeration (scale) economies, and (iii) the role of technical progress, equation 4.3 can be manipulated to give:

$$q = \alpha k + (\alpha + \beta) \ell + \lambda \quad (4.4)$$

where q , k , ℓ are logarithmic growth rates of output, capital-labour ratio, and labour respectively and where λ denotes the growth rate of exogenous technical progress. Knowing that by definition $\ell = q - p$ where p is the logarithmic growth rate of (labour) productivity, we can substitute to get:

$$p = \left(\frac{\alpha}{\alpha + \beta}\right)k + \left(\frac{\alpha + \beta - 1}{\alpha + \beta}\right)q + \frac{\lambda}{\alpha + \beta} \quad (4.5)$$

or

$$p = ak + bq + c \quad (4.5a)$$

The specification in equation (4.5a) is similar to Michl's (1985) "augmented technical progress function", which extends the Verdoorn law to incorporate the impact of capital deepening. It

also resembles McCombie's (1986) equation (2) relating growth of productivity to growth of output and capital. The coefficients of k and q in equation (4.5a) are expected to be positive and their values will show the level and importance of scale economies present in each region. Estimating equation (4.5a) will allow us to test empirically the role of capital formation in determining growth of productivity, and therefore provides us with an estimate of the role investment plays in regional disparities.

The equation was estimated over the whole pooled cross-section 1961-1990 and over the cross-section for the following cyclically neutral sub-periods: 1961-73, 1973-1981, and 1981-1990. The results show that there is a very significant relationship between growth of productivity (p) and growth of capital-labour ratio (k) and output (q). To do the estimation, I used data on regional gross domestic product, capital stocks, and employed labour. *Provincial Economic Accounts* (Catalogue 13-213) published by *Statistics Canada* is the main source for regional gross domestic product and regional labour. For the period 1961-1966 the data for regional employed labour were taken from *Historical Statistics of Canada*, second edition, 1983, published by *Statistics Canada*. Data on Regional capital stocks are not published but available from the *Investment and Capital stock Division, Statistics Canada*.

The productivity equation (4.5a) is estimated for the following regions: Atlantic Canada, Quebec, Ontario, the

Prairies,²² Alberta, and British Columbia. There is, then, reason to believe that the error terms may be correlated across regions. This would be the case if, say, the impact of a decline in output in the leading region(s) is felt throughout the country. It is well known that, in such a case, the use of OLS methods to estimate each equation separately may be less efficient than estimating all equations jointly. When contemporaneous correlation exists, a gain in efficiency is obtained by using the seemingly unrelated regressions estimation (SURE) technique. To test for the existence of contemporaneous correlation, Breusch and Pagan (1980) suggest the use of the Lagrange multiplier test statistic. This test, known as the "Breusch-Pagan LM test for diagonal covariance matrix", allows us to investigate whether a generalized least squares (GLS) is worthwhile and, therefore, if there is any efficiency to be gained by applying least squares to the whole system.

The critical value at the 5% level of confidence from the chi-square distribution with 15 degrees of freedom is 24.99, whereas the calculated chi-square from the squared correlations yields a value of 109.94. It is therefore concluded that contemporaneous correlation exists and that the use of SURE is justified. The results are reported in Table 4.1.

Prior to estimation, tests for the presence of multicollinearity were conducted. Correlation coefficients between k and q were calculated for the entire pooled sample ($r_{kq} = 0.14$)

²² The Prairie region is defined here to include Manitoba and Saskatchewan.

Table 4.1

Regression Results of the Productivity Equation (Model 4.5a)							
	Constant	Coef of k	Coef of q	1/Coef of q = (scale factor)	R ²	Runs Test	r _{kq}
Atlantic	-0.025 (-1.24)	0.52 (6.84)	0.93 (18.20)	1.08	0.88	(10, 15+, 14-)	0.01
Quebec	-0.018 (-1.12)	0.57 (6.46)	0.78 (10.39)	1.27	0.51	(9, 15+, 14-)	-0.40
Ontario	-0.021 (-1.38)	0.46 (5.72)	0.76 (14.87)	1.31	0.72	(10, 11+, 18-)	-0.46
Prairie	-0.014 (-0.75)	0.30 (3.88)	0.94 (28.71)	1.06	0.95	(11, 14+, 15-)	-0.57
Alberta	-0.028 (-1.57)	0.30 (2.26)	0.85 (17.22)	1.19	0.86	(10, 13+, 16-)	-0.26
British	-0.024 (-1.84)	0.48 (4.39)	0.78 (11.74)	1.27	0.52	(11, 15+, 14-)	-0.61
Note: Values in parentheses are t-ratios							
r _{kq} is the simple correlation coefficient of k and q.							

and for each individual region (see Table 4.1). These coefficients showed generally weak and negative correlations, suggesting a lagged response of q to k (see figures A1-A6 in the Appendix). Estimation of equation (4.5a) produced significant t -ratios as well as high \bar{R}^2 's. Also, the standard errors of estimate are quite small, thus indicating that the problem of collinearity is not serious. However, initial results showed the existence of serial correlation in most regions. Estimation results are therefore obtained via the SURE method where the Cochrane-Orcutt correction for serial correlation is applied.

The constant term in the equation captures the effect of disembodied technical progress. Embodied technical progress is not measured explicitly, but is incorporated implicitly in new capital. The negative sign of the constant term implies the existence of some negative disembodied technical progress or external diseconomies. This result is consistent with previous studies such as that by Anderson (1990) who found negative values of exogenous technical progress in Atlantic Canada and Ontario for the period 1962-84. The same study found that the small positive values in the other regions except Alberta, were not significantly different from zero. Chatterji and Wickens (1982) have also found short-run negative values of exogenous technical progress in the British economy for the period 1961-77.

In estimating his augmented technical progress function, Michl (1985: 486) also noted that the value of the constant was lowered and became statistically insignificantly different from zero after

including the K/L ratio as an explanatory variable and concluded that "the economic interpretation is that in a properly specified technical progress function there is no evidence for the existence of any autonomous technical progress." Table 4.1 shows that the negative values of autonomous technical progress are not significantly different from zero.²³

The elasticity of productivity with respect to output growth over the period 1961-1990 ranged between 0.76 and 0.94. These estimates are higher than those previously reported in the literature. The higher these coefficients, the less substantial the economies of scale. In this regard, it is interesting to note that regions of a weaker industrial structure (Atlantic Canada and the Prairies) have recorded the highest coefficients. By contrast, Quebec and Ontario, the "industrial core" of the country, showed higher levels of scale economies (lower coefficients of q). In the two most western regions of the country, British Columbia and Alberta, where resource industries are the dominant sector, the Verdoorn relation is somewhat weak, especially in Alberta. This is consistent with other studies (McCombie and De Ridder 1983, and Kaldor 1966) who found that in general, productivity growth in the primary sector (agriculture and mining) shows a large trend factor independent of the growth of output, thus resulting in a Verdoorn

²³ Note that estimation of a neoclassical production function which excludes the existence of agglomeration economies and assumes constant returns to scale has typically found significant positive levels of disembodied technical progress (see Uri, 1984; Denison, 1979; and also Anderson's (1990) Model 1).

coefficient not significantly different from unity.

It is important, however, to remember that the present study looks at the overall relationship between growth of regional GDP and growth of regional productivity. The scale economies at the regional level range from 1.04 in the Prairies (1.08 in Atlantic Canada) to 1.31 in Ontario. Quebec and British Columbia showed similar economies of scale (1.28) and Alberta followed by 1.19.

Growth in capital-labour ratio (k) seems to have more effect on growth of productivity (p) in Quebec and Atlantic Canada. In this region, a 10% increase in the growth rate of k leads to a 5.2% increase in the growth rate of productivity (p), an impact higher than in any other region except Quebec.²⁴ This finding is in contrast to other studies which argue that capital intensity has no significant impact on productivity growth and decline (see for instance, Bradfield, 1976: 249-50; 1988: 93-97 and Anderson, 1988: 80-82). In Ontario and British Columbia the coefficients of k are all significant and of plausible magnitudes. In these regions productivity growth has a significant response to growth rates of capital intensity, i.e., to the degree of mechanization of production.

To summarize, the Verdoorn law, i.e., the relationship between productivity growth and output growth, is stronger in Ontario, Quebec and British Columbia, the three most industrialized regions where scale economies are likely to play a role. The same regions

²⁴ Sharpe (1990: 33) also argues that part of productivity growth in Atlantic Canada is attributable to growth in the capital-labour ratio.

have also shown a significant relationship between growth of capital-labour ratios and that of productivity. All the coefficients are significantly different from zero and \bar{R}^2 's are well above 70 percent except for Quebec and British Columbia. This suggests that the regression results may be a good approximation of what explains changes and movements in productivity growth.

Having obtained estimates of the parameters relating growth of productivity to growth of capital-labour ratio and output, we can now use those estimates to measure the contribution of these factors to the slowdown of productivity growth. The results are shown in Table 4.2. The left column of Table 4.2 shows the actual change in productivity growth rate (p) for the two periods 1961-73 to 1973-81 and 1973-81 to 1981-90. The third column is the predicted value of productivity growth (\hat{p}) calculated by adding the effects of changes in growth rates of capital-labour ratio and output:

$$\hat{p} = a\Delta k + b\Delta q$$

The performance of the model in predicting real change in productivity growth is generally quite reasonable (compare Column 3 to Column 4 in Table 4.2). During the first period 1961-73 to 1973-81, the productivity growth rate declined in all regions except Alberta. The model never fails to predict the expected (positive or negative) change, although it overpredicts the magnitude of the (positive) change in Alberta. As can be seen from Column 1 and Column 2, the decline in productivity growth has been

Table 4.2

Productivity Changes, Predictions and Contributing Factors				
<u>First Period 1961-73 to 1973-81</u>				
	k_1	q_1	\hat{p}_1	actual p_1
Atlantic	-0.89	-2.47	-3.37	-2.26
Quebec	0.00	-1.46	-1.46	-1.00
Ontario	-0.32	-2.46	-2.78	-2.40
Prairies	-0.57	-0.73	-1.30	-1.51
Alberta	-0.06	2.12	2.07	0.34
B.C	-0.84	-1.60	-2.45	-1.34
<u>Second Period 1973-81 to 1981-90</u>				
	k_2	q_2	\hat{p}_2	actual p_2
Atlantic	-0.24	1.62	1.38	2.14
Quebec	-0.21	0.10	-0.10	0.72
Ontario	0.41	1.36	1.77	2.38
Prairies	-0.18	-2.30	-2.48	-1.27
Alberta	0.21	-7.35	-7.14	-3.93
B.C	0.36	1.61	-1.25	0.07
<u>Note :</u>				
k_i, q_i are the contributions of growth in capital-labour ratio and output respectively in period i . $i=1,2$.				
\hat{p}_i is the predicted change in productivity in period i . $i=1,2$				
p_i is the actual change in productivity in period i . $i=1,2$.				

largely caused by the decline in growth of output.²⁵

Changes in growth rates of capital intensity had more effect in British Columbia and the Prairies where their contributions to the predicted decline in productivity growth rate were 34 percent and 43 percent respectively. The 1973 recessionary period has clearly negatively affected investment in these regions as it did in Atlantic Canada, where the decline in growth rate of capital-labour ratio contributed by 26 percent to the predicted decline in productivity growth rate. However, note that, due to the rise in oil prices, investment in Alberta did not suffer the same setbacks and therefore contributed little to the decline in productivity growth rate. The same is true for Ontario and Quebec which have more diversified economies.

The second period 1973-81 to 1981-90 has been a period of slow recovery for all regions except Alberta, which felt the consequences of the decline in world oil prices. The downturn in oil exploration industries (along with other related industries) resulted in a decline of the growth rate of output. This decline explains most of the predicted decline in productivity growth rate in Alberta as well as in British Columbia and the Prairies. Although growth rates of capital intensity continued to decline in Atlantic Canada, Quebec and the Prairies, growth rates of output have generally improved. This improvement in growth rates of output

²⁵ In the case of Alberta, positive (albeit small) growth rates of productivity have been also apparently caused by increases in output (largely dominated by oil industries), especially during the oil boom of the 1970s.

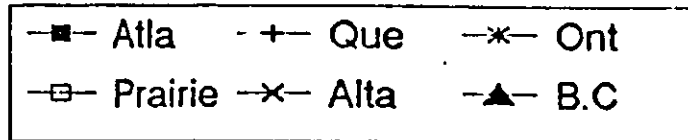
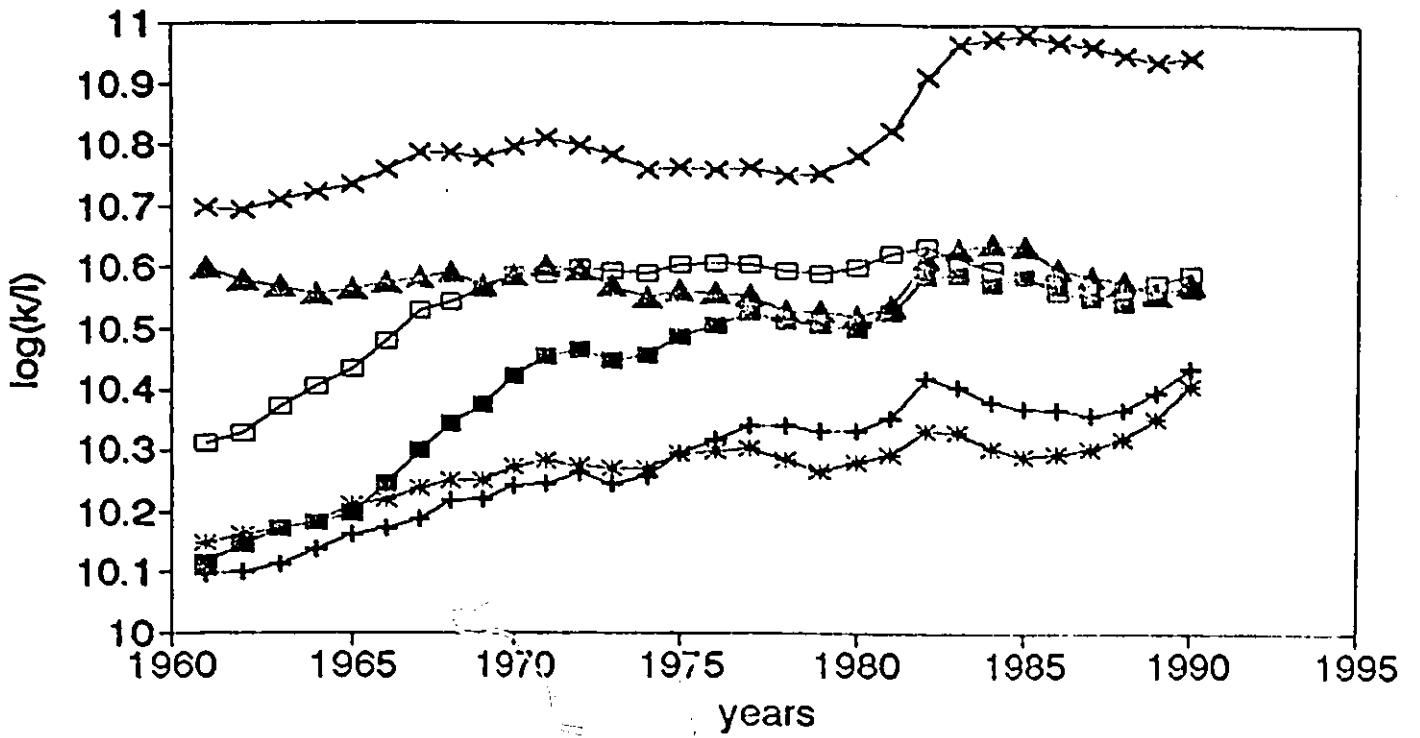
has offset the negative impact of the decline in capital intensity on productivity growth rate in Atlantic Canada. In Ontario, 23 percent of the (predicted) increase in p was due to an increase in k .

If the gap in regional disparities of labour productivity has narrowed since the 1960s, it must be noted that it is partly because of the large decline in productivity growth in Ontario during the first period (1961-73 to 1973-81). In fact, Ontario recorded the largest decline during this period. Ontario has also recorded the largest increase during the second period which explains why it still stands above the rest of the regions (except Alberta). Movements in capital-labour ratios played an important role in these changes. Capital intensity grew faster in Atlantic Canada, the Prairies and Alberta than it did in central Canada (Ontario and Quebec) or British Columbia (see Figure 4.1). And as argued above, growth in capital accumulation and investment translates into growth of output and productivity, thereby contributing to closing the gap between the different regions.

Overall, negative or positive changes in output growth have generated similar changes in productivity growth for all regions with one exception during the entire period 1961-1990 (see British Columbia in Table 4.2, second period). Given that changes in output also indicate the role of scale economies, it is particularly interesting to note the difference between the two periods 1961-73 to 1973-81 and 1973-81 to 1981-90. The pre-1973 period has been a period of rapid expansion for all regions, which recorded high

Figure 4.1

Growth in capital intensity



rates of growth of output. From 1973 to 1981 growth was relatively sluggish and most regions (except Alberta)²⁶ recorded rather low growth rates. This decline in output growth rates resulted in a slowdown of productivity growth due to the fact that firms were unable to capture new scale economies. However, during the second period, when some regions started recovering between 1981-90, productivity growth rates also picked up. Over the entire period 1961-1990, changes in capital intensity appear to lead changes in output (see Figures A1-A6 in the Appendix) and at least during the first period declines in k have strongly reinforced declines in q in order to push productivity growth down.

4.5 Conclusion

In this chapter, I reviewed the relevant literature on productivity growth and regional disparities. It was noted that most studies on productivity growth emphasize the close relationship between capital accumulation and labour productivity. The presence of agglomeration economies has also been used in the literature to explain why regional disparities may exist and persist over time. Agglomeration economies attract capital and labour and promote technical progress through higher rates of innovation and higher productivity by attracting more skilled workers. Agglomeration of economic activity can, therefore, influence regional productivity by influencing the rate of

²⁶ See footnote 25

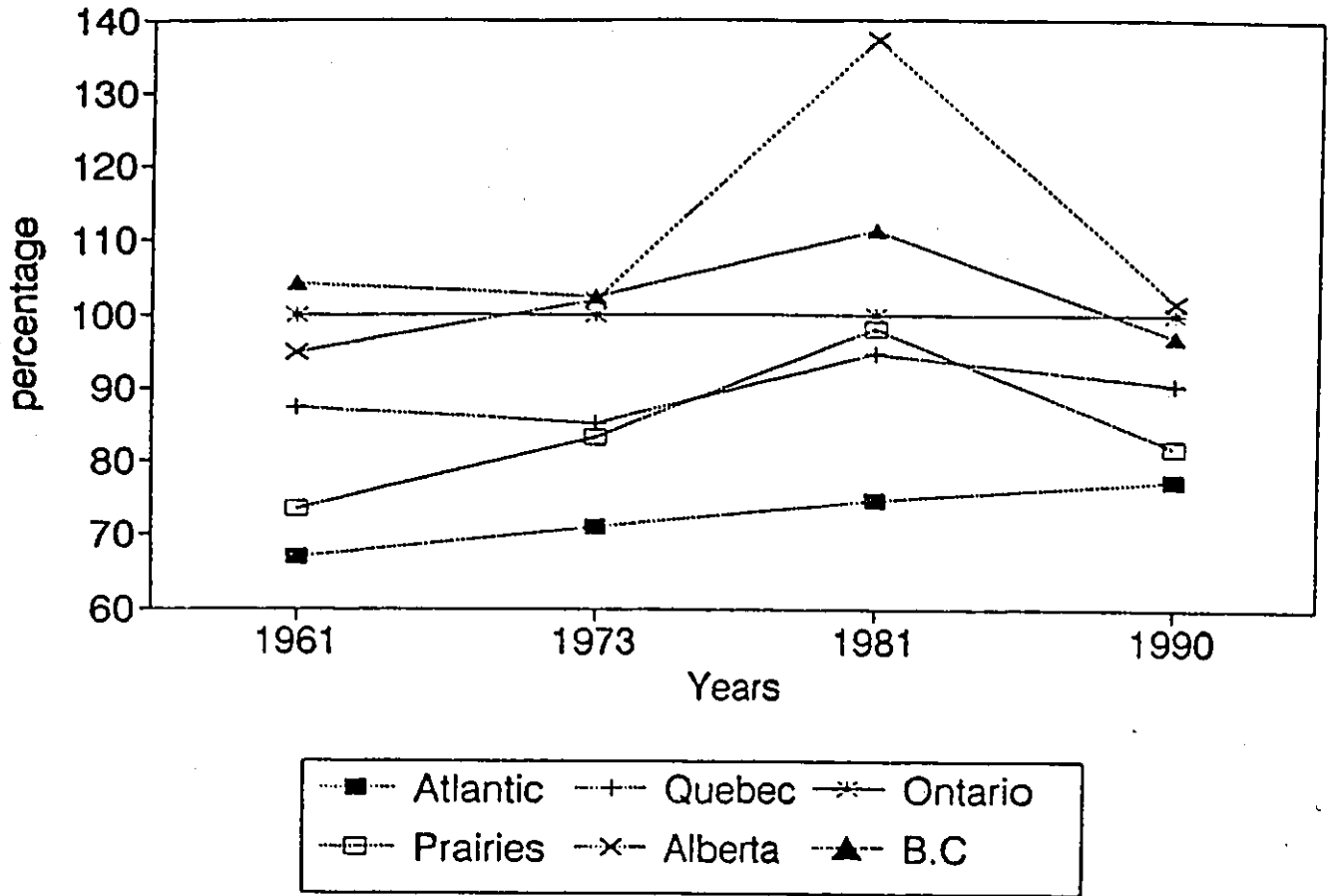
investment.

To evaluate the effects of each of these factors on productivity growth in Canadian regions, I used a model based on Kaldor's (1961) technical progress function and Verdoorn's law. The results show that the decline in productivity growth rates during the 1970s has been caused partly by a decline in growth of output and in the rate of investment. Changes in capital intensity and output growth have varied from region to region. These changes had different impacts on regional productivity growth rates and contributed to a reduction in the huge gap observed during the 1960s (see Figure 4.2).

However, by the end of the sample period, productivity levels in all regions declined relative to Ontario (see Figure 4.2). Capital-labour ratios have stabilized in most regions in the 1980s except Ontario which recorded a slow increase. Ontario also recorded the largest increase in productivity during this period. Differences in labour productivity have been reduced by bringing down levels in Alberta and British Columbia but, at the same time, productivity in the rest of the regions has deteriorated relative to Ontario.

Figure 4.2

Regional Productivity as a percentage of Ontario



Appendix A (of Chapter 4)

The following discussion is based on McCombie (1986) and Bairam (1987).

Rowthorn (1979) has shown that Verdoorn's (1949) original model suffers from an identification problem. The model consists of the following five equations:

$$Q = K^{\alpha}L^{\beta} \quad \text{production equation} \quad (\text{A.1})$$

$$W = \beta(Q/L) \quad \text{labour demand equation} \quad (\text{A.2})$$

$$W = \beta(L/N)^{\lambda}e^{\lambda t} \quad \text{labour supply equation} \quad (\text{A.3})$$

$$k = \gamma(Q/K) \quad \text{capital supply equation} \quad (\text{A.4})$$

$$N = N_0e^{\pi t} \quad \text{population growth equation} \quad (\text{A.5})$$

Where Q is output in the manufacturing sector, K is the capital stock, L is the level of employment. N is the total active population and W is the wage rate. ρ is the elasticity of labour supply with respect to the wage rate. λ and π are the exogenous growth rates of W and N respectively. α and β are the familiar output elasticities and γ is the average propensity to invest.

Taking the logarithm of equation (1) and noting that by definition $p = q - l$, where l is the growth rate of employment we obtain the following relationship between growth of productivity (p) and growth of output (q)

$$p = \frac{\alpha}{\beta} k + \frac{(\beta-1)}{\beta} q \quad (\text{A.6})$$

where k now stands for capital-labour ratio. But another relationship between p and q could also be derived from the labour

market equations. From (3) and (5), the growth of wages is given by:

$$w = \rho l + \phi \quad (\text{A.7})$$

where $\phi = \lambda - \pi\rho$. However from (2) we also have:

$$p = w \quad (\text{A.8})$$

so that after combining (7) and (8) we have

$$p = \frac{\phi}{1+\rho} + \frac{\rho}{1+\rho} q \quad (\text{A.9})$$

The problem is that by regressing p on q , we cannot immediately say whether the estimated coefficient (Verdoorn's coefficient is equal to $(\beta-1)/\beta$ or $\rho/(1+\rho)$. This problem arises of course because Verdoorn's model implies that the growth of labour is a function of the growth of wages which, in turn, is determined by the growth of productivity. This problem does not arise in the Kaldorian model because it is assumed there that growth (occurring primarily in the manufacturing sector) is not constrained by the supply of labour, i.e., Kaldor (1966) assumes the existence of surplus labour in the non-manufacturing sector.

Figure 4.A1

Atlantic: movements in p, k and q

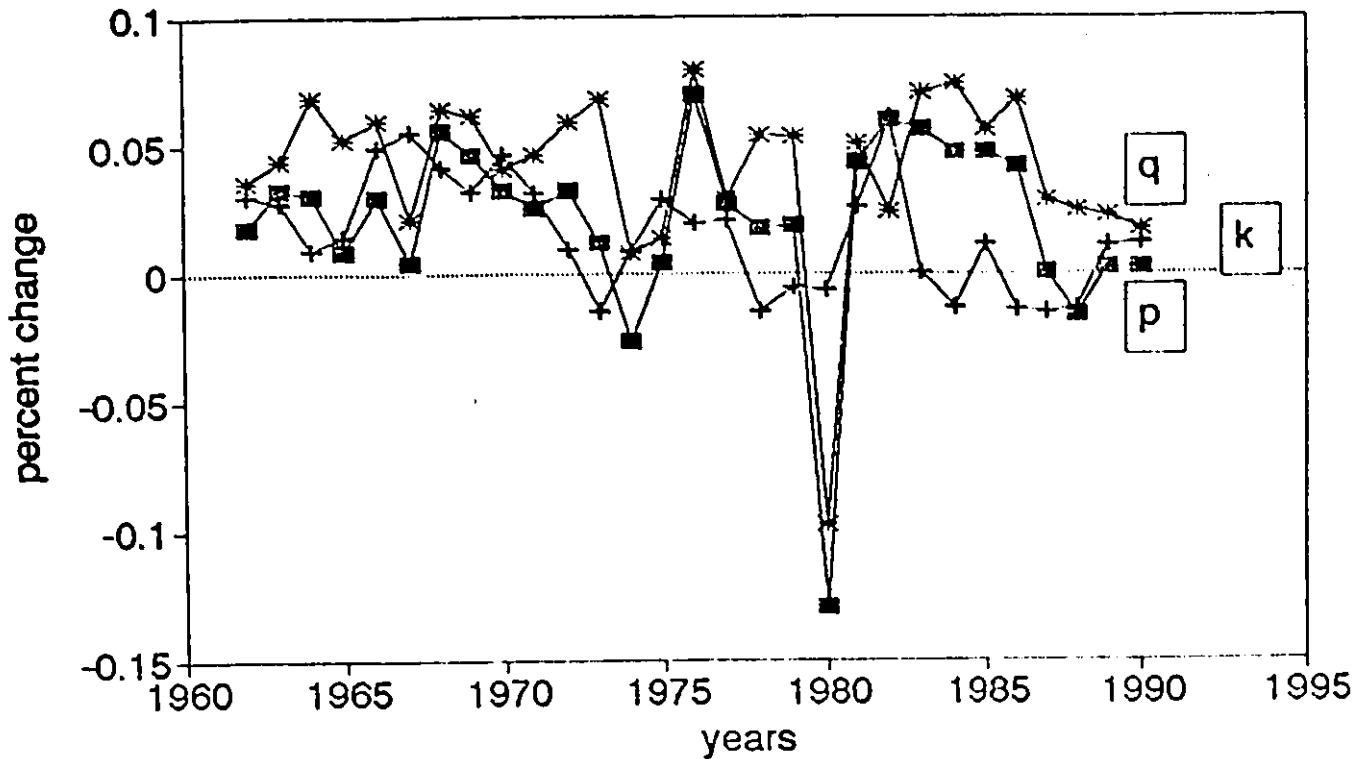
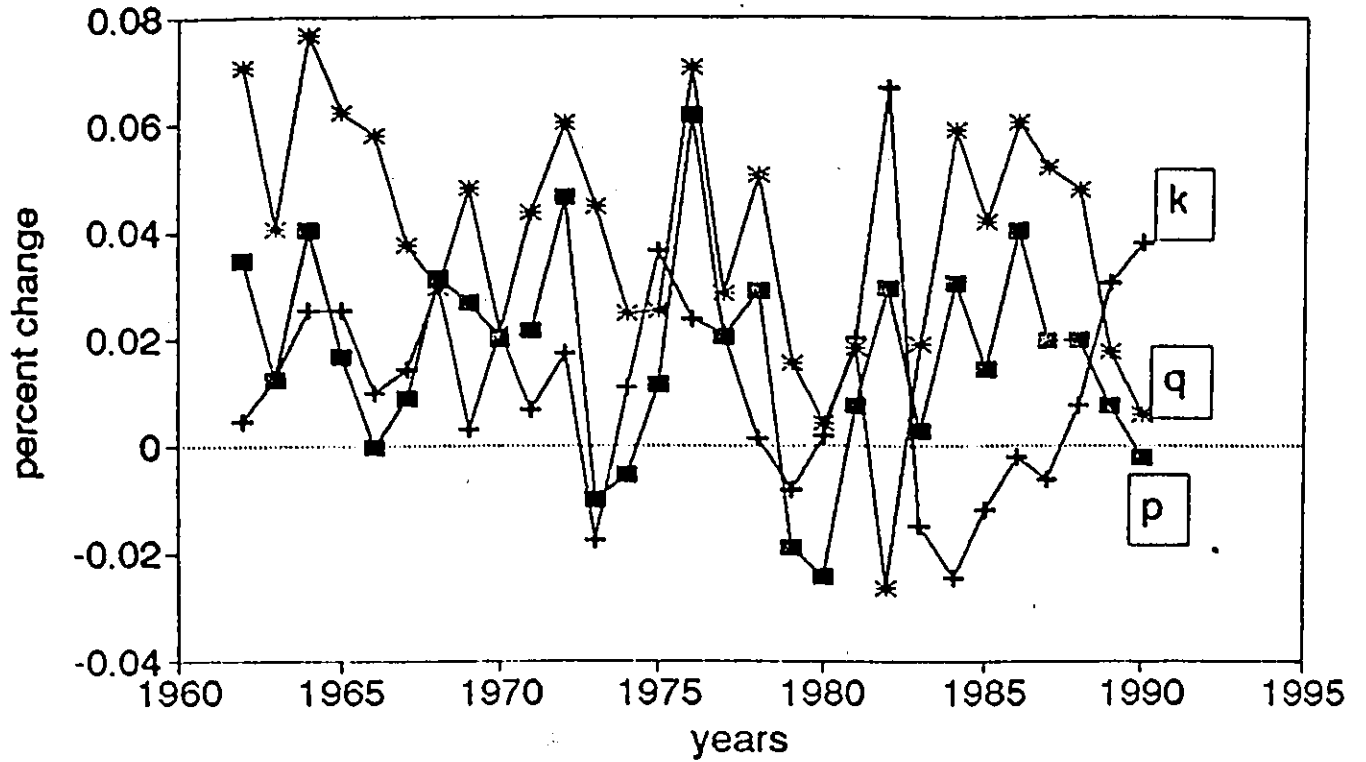


Figure 4.A2

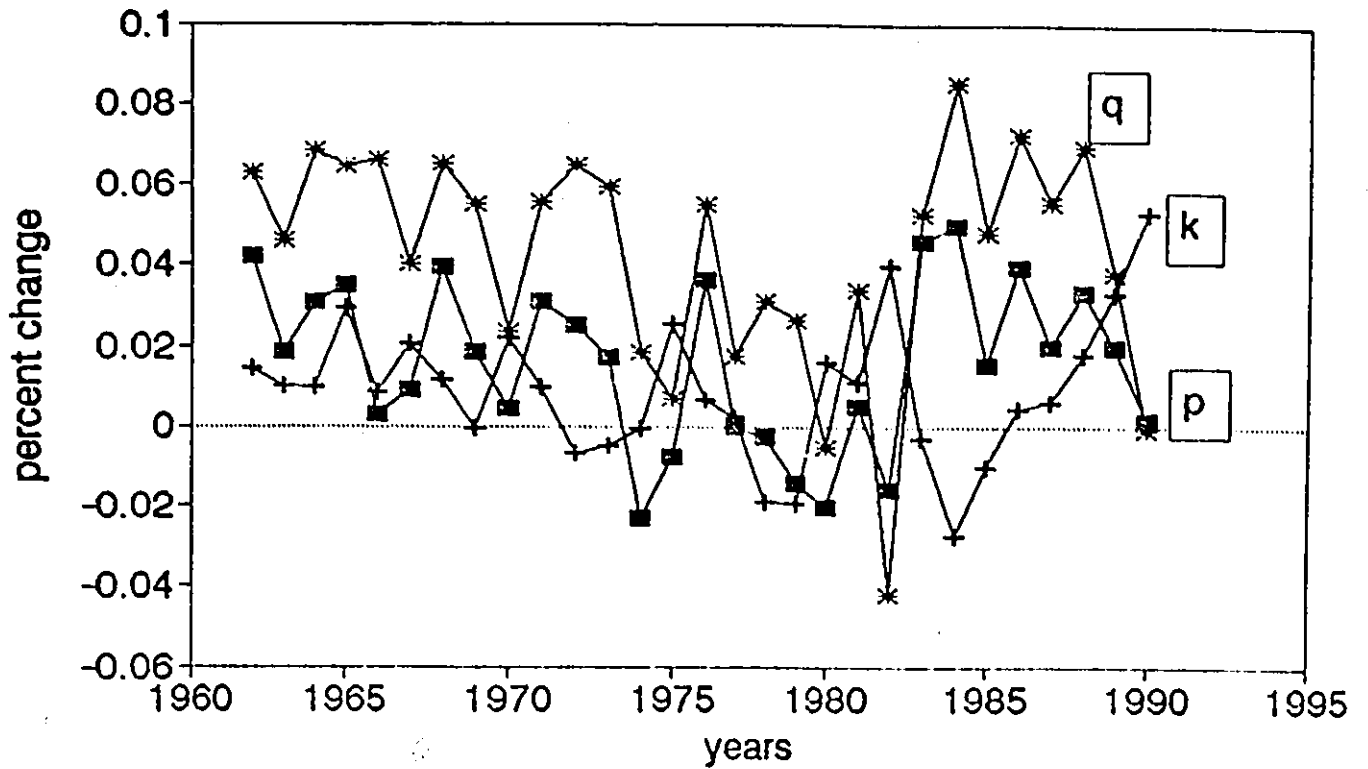
Quebec: movements in p, k and q



—■— growth rate of p —+— growth rate of k —*— growth rate of q

Figure 4.A3

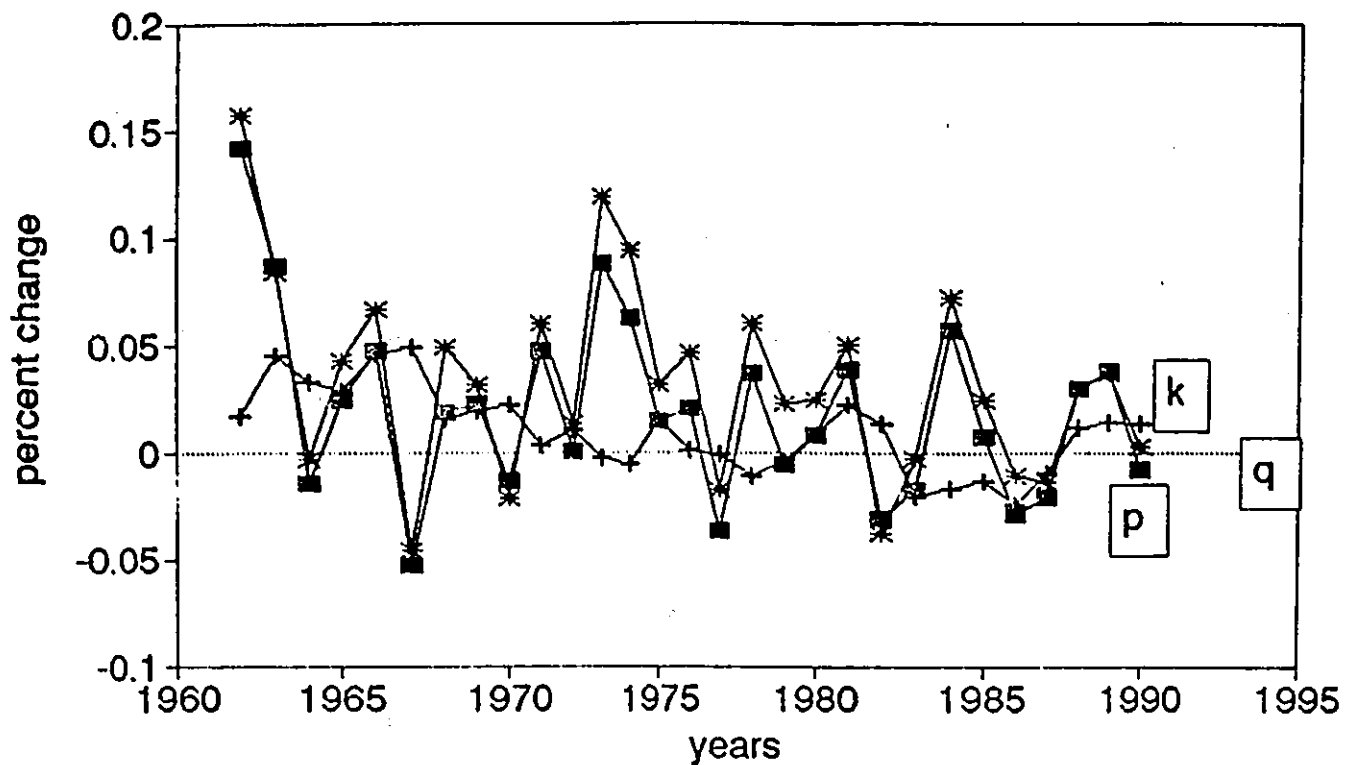
Ontario: movements in p, k and q



—■— growth rate of P —+— growth rate of K/L —*— growth rate of Q

Figure 4.A4

Prairie: movements in p, k and q



-■- growth rate of P -+- growth rate of K/L -* growth rate of Q

Figure 4.A5

Alberta: movements in p, k and q

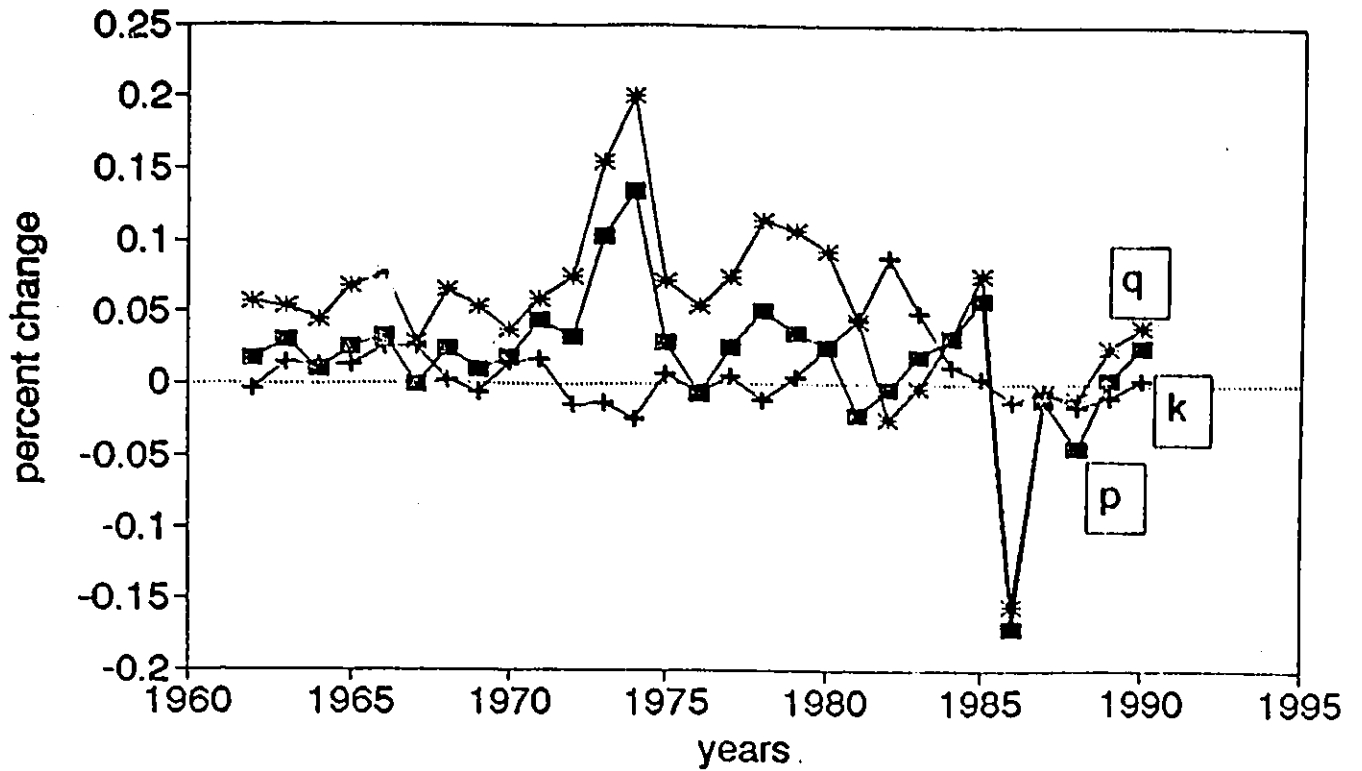
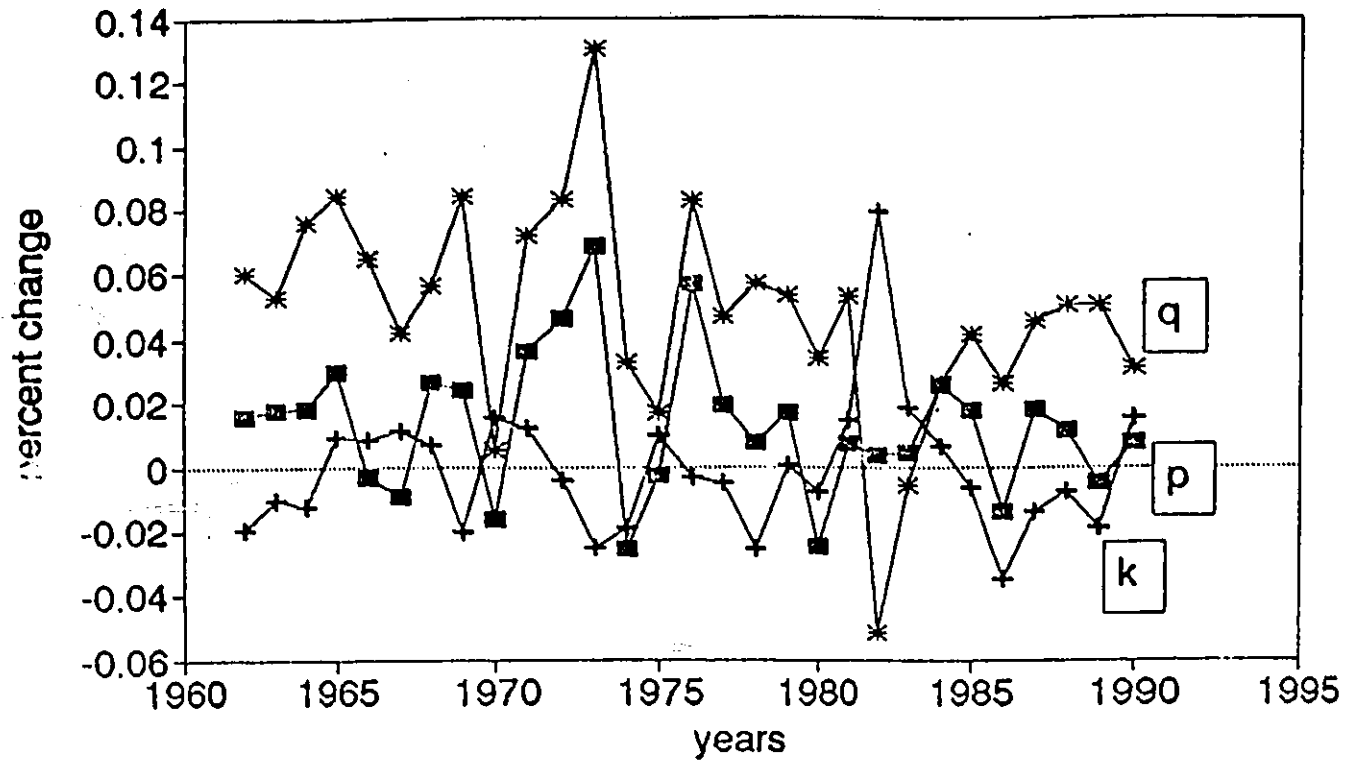


Figure 4.A6

B.C: movements in p, k and q



—■— growth rate of P —+— growth rate of K/L —*— growth rate of Q

Chapter Five

Optimal Allocation of Investment and Regional Growth

5.1 Introduction

It is generally supposed that flows of private capital from one industry or region to another reflect differences in profitability. Capital (private) tends to flow from less profitable to more profitable industries. In the previous chapters, it was argued that more profitable industries tend to be located in regions with well-developed infrastructure.²⁷ Assuming that infrastructure indeed exerts an attraction effect on private capital, the issue of infrastructure investment becomes very important since it deals with the fact of industrial concentration, which is both a source of agglomeration economies and a symbol of regional disparities. The question that comes to mind then is the following: Can the government 'redirect' the flow of capital so as to attenuate regional inequalities while ensuring high levels of growth?

In a market economy, "the government cannot directly control private investment or consumption, but it can influence them through its instruments, such as taxes and creation of retirement of debt" (Arrow and Kurz, 1970: p:xv). In order to achieve desired

²⁷ This should by no means imply that less profitable firms or industries are the lot of regions with a weaker industrial basis. It does however imply, in accordance with Verdoorn's law, that "the existence of substantial economies of scale" means that there are endogenous forces that make the faster growing regions experience higher rates of productivity growth and therefore benefit from an greater competitiveness.

objectives, policymakers can manipulate various instruments or variables of macroeconomic policy planning. A useful technical tool for the analysis of such policymaking is optimal control theory whose most popular applications are to problems of economic growth, especially in trying to find an optimal allocation of output to consumption and investment at the national level (see the seminal works of Shell, 1967 and Arrow and Kurz, 1970). Empirical studies as well as historical experience have shown that economic growth is a slow process characterized by periods of stagnation and even contraction. The same evidence has also shown, however, that if this process is well understood, it can be controlled in all its stages so that desirable outcomes can be achieved.

However, more recently the sectoral and regional allocation of investment over time has become more important in view of the increasing burden of regional disparities and their unacceptability in a democratic society. Given the importance of investment in economic growth, optimal allocation of investment among regions amounts to solving problems of optimal regional growth and disparities. Public capital expenditure has been considered in the literature as a major stimulus to regional growth via the positive impact it has on the private sector. When we examine the share of public investment in the various Canadian regions over the last thirty years, one is struck by the fact that it has been either stagnant or declining in the poor regions of Atlantic Canada and the Prairies (see Table 5.1 below). The share of public investment increased in Alberta and British Columbia as well as in Quebec but

declined somewhat in Ontario between 1961 and 1990.

Table 5.1

The Share of Public Investment by Region

	<u>Atlantic</u>	<u>Quebec</u>	<u>Ontario</u>	<u>Prairies</u>	<u>Alberta</u>	<u>British Columbia</u>
1961	9.1	19.9	35.5	12.1	10.8	12.6
1990	9.4	22.1	34.3	7.4	12.3	14.5

Source: Statistics Canada, *Provincial Economic Accounts*, (Catalogue 13-213)

The first attempt to deal with the issue of regional allocation of investment funds was that by Rahman (1963) and Takayama (1967). The Rahman-Takayama model considers the optimal allocation of investment between two regions and attempts to maximize a terminal objective function (the national income). Although this model deals with optimal regional investment allocation, it clearly pays less attention to interregional disparities than it does to growth of national income. This formulation may lead to a policy which will consider a concentration of investment in the most productive region in order to ensure high growth and maximize (national) income; and only in a later stage may this policy consider income redistribution to ensure regional equality. Besides the fact that this type of policy ignores interregional disparities during the planning period, it suffers from a major deficiency in that it relies on income transfers in order to achieve regional equity. However, transfer payments do not represent a viable long-term solution to regional

disparities and might even increase the dependency of the "assisted" regions since this type of policy is not based on investment and employment creation.

Others (see Michel et al., 1983) have attempted to consider regional disparities but restricted their analysis to the problem of allocation of public funds in a two-region model. Ignoring the private sector reduces the explanatory power of the model and may lower the significance of its policy recommendations. More recently, Friesz and Luque (1987) used a more general model which encompasses both the private and the public sectors but failed to consider the problem of regional disparities. Their goal is to maximize national income.

The goal of this chapter is to consider the trade-off between growth of national income and reduction of regional inequalities over a given time period $[0, T]$. The problem of optimal economic growth then becomes one in which the (federal) government selects the optimal levels of investment and other fiscal instruments so as to ensure that average national income is maximized while each region of the country enjoys a comparable standard of living. By considering these two seemingly antagonistic goals simultaneously in one objective function, the government has to solve the following optimal control problem.

5.2 The model

Consider n regions, each of which has a different taxation rate and investment policy. These regions differ also in their

growth rates as well as in the initial conditions governing the determination of the level of local funds available for investment.

The model is as follows:

$$(1) \quad F(T) = \text{Max} \left[w_1 \frac{\sum_{i=1}^n Y_i(T)}{\sum_{i=1}^n L_i(T)} - w_2 \sum_{i=1}^n \left(\frac{Y_i(T)}{L_i(T)} - \frac{\sum_{i=1}^n Y_i(T)}{\sum_{i=1}^n L_i(T)} \right)^2 \right]$$

where

- Y_i , the output level in region i , is the state variable.
- L_i is the level of employment in region i and (Y_i/L_i) is the average labour productivity.
- T is the terminal time, i.e, the end of the planning period.
- w_1 is the weight attached to growth concerns as opposed to w_2 , the weight attached to minimization of regional disparities in the planning process.

The model maximizes an objective function that depends positively on national average product and negatively on the discrepancy between average labour productivity in any region i and the national average, subject to the following conditions:

$$(2) \quad 0 < t \leq T$$

$$(3) \quad \dot{Y}_i(t) = [\sigma_i \lambda_i (1 - r_i(t)) + \delta_i \mu_i(t) r_i(t)] S(t); \quad \forall i$$

$$(4) \quad Y_i(0) = Y_i^0; \quad \forall i, \quad S(t) = \sum_{i=1}^n s_i Y_i(t).$$

$$(5) \quad \mu_i(t) \geq \alpha_i \geq 0 \quad ; \quad \forall i, \quad a = 1 - \sum_{i=1}^n \alpha_i > 0, \quad \sum_{i=1}^n \mu_i = 1, \quad \sum_{i=1}^n \lambda_i = 1.$$

$$(6) \quad 0 \leq r_0 \leq r_i(t) \leq r_1 \leq 1; \quad \forall i.$$

$$(7) \quad \text{if } \left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{\sum_{i=1}^n L_i} \right) > 0, \quad \text{then } r_i(t) = r_1$$

$$(8) \quad \text{if } \left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{\sum_{i=1}^n L_i} \right) < 0, \quad \text{then } r_i(t) = r_0$$

Equation (2) is a time constraint which restricts the planning period to $[0, T]$. The optimization is done for any time t such that $0 < t \leq T$.

Equation (3) is the *equation of motion* that traces the trajectory of output growth. The variables and parameters in that equation are explained below:

- $\dot{Y}_i(t)$ is the growth rate of output over time.
- $S(t)$ is the sum of all available funds for investment and at the regional level it is assumed to be proportional to regional income so that $S_i = s_i Y_i$, as stated in equation (4).
- $r_i(t)$ is the taxation rate which means that $r_i(t)S(t)$ represents government funds and $[1-r_i(t)] S(t)$ represents private funds

available for investment in region i after taxes have been levied.

- $\mu_i(t)$ is the fraction of public funds invested in region i , so that the share of that region is $\mu_i(t)r_i(t)S(t)$. The control variables of the model are $r_i(t)$ and $\mu_i(t)$.
- λ_i represents the fraction of private funds invested in region i so that the region's share amounts to $\lambda_i(1-r_i(t))S(t)$. Since λ_i describes the behaviour of private investors, and is therefore the result of the private decision making process, it is exogenous to the model.
- σ_i and δ_i are output-capital ratios for private and public investment, respectively, in region i .

Equation (5) introduces an additional degree of freedom whereby the government is allowed some administrative quantity controls. For this reason, it sets $\alpha_i(t)$ as the lower limit of $\mu_i(t)$. The variables α_i are expected to be high for the poor regions and as low as zero for the more prosperous ones. In the case where α_i proves to be insufficient, the central government can select a target region (one at a time) among the poor ones and give it an arbitrary amount (a) such that constraint (5) is respected.

- r_0 and r_1 in equation (6) are constants which represent respectively the lower and upper limits of the control variable $r_i(t)$.

Equations (7) and (8) are the constraints determining the values that will be taken by the control variable $r_i(t)$.

Equation (7) can be written as

$$(7a) \quad (r_i - r_1) \left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{n \sum_{i=1}^n L_i} \right) \geq 0$$

and equation (8) can be written as

$$(8a) \quad (r_i - r_0) \left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{n \sum_{i=1}^n L_i} \right) \geq 0.$$

In what follows, for convenience, we set

$$\left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{n \sum_{i=1}^n L_i} \right) = D_i(t)$$

Kaldor (1961) suggested that technical progress, and hence long-run growth, is mainly induced by capital accumulation. Kaldor's technical progress function relating the rate of growth of output per worker (\dot{y}) to the rate of growth of capital per worker (\dot{k}) is similar to the well-known Harrod-Domar growth model where output (Y) is proportional to the stock of capital (K), that is, $Y = \sigma K$, where σ is the output-capital ratio for the private sector as defined above.²⁸ Since S_i , the sum of available funds for investment, is proportional to the regional output level, it

²⁸ In balanced growth models, the output-capital ratio is assumed to be constant. However, in the present model, the derived optimal allocation of investment funds is likely to alter this ratio in any given region as accumulation takes place.

follows that $S_i = s_i \sigma_i K_i$, i.e., capital stocks represent an important factor affecting the regional surplus and, therefore, the local funds available for reinvestment. This point was made clear and discussed extensively in chapter Three.

The absence of labour as a separate input in the production function of the latter model carries the idea that labour and capital are always combined in fixed proportions. An important difference however between Harrod-Domar model and Kaldor's (1961) model is that Kaldor assumes that technical progress is a function of investment. The importance of investment in regional growth was discussed in the previous chapters. In this chapter, the analysis of investment is taken one step further to show that, through a more active role on the part of the government, an optimal allocation of investment funds can ensure *both high economic growth and regional equity*.

If the issue of regional equity is important, we can choose w_2 large enough by comparison to w_1 . In a case like this the objective function can be considered as a quadratic penalty function where w_2 is the penalty. The maximisation of such a function consists of maximizing the first term and minimizing the second one (McCormick, 1983). The objective of the federal government is to allocate investment funds to the various regions of the country in such a way that growth is maximized and regional disparities are minimized. To determine the optimal allocation, the government must solve the maximization problem defined above. The Hamiltonian associated with that problem is:

$$(9) \quad H = \sum_{i=1}^n P_i(t) \left(\sigma_i \lambda_i (1-r_i(t)) + \mu_i(t) \delta_i r_i(t) S(t) \right).$$

where $(P_i(t))$ are the costate (or auxiliary) variables. Thus the optimal control problem becomes:

$$(10) \quad \text{Max}_{\mu, r} H(y, r, \mu, t)$$

subject to the constraints

$$(11) \quad \mu_i(t) \geq \alpha_i ; \quad \sum_{i=1}^n \mu_i = 1$$

$$(12) \quad (r_i - r_0) \left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{n \sum_{i=1}^n L_i} \right) \geq 0$$

$$(13) \quad (r_i - r_1) \left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{n \sum_{i=1}^n L_i} \right) \geq 0$$

$$(14) \quad 0 \leq r_0 \leq r_i(t) \leq r_1 < 1.$$

Given that the government can control directly the share of

public funds (μ_i) it decides to invest in a given region, a lower limit such as the one given by condition (11) may not be sufficient for some poor regions so that there is need for more investment. In this case, we can target a given region j and the solution of the control variable μ_i will be of the following form:

$$(15) \quad \mu_i(t) = \alpha_i \quad \text{for all } i \neq j,$$

$$(16) \quad \mu_i(t) = \alpha_i + a \quad \text{for } i = j.$$

The criterion used to select such a region will be discussed later.

The role of public capital in raising output, productivity and capital formation in the private sector has been emphasized in the literature by Sakashita (1967), Arrow and Kurz (1970), and Eisner (1980). More recently, Ratner (1983), Aschauer (1989a, 1989b), and Munnell (1990) have suggested that the "productivity slump" (in the U.S.A) has been largely caused by a decline in the growth of the public capital stock. Friedman (1988: 202) argues that "government investment in roads, bridges, airports, port facilities, and other kinds of infrastructure...has a direct bearing on how easy or difficult it is, and also how cheap or costly, for companies to do business." Indeed, public capital provides highways and roads which are used to facilitate the acquisition and distribution (by lowering transportation costs) of goods and services in the private sector. Public capital also provides educational services which directly affect the quality of labour services and, hence, income

and productivity.

The argument in favour of raising public capital spending is based on the assumption that private and public capital are complements and do not crowd each other out.²⁹ Therefore, a larger quantity of public capital in a given region improves the opportunities for private capital to increase the rate of return. This will attract other firms to the area and provide an incentive for the existing ones to increase their investment. Public capital can also affect the private sector output directly by changing the magnitude and the quality of services it provides to the private sector firms. Thus, it can be concluded that an increase in public capital spending in the poorer regions will stimulate the private sector output and productivity and, therefore, will provide an opportunity to reduce interregional disparities in employment and income.

Assuming that region j is known, (e.g., the poorest of them all), it will receive $\mu_j = \alpha_j + a$ of public investment and investors within its jurisdiction will be subject to a taxation rate $r_j = r_0$. Also, knowing that we only need to maximize the part of the Hamiltonian which is dependent on the control variables, our maximization problem can then be written as follows:

²⁹ On the argument of substitutability and crowding out, see Kormendi (1983) and Kormendi and Meguire (1990).

$$(17) \quad \text{Max}_r \left(\sum_{i=1}^n P_i(t) [\alpha_i \delta_i - \lambda_i \sigma_i] r_i(t) + aP_j(t)r_j(t)\delta_j S(t) \right)$$

subject to

$$(18) \quad (r_i - r_0)D_i(t) \geq 0$$

$$(19) \quad (r_i - r_1)D_i(t) \geq 0$$

$$(20) \quad (r_i - r_0) \geq 0$$

$$(21) \quad (r_1 - r_i) \geq 0$$

We can thus construct the Lagrangian:

$$(22) \quad L = H(y, r, t) + \sum_{i=1}^n \theta_i^1 (r_i(t) - r_0)D_i(t) \\ + \sum_{i=1}^n \theta_i^2 (r_i(t) - r_1)D_i(t) + \theta_i^3 (r_i(t) - r_0) \\ + \theta_i^4 (r_1 - r_i(t)).$$

where θ_i^1 , θ_i^2 , θ_i^3 , and θ_i^4 are the Lagrange multipliers associated with the maximization of the Hamiltonian.

Region j will be chosen among the poor regions at the end of each phase of the planning period. The phase here can be thought of as a fiscal year or any other short term plan in a long term planning period. Region j will benefit from additional public investment if

$$D_j(t-1) = \underset{i}{\text{Min}} \{ D_i(t-1), i = 1, \dots, n \}$$

The optimality conditions of the maximum principle (Pontryagin

maximum principle) for any $i \neq j$ are:

$$(23) \quad \frac{\partial L}{\partial r_i} = 0 = P_i(t) (\alpha_i \delta_i - \lambda_i \sigma_i) S(t) + (\theta^1_i + \theta^2_i) D_i(t) + \theta^3_i - \theta^4_i .$$

$$(24) \quad \dot{P}_i(t) = - \frac{\partial L}{\partial Y_i} = -s_i \sum_{i=1}^n P_i(t) \left[[(1-r_i(t)) \sigma_i \lambda_i + r_i(t) \mu_i(t) \delta_i] \right. \\ \left. - \theta^1_i (r_i - r_0) \left(\frac{1}{L_i} - \frac{1}{\Sigma L_i} \right) - \theta^2_i (r_i - r_1) \left(\frac{1}{L_i} - \frac{1}{\Sigma L_i} \right) \right] .$$

$$(25) \quad P_i(T) = \frac{\partial F(T)}{\partial Y_i} = \frac{w_1}{\Sigma L_i(T)} - 2w_2 \left(\frac{1}{L_i(T)} - \frac{1}{\Sigma L_i(T)} \right) D_i(T) .$$

$$(26) \quad \dot{Y}_i = \frac{\partial H}{\partial P_i} = \left[[(1-r_i(t)) \sigma_i \lambda_i + \mu_i r_i(t) \delta_i] S(t) \right]$$

$$(27) \quad (r_i - r_0) D_i(t) \geq 0; \theta^1_i \geq 0; \theta^1_i (r_i - r_0) D_i(t) = 0$$

$$(28) \quad (r_i - r_1) D_i(t) \geq 0; \theta^2_i \geq 0; \theta^2_i (r_i - r_1) D_i(t) = 0$$

$$(29) \quad (r_i - r_0) \geq 0; \theta^3_i \geq 0; \theta^3_i (r_i - r_0) = 0$$

$$(30) \quad (r_i - r_1) \geq 0; \theta^4_i \geq 0; \theta^4_i (r_i - r_1) = 0$$

5.3 Analysis of the optimality conditions

There are three scenarios to be examined by looking at the optimality conditions. The interpretations of the results derived in this section are found in section 5.5.

i) First, in the case of rich regions, i.e., those where productivity is higher than the national average

$$D_i(t) = \left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{n \sum_{i=1}^n L_i} \right) > 0$$

constraint (7) implies that the taxation rate $r_i(t)$ must be the highest, that is, equal to r_1 . To ensure that $r_i(t) = r_1$ we choose $\theta_i^4 > 0$. Once this equality is assured, the constraint (19) becomes binding and we have $(r_i - r_1)D_i(t) = 0$ so that we can select $\theta_i^2 = 0$ without any loss of optimality. Since $r_i(t) = r_1 > r_0$ and $(r_i - r_0)D_i(t) > 0$, optimality conditions (27) and (29) yield $\theta_i^1 = \theta_i^3 = 0$. Thus a solution for the multipliers is

$$\theta_i^1 = \theta_i^2 = \theta_i^3 = 0; \text{ and } \theta_i^4 > 0$$

For this solution, condition (23) gives

$$P_i(t) (\alpha_i \delta_i - \lambda_i \sigma_i) = \theta_i^4 / S(t) , \text{ which is strictly positive.}$$

ii) Second, in the case of poorer regions where productivity is less than the national average

$$D_i(t) = \left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{n \sum_{i=1}^n L_i} \right) < 0$$

the control variable $r_i(t)$ should be the lowest, i.e., equal to r_0 . To ensure that, we set $\theta_i^3 = 0$. Consequently, the constraint (18) becomes binding and we can take $\theta_i^1 = 0$ without loss of optimality. Since $r_i - r_0 = r_i - r_0 > 0$ and $(r_i - r_0)D_i(t) > 0$, optimality conditions (28) and (30) imply that $\theta_i^2 = \theta_i^4 = 0$ and condition (23) gives

$$P_i(t) (\alpha_i \delta_i - \lambda_i \sigma_i) = -\theta_i^3 / S(t), \text{ which is strictly negative.}$$

iii) Finally, if it so happens that a region has the same productivity level as the national average, that is, when

$$D_i = \left(\frac{Y_i}{L_i} - \frac{\sum_{i=1}^n Y_i}{n \sum_{i=1}^n L_i} \right) = 0$$

we want $r_i(t) = r^*$, an equilibrium taxation rate that would leave investors indifferent from moving out or staying in the region. In this case conditions (18) and (19) become equal to zero for any value of r_i and the solution is indeterminate. It is possible to pursue this question further and try to determine the existence of a singular control (see Bryson and Ho, 1975; Friesz and Luque, 1987) but for the purpose of this study it is sufficient to let $r^* = r_0$ and since in the case of indetermination the Lagrange multipliers can take on any value, we set them all equal to zero and condition (23) becomes

$$P_i(t) (\alpha_i \delta_i - \lambda_i \sigma_i) = 0.$$

5.4 Determination of the costate variables

Consider now equation (24) and let

$$(31) \quad K(t) = \sum_{i=1}^n P_i(t) \left[[(1-r_i(t)) \sigma_i \lambda_i + r_i(t) \mu_i(t) \delta_i] \right]$$

equation (24) becomes:

$$(32) \quad \dot{P}_i(t) = -s_i K(t).$$

In order to determine $P_i(t)$ we multiply each equation in (32) by

$[(1-r_i(t)) \sigma_i \lambda_i + r_i(t) \mu_i(t) \delta_i]$ and add them up which gives

$$(33) \quad \dot{K}(t) = -AK(t)$$

where $A = \sum_{i=1}^n s_i [(1-r_i(t)) \sigma_i \lambda_i + r_i(t) \mu_i(t) \delta_i]$ and $K(t)$ is as defined in

equation (31). From equation (33) we can determine the value of $K(t)$ which is

$$(34) \quad K(t) = K(T) e^{A(T-t)}.$$

Note that $\text{Max}_{r, \mu} H \Leftrightarrow \text{Max}_{r, \mu} K \Leftrightarrow \text{Max}_{r, \mu} A$

and therefore we have $K^*(t) = K(T) e^{A^*(T-t)}$ where $A^* = \text{Max}_{r, \mu} A$

Finally, by integrating (32) we get the value of the costate variable $P_i(t)$:

$$(35) \quad P_i(t) = P_i(T) - (s_i/A^*)K(T) \left(1 - e^{\lambda(T-t)} \right)$$

where the value of $P_i(T)$ is readily determined by setting

$$D_i(T) = \left(\frac{Y_i(T)}{L_i(T)} - \frac{\sum_{i=1}^n Y_i(T)}{\sum_{i=1}^n L_i(T)} \right) = 0 \quad \text{since this is the}$$

objective at time T , the end of the planning period. Now that we know the values of the costate variables, we can easily determine the values of the control variables.

5.5 Determination of the control variables

For any region i , $i \neq j$, the control variables are derived as follows:

if $P_i(t) (\alpha_i \delta_i - \lambda_i \sigma_i) > 0$ then $r_i(t) = r_1$

if $P_i(t) (\alpha_i \delta_i - \lambda_i \sigma_i) < 0$ then $r_i(t) = r_0$

and if $P_i(t) (\alpha_i \delta_i - \lambda_i \sigma_i) = 0$ then $r_i(t) = r^*$, which is here constrained to level r_0 as explained in section 5.3. This policy means that in areas where labour productivity has been higher than the average and where the share of government spending has been

proportionally higher, the government must now pursue a policy of high taxation and low investment. Conversely, where the share of government spending has been relatively low and labour productivity less than the national average, the government must reverse this trend by making more funds available to investors in these regions through lower taxes and more investment spending. This bang-bang solution is an optimal policy under the constraints of the problem since the objective function (17) is linear in the control variable r_i .

In its final report, the *National Advisory Board on Science and Technology* (1991: 12) outlined the difficulties encountered by firms in general, and particularly the small and those planning industrial innovation, in gaining access to capital. The Board's recommendations on how to improve the access to capital for small firms are of particular interest to those located in poor regions. These recommendations included:

- Tax measures ...[such as] exemption of founders' shares from the capital gains tax; tax incentives to direct retirement funds to venture capital purposes; and special tax incentives to attract experienced managers of knowledge-based companies from other countries.
- Spending measures ...[like] government assistance programs of all types [which] improve access to capital, especially if their contributions can be classed as equity (or a contingent liability), rather than debt. A program in which government would match part of the equity raised by the private sector, to be repaid by royalties on future sales, would [also] meet this test because repayment is contingent upon sales...*To assist in the development of management resources, it has been suggested that the government provide loans to companies to defray the extra costs associated with attracting management personnel from elsewhere in Canada, or from other countries.* (pp. 14-15; emphasis added)

We are now in a position to address the question of efficiency

and equity. It is obvious that shifting funds from regions where productivity is higher than the average and redirecting them to low-productivity regions results in a loss of efficiency during the first years of the planning period. However, if the objective includes both growth and minimization of interregional differences, then the optimal policy is to allow low-productivity regions to grow faster while always making sure that high-productivity regions will never fall behind.

By manipulating the control variables μ and r , the government is able to affect regional growth. Optimality condition (26) traces the growth path for regional economies. Some relatively simple mathematical manipulations of equation (26) allow us to get the level of output in each region:

$$(36) \quad Y_i(t) = Y_i(t-1) + (B_i/B)S(t-1)[e^{\mu} - 1]$$

where $B_i = (1-r_i) \sigma_i \lambda_i + \mu_i r_i \delta_i$ and $B = \sum_{i=1}^n s_i B_i$.

$Y_i(t-1)$ is the level of output in region i and $S(t-1)$ is the total sum of available funds for investment at time $(t-1)$. Regional output thus depends on the previous growth rates in the region and this is captured by $Y_i(t-1)$. It also depends on policy parameters which can be affected by the government.

As mentioned before and can easily be seen from equation (36), the low (*high*) rates of taxation (r) and high (*small*) shares of investment (μ) increase (*lower*) the regional output level. But if (μ) contributes directly to raising regional output, it also

contributes indirectly via the positive impact public capital spending has on private investment. In this context, it is easy to see that there are secondary effects which will result from the positive effects on other variables such as those which were considered in previous chapters as important determinants of private investment. In particular, such investment and tax policies will contribute to increase the existing level of capital stocks in the poorer regions. They may also affect the rate of return and the cost of capital, which have important implications for regional growth rates and the magnitude of regional profits and, therefore, for the regional surplus available for reinvestment.

The second part of equation (36) is of great significance to us since it shows that regional output depends on the specific regional parameters such as the capital-output ratio both in private (σ_i) and public (δ_i) sectors, the share received from private (λ_i) and public (μ_i) investment funds, and the level of taxation rates (r_i) set by the government. These parameters ultimately determine the share of total investment funds $S(t-1)$ to be allocated to the region:

$$\frac{(1-r_i) \sigma_i \lambda_i + \mu_i r_i \delta_i}{\sum_{i=1}^n s_i [(1-r_i) \sigma_i \lambda_i + \mu_i r_i \delta_i]} \cdot S(t-1) \cdot e^{\sum_{i=1}^n s_i [(1-r_i) \sigma_i \lambda_i + \mu_i r_i \delta_i]}$$

Regional output levels, thus, depend in a crucial manner on investment decisions which, in turn, are susceptible to changes in the regional economic policy. Therefore, it is the government's

responsibility to select such control variables and other incentives in such a way that the spatial distribution of economic activity in general, and that of investment funds in particular, develop in accordance with the specified objectives of economic growth and regional equity.

5.6 Conclusion

In this Chapter, I developed a model that takes into account the trade-off between growth of national income and reduction of regional inequalities. Optimal growth in such a setting forces the central government to redirect investment funds from one region to the other by choosing optimal control variables so that in the end, national average income is maximized while each region of the country enjoys a comparable standard of living.

Shifting investment funds from high-productivity to low-productivity regions often results in an efficiency loss during the first years of the planning period $[0, T]$. However, the model proposed here is flexible since although it allows low-productivity regions to grow faster, it also prevents the high-productivity regions from falling behind. When productivities (and perhaps opportunities for employment, etc.) are equalized, the government will pursue a neutral policy by choosing an equilibrium taxation rate $r_i(t) = r^*$ and an investment policy μ_i such that economic growth is maximized while controlling for regional disparities.

Chapter Six

Conclusions

Regional economic disparities in Canada have existed and persisted for a long time. Income differences between poor and rich regions are substantial enough to have led to governmental corrective measures. For instance, per capita income in Atlantic provinces has been around 30 percent less than the national average since the 1960s. Unemployment rates in the poor provinces are sometimes twice as high as the national average. The location of the key economic sectors is highly concentrated in Ontario and Quebec whereas the Atlantic and Western provinces continue to be essentially resource-based economies. Many are now arguing that the unequal distribution of wealth and poverty in Canada can be explained by the unequal regional distribution of production (Howlett and Ramesh, 1992).

The regional distribution of production, i.e., its geographic location, is intimately tied with the process of regional capital accumulation. Although traditional economic theory has long considered investment and capital accumulation as central to the analysis of capitalist economies, the regional literature as well as empirical analysis in Canada have largely ignored the importance of capital formation in determining the relative economic growth or decline of the various regions of the country. The present study has focused on the role which capital accumulation has played in regional disparities in Canada over the last thirty years.

Two main questions were addressed. The first question dealt with the importance of the spatial distribution of capital stocks in determining regional patterns of growth in output, productivity, and employment. This occupied the major part of the thesis and meant an analysis of the factors that determine the allocation of capital between regions and make some regions attract and, therefore, accumulate more capital than others. The second question dealt with the policy-related problem of reducing regional disparities by altering the present pattern of capital accumulation. The role of the state was essential in implementing investment and tax policies that would lead to an allocation of investment funds that is optimal in achieving both high levels of national growth and the reduction of regional disparities.

The centrality of capital formation in the regional economic analysis taken here stems from the basic fact that an expansion in the stock of capital constitutes a major stimulus to regional economic growth. Conversely, a relative decline in the capital stock of a region, due to obsolescence or low investment rates, has often been followed by an increase in unemployment, plant relocation, and out-migration of population and economic activity. Capital mobility seems to determine the shifts of productive activity between regions. Chapter Two of the thesis established some strong correlations between the spatial distribution of capital on the one hand and, regional growth in output, employment, and interregional migration on the other hand. This means that the direction of investment and, therefore, the rates of capital

accumulation are important considerations for the analysis of regional disparities.

The abundance as well as the age structure of capital stocks are important factors that determine the levels of regional output and employment. Canadian regions differ greatly as to the quantity and quality of their capital stocks and their industrial structure. These differences translate into differences in growth rates of output, employment, and unemployment. The intensity of fixed capital in production has a direct impact on labour productivity, but even more important is the age structure of capital stock, i.e., the level of technology, since the new capital equipment incorporates the most recent technology which helps labour productivity to increase faster.

Most economic theories recognize the central role of investment in regional development. It was noted in the thesis that the conflicting explanations of regional disparities by these theories stem essentially from two basic yet contradictory conceptions of investment. One approach stresses the cumulative tendency and sees capital accumulation as an essentially concentrated phenomenon. The other approach perceives capital as a highly mobile factor adjusting relatively quickly to spatial differences in costs and returns.

From an analysis of the theory and a review of previous research, it appears that the following factors are most important in determining regional investment:

- the existing level of capital stock,

- the scale of production and capacity utilization,
- labour costs and commodity prices,
- the rate of return and the cost of capital,
- the magnitude of past profits, i.e., the regional surplus available for reinvestment and the access to financial resources,
- the age structure and the rate of depreciation of capital stock,
- regional growth and business cycles.

A detailed analysis of the spatial dimension of regional investment shows that regional capital accumulation in Canada is strongly influenced by the relative growth rate of a region, the relative size of its capital stock, profit levels and a measure of labour cost that takes into account changes in labour productivity. In this context, it was noted that one of the impediments to rapid growth of capital accumulation in the poorer regions was the limited availability of finance, especially that generated from local funds. The availability of investment funds seems to exert a considerable influence on regional capital accumulation and, therefore, on regional growth.

Studies on productivity growth have generally assumed a positive relationship between capital accumulation and labour productivity. Verdoorn's law states that the rate of change of productivity is influenced by the rate of change of output. The presence of agglomeration economies has also been used in the literature to explain regional differences in productivity. It is argued that agglomeration of economic activity can influence labour productivity by influencing the rate of investment, technical

progress and innovation. In order to evaluate the effects of these factors on productivity in the context of Canadian regions, I used a model based on a combination of Verdoorn's law and Kaldor's technical progress function. It was found in this study that regions that are well endowed with capital stocks and have a larger and well developed industrial structure have also experienced higher rates of investment and capital accumulation. These regions have also enjoyed high productivity growth rates. Over the period 1961-1990 changes in capital intensity appear to have led changes in output and during the "productivity slump" of the 1970s declines in the growth rates of capital-labour ratios have strongly reinforced declines in growth rates of output in order to slow down productivity.

The results obtained in Chapters Two, Three and Four are based on an analysis of available data on regional investment and capital stocks. The measurement of capital stocks is based on estimates from the *Capital and Repair Expenditure Survey* and on a variety of assumptions concerning the service life of assets and their depreciation. The evaluation of proposed policies therefore critically depends on the accuracy of such measures.

The analysis carried here was also constrained by the availability of such data. For instance, the study focused on disparities and movements of capital between provinces and/or group of provinces, thus ignoring the substantial intra-provincial differences that may exist in investment, productivity, etc. This is an important topic for further research if such data become

available. Another interesting area for future research that arises from the present study is the potential use of such data on capital stocks and investment for the purpose of an intersectoral-interspatial analysis in order to determine to what extent certain "regions" compete against or complement others and in what sectors. Such an analysis may prove to be helpful in understanding the experiences of growth or decline in particular areas.

Most studies on regional disparities in Canada agree that policies aimed at influencing employment location and labour migration have not been very successful. A more effective regional policy must be careful to include explicit questions related to the regional allocation of investment. Various policy instruments such as financial and fiscal incentives as well as administrative controls can be used in order to achieve a more equitable distribution of investment and employment and, hence, improve the productivity and growth prospects in the poorer regions. In spite of the importance of this question in a multi-regional economy such as Canada, there is a serious scarcity -- both at the theoretical and the empirical level -- of studies which have attempted to tackle the issue.

Chapter Five developed a model to determine the optimal allocation of investment funds taking into account both objectives of national growth and regional equity. The model is based on optimal control theory and considers both the maximization of national income and minimization of regional inequalities in one objective function. The model assumes that all public investment

funds are pooled together and then redistributed to the regions. This allows the central government to redirect investment funds (private and public) from one region to another by choosing optimal control variables. Such a policy would promote growth in all regions and help to alleviate regional disparities over a specified planning period. The model also allows the government to introduce some administrative quantity constraints on the amount of funds invested in the more prosperous regions.

Such quantity controls allow the government to reallocate investment funds and increase public capital in the poorer regions. The argument in favour of raising public capital in poorer regions is based on the idea that, besides its direct productivity, public capital spending on material infrastructure and educational services also contributes to raising output, productivity, and capital formation of the private sector. Where there are improved opportunities for private capital to increase its rate of return, other firms will be attracted to the area and the existing ones will have an incentive to increase their investment. This will stimulate growth and provide an opportunity to reduce interregional disparities in employment and income.

When growth and regional equity are taken simultaneously in the objective of the government, optimal control theory proves to be a powerful tool in finding the optimal allocation of investment funds. The thesis shows that, in such a case, the optimal policy is not to concentrate investment in the more productive regions, but to increase capital where it is scarce. This may result in an

initial loss of efficiency but, if the planning period is long enough, this loss will be compensated by the gain from the fast growth in the regions previously noted for their slow productivity and from achieving the objective of equalization.

The model developed in Chapter Five is a useful theoretical guide in attempting to formalize the two objectives of national growth and regional equity. Its practical usefulness can be made clearer by an empirical study. No attempt, however, has been made here to do such a study. This task is left for future research.

Finally, it can be said that one of the most important factors of economic development of a country or region is the building-up of its capital stock. However, accumulation of capital is not limited only to the physical expansion of capital stocks and the increase in the productive capacity. It also involves qualitative enhancement through technological advances which are expressed in the design of new capital as well as in the skill and education levels of the country's / region's labour force. Capital accumulation is therefore at the centre of the growth process. The "great social advantages" from aiming at a regionally planned and controlled rate of investment are to raise employment and incomes in the poor regions.

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