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Depression and War: Three Essays on the Canadian Economy 1930-45

By

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Abstract

Two main points histories of the Second World War in Canada traditionally emphasize are 1) the role of war-related fiscal policy in finally ending the Great Depression and 2) the success of government control over the economy. Potential output estimates show a large output gap still in existence in 1939, with it quickly closing by 1941. The Dominion government's war-related fiscal policy emerges as the factor explaining this rapid recovery. But Dominion fiscal policy was also important to recovery before the war. Canada's participation in bi-lateral trade negotiations, which lowered tariffs, the chief instrument of contemporary Dominion government fiscal policy, in reciprocation for similar concessions, stimulated exports, the chief source of recovery before the war.

The matter of success rests largely on how well the Department of Munitions and Supply achieved the Dominion government's strategic aims during the war. Two strategic aims identified in this thesis are the government's desire to minimize the costs associated with war production and to avoid over-expansion in the iron and steel industry. Examining the production records of the Dominion Steel and Coal Company (Dosco), a primary iron and steel firm, and the Trenton Steel Works, a secondary manufacturing firm, shows how the government allocated production in a least cost manner among Canadian producers, consistent with the first of these two aims. Through its Crown Corporations, the Department also strove to minimize the costs associated with establishing war plant. Concerning the second aim, the government avoided rehabilitating Dosco's steel plate mill until sufficient domestic demand warranted it. With its capacity extraneous to the Canadian industry, the government closed the mill after the war. In contrast to the importance previous research placed on political factors in explaining the government's conduct of the war effort, this thesis argues that considerations production costs and input prices were a vital part of the government's decision making process.

Résumé Analytique

Le rôle des politiques fiscales imposées par la guerre et destinées à mettre un terme à la grande dépression, ainsi que la réussite du gouvernement à contrôler l'économie, constituent deux des aspects les plus documentés par les histoires de la Seconde guerre mondiale. Les rendements estimés illustrent un écart jusqu'en 1939, mais qui diaparaît en 1941. L'émergence des politiques fiscales du Dominion canadien expliquent cette rapide reprise économique. Mais ces mêmes politiques ont également joué un rôle important dans la reprise économique d'avant-guerre. La participation canadienne aux négociations sur les échanges bi-latéraux, qui ont conduit à une réduction des tarifs, principal instrument des politiques fiscales d'un Dominion contemporain, en retour de concessions similaires, a stimulé les exportations, principale source de reprise avant la guerre.

Cette réussite s'appuie en grande partie sur les façons par lesquelles le Département of Munitions and Supply est parvenu à mettre en oeuvre les objectifs stratégiques du Dominion. Cette thèse identifie deux de ces objectifs: la minimalisation des coûts liés à la production de guerre et le contrôle du développement de l'industrie du fer et de l'acier. L'examen des dossiers de production de la Dominion Steel et de la Coal Company (Dosco), deux producteurs importants de fer et d'acier, et de la Trenton Steel Works, une firme manufacturière secondaire, démontre comment le gouvernement est parvenu à contrôler les coûts et à atteindre les objectifs en question. Par l'intermédiaire de ses corporations de la Couronne, le Département a également réussi à minimiser les coûts associés à l'implantation des usines de guerre. En ce qui a trait au deuxième objectif, le gouvernement a évité la réhabilitation de la Dosco jusqu'à ce que la demande domestique la justifie. Le gouvernement a fermé cette usine après la guerre. Par opposition à l'importance accordées aux facteurs politiques dans la recherche antérieure sur la conduite du gouvernement dans ses efforts de guerre, cette thèse veut démontrer que des questions de production et de politique des prix ont joué un rôle vital dans le processus décisionnel du gouvernement.

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List of Abbreviations

Besco	British Empire Steel Company
BI	Beaton Institute
Disco	Dominion Iron and Steel Company
Dosco	Dominion Steel and Coal Company
DND	Department of National Defence
EPT	Excess Profits Tax
kg	kilogram
lbs	pounds
NAASC	Navy, Army and Air Supply Committee
NAC	National Archives of Canada
PANS	Public Archives of Nova Scotia
WSB	War Supply Board

Introduction

The landscape of Canadian economic history is quite barren of studies on the Second World War. This is unfortunate since a number of issues concerning the war remain largely unexplored by the tools of economic analysis. This dissertation addresses two questions surrounding the role of the Second World War in Canadian economic history. First, it examines the significance of the war in promoting the recovery of the Canadian economy from the Great Depression and looks at the factors behind the recovery in the late 1930s. Second, it studies the issue of the Dominion government's success at directing the war effort. Using detailed archival data, this thesis studies the wartime experience of a primary iron and steel firm, the Dominion Steel and Coal Company (Dosco), and a secondary manufacturing involved in munitions production, the Trenton Steel Works Limited.

Conventional wisdom about the economic effects of the Second World War accord it a central role in ending the Great Depression and restoring full employment output. Implicitly, this view argues that the Dominion government's fiscal policy, resulting in the tripling of government expenditure, acted as an effective counter-cyclical force. How significant was the increase in aggregate demand sparked by the Dominion government's war-related fiscal policy to the Canadian recovery? Was war-related fiscal policy primarily responsible for ending the Depression in Canada or did it merely help finish a recovery that was almost complete by 1939? The absence of a potential real output series to compare with actual output figures for the 1930s and early 1940s prevents an answer to even this simple question. To answer it, I construct a series of potential output estimates. Their construction and comparison with actual output figures reveals

that an output gap of approximately 20% remained in 1939. In less than two years, Dominion government expenditure raised aggregate output by a sufficient amount to close the output gap and complete the recovery. The calculation of fiscal and monetary policy multipliers and two policy experiments that assess the relative importance of each show the role of fiscal policy played in providing a quick recovery. Monetary policy was accommodating over the same period. The policy experiments also suggest that the Dominion government's fiscal policy helped stimulate output before the war while monetary policy was accommodating. Given the reported absence of stimulative fiscal policy measures following the trough of the Depression in the 1930s, this finding is most curious. The Dominion government presented its first Keynesian-style budget, containing explicit stimulative measures in 1939. Prior to that year, the Dominion government's fiscal measures were contractionary in nature during the downturn and initial stages of the recovery. Even in the later stages of the recovery, its fiscal policy could best be termed as neutral. What can account for the apparent importance of fiscal policy?

The answer to this paradox lies in the fact that most accounts of contemporary fiscal policy ignore the external realm in which it operated. This external realm refers to the Dominion government's use of tariffs as a fiscal instrument to stimulate domestic production and employment. R. B. Bennett, in fact, employed these two reasons to promote his revisions to the Dominion tariff schedule, regarded as the most significant since the time of National Policy. Largely unsuccessful in protecting domestic employment during the downturn, the Dominion tariff later became a useful bargaining device with which to seek lower tariffs on Canadian exports from foreign governments in return for similar concessions by the Dominion government.

Therefore, unlike internal fiscal policy (which includes the taxation and expenditure instruments occupying more conventional notions of fiscal policy), the stimulative effects stemming from the Dominion government's external fiscal policy would be observed from their effects on exports and not through a change in government or consumption expenditure.

To determine whether or not this hypothesis holds true for the effects from the Dominion government's external fiscal policy, I estimate a series of partial equilibrium demand equations for exports to Britain and the US. As a suitable policy variable, I select the average Canadian tariff rate on imports from each country. While a controversial measure, this variable is the most appropriate given the question I seek to answer: "Were reductions in Dominion tariff rates a significant factor in the Canadian recovery of the later 1930s?" A series of simulations shows, that had the Dominion government left its tariff unadjusted and not participated in successive rounds of trade negotiations to reduce trade barriers, exports to both countries would have lagged in the later 1930s, slowing down the overall recovery.

The results of the first essay provide a quantitative affirmation of the traditional importance of the government's war-related fiscal policy in ending the Great Depression. They also demonstrate a role for the Dominion government's external fiscal policy in the later stages of the pre-war recovery, a role largely ignored by the research to date.

The second part of this thesis examines the Dominion government's efforts to control and plan war production in Canada to address the problematic issue of the government's success in

directing the war effort. Determination of success depends on whether or not there exists an acceptable criterion/criteria against which the government's planning and control efforts may be judged. Fortunately, Milward's economic history of the Second World War, *War Economy and Society*, provides a useful concept for establishing criteria that allow us to address this issue. This starts with the premise that a government's conduct of a war effort requires a strategic plan. This plan defines the goals it wants to achieve and is a synthesis of not only economic factors but political, military, social and psychological ones as well. These factors define the available course(s) of action a country's government can undertake to prosecute a war effort and the constraints within which the government's war effort must operate. Conscription of a nation's population for military service or war production is one example. This strategic plan includes the production priorities designed to supplant the normal market mechanisms and effect a conversion of the economy away from the production of civilian goods towards munitions.

As Milward notes, economists (and other researchers for that matter) generally assume that a war reduces a nation's economic priorities to the following maxim: maximize the economy's output regardless of the cost involved (Milward 1979, 19). In turn, this priority becomes *the* dominant strategic aim in striving for victory. Indeed, several of C. D. Howe's (the Minister of the Department of Munitions and Supply) comments create the impression that the Canadian war effort was unfettered by financial or economic considerations. Addressing his own executives within the Department in regards to what principles they should apply to war production, Howe apparently dismissed the need for any type of economy:

"We have no idea of the cost," the minister admitted, "but before the war is over

> everything will be needed so let's go ahead anyway. If we lose the war nothing will matter .... If we win the war the cost will still have been of no consequence and will have been forgotten." Howe's cabinet colleagues backed him up. The need was dire, and for the moment the dollar sign was off (Kilbourn and Bothwell, 133).

In truth, Howe's much lauded decision to 'remove the dollar sign' from the cost of the Canadian war effort refers to what Milward terms the end of financial control over its direction. So long as a country's government viewed war solely in terms of financial costs, Milward writes, then its conduct would be subject to purely financial considerations (Milward, 102). If the Allied war effort was to continue following Dunkirk with any hopes of success or victory then this method of control had to end. The War Measures Act gave the government the necessary powers and, through its creation of the Department of Munitions and Supply, the tools to replace the market mechanisms and incentives on which its predecessors, the War Supply Board and the Defence Purchasing Board had solely relied. The 'business as usual' atmosphere that permeated the Canadian war effort and that of its allies between September 1939 and May 1940 could not continue following June 1940 once Britain faced the urgent matter of survival as a nation.

Milward considers a government's correct strategic plan, contingent upon the desire for victory, to be the choice of a level of production greater than that of the enemy. Depending on its size relative to its opposition, this may or may not involve the maximization of its production. Obviously, the Dominion government's ultimate strategic aim was victory over the Axis powers, an aim shared at first with Britain and the other Commonwealth countries and later the US. This goal, however, was inconsistent with Milward's correct strategic plan. Canada could not possibly outproduce the Axis powers by itself or even hope to turn the tide of the war with its

own productive effort. It had neither the industrial maturity nor the physical or financial resources required by such a task. This ensured that it would occupy a minor, but sometimes important role, in the allied production programme.

The corollary that follows from Milward's strategic aim of outproducing the enemy is that the correct strategic synthesis of factors makes only those demands necessary to achieve the intended strategic purpose. The issue of a government's success in its conduct of a war effort boils down to the question of how well it achieved the objectives contained within its own strategic plan, given that it formulated the correct plan. Therefore, this thesis will not consider the issue of whether the government converted too much of the Canadian economy to war production, away from civilian consumption. Instead, it focuses on a narrower issue–given that the government's strategic plan required it to increase the output of selected industries, did it generate the extra output as cheaply as possible?

Previous work on the Canadian strategic synthesis stressed the existence of political factors and their importance in explaining the allocation of investment and production, even to the detriment of the government's strategic aims. Both Forbes (1986) and Schultz (1986), for instance, cite several investment and production decisions the Department made that favouring firms located in Central Canada. These firms featured either close political connections to the ruling Liberal government or personal connections to those within the Department. These decisions, which resulted in the failure to utilize manufacturing capacity in the three Maritime provinces, would later cost the war effort lost production and needless delays. These political

factors flourished and influenced the conduct of the war effort despite the establishment of the Department which was supposed to facilitate the rapid conversion of the Canadian economy, accelerate war production and prevent politics in general from interfering with war production. Designed to function as the government's economic agent, the Department undertook the direct planning and allocation of investment and war production, temporarily suppressing market mechanisms supposedly in a manner consistent with the government's strategic aims.

The fact that political factors dominate explanations of wartime investment and production decisions and patterns raises questions about the relevance of economic factors to the overall Canadian strategic synthesis. Did the Department allocate production on the basis of production costs and prices? How did the Department make its investment decisions as to where and how much to build? Did economic costs even enter into the Department's decision calculus? In short, the answer is yes, they did. The results of the second and third essay show that economic factors played a large, dominant role in the Dominion government's strategic synthesis.

By examining the experience of individual firms during the war, the second and third chapters uncover the existence and importance of economic factors in the Dominion government's strategic synthesis. These firms are both located in Nova Scotia, a province which has been described as unfairly treated by the government's allocation of war production and investment. The two chapters also judge the government's success in achieving the strategic aims they uncover. The second essay examines the government's experience with the domestic primary iron and steel industry using the example of the Dominion Steel and Coal Company. The

least profitable Canadian steel producer, Dosco's steel plant experienced large operating losses and required large subventions to remain in production despite a guaranteed disposition for its output. This situation resulted from the company falling victim to "the squeeze", a consequence of the government's method of price control. Rising input costs in the face of frozen selling prices reduced and eliminated the company's profit margins. However, the government did not just happily accept its financial liability for the steel plant's losses, it actively sought to minimize them and reduce its liability to cover them. For example, once the peak of war production passed, the Department adjusted the price of the company's steel plate to reflect the true costs of production. It did this in hopes that the Crown Corporation purchasing the plate would cancel orders placed with Dosco, transfer them to other Canadian producers, and curtail production at the plant. The Crown Corporation did cancel its orders but the company found other markets to remain in production. In short, we observe the Department attempting to minimize the costs associated with the war's productive effort by allocating production amongst the Canadian steel plants in a least cost fashion.

Dosco's rising material input costs reflected the resource constraints the government and company encountered while attempting to maximize steel production. With the source for two of the three principal inputs for pig iron production located in Newfoundland, German U-boats disrupted their transport by ship across the Cabot Strait to Dosco's blast furnaces in Sydney, Cape Breton. This disruption forced the government and company to develop a local ore mine to maintain iron and steel production. The ore's inferior quality, compared to the company's normal ore, and its high cost raised Dosco's pig iron production costs and lowered the productivity of its

blast furnaces. Although the decision to use this ore seemed contrary to the government's aim of maximizing steel production at the lowest possible cost, wartime circumstances forced this course of action. This decision was a response to a unique wartime situation and represented the best possible way to maximize steel production given the constraints imposed by location of the company's material inputs and the existence of German U-boats.

This least cost principle in the allocation of war work extends to the example of munitions production which is the topic of the third essay. Using the records of the Trenton Steel Works Limited, a small secondary manufacturing firm, I show that the Department transferred the balance of a contract to produce 5.5 inch artillery shells from Trenton to Ontario Forgings Limited in response to Trenton's high costs of production. The Department transferred production once it was able to establish the relative cost positions of the two producers and Trenton conceded that further cost reductions would not be forthcoming. Here again, the Department acted to minimize the costs associated with the war effort and allocate production in a least cost manner among firms engaged in munitions production.

The claim that political factors dominated in the strategic synthesis also extends to the Department's wartime investment decisions. Both Dosco and Trenton serve as useful examples to demonstrate the economic factors and principles at work governing the Department's wartime investment decisions. In the case of Dosco, the firm had in mothballs a steel plate mill dating from the end of the First World War. Its main product was ship's plate used in the construction of steel hulls. The expected domestic boom in ship construction for cargo ships to transport

supplies across the North Atlantic and naval ships to protect them while in convoy appeared to provide the perfect opportunity to rehabilitate the mill, place it back into production, and thus diversify Dosco's product line. However, the company's own designs for the mill early in the war ran afoul of the Department's planners and the war production programme's limited, fluid nature. The Department's overriding concern with wartime plant expansion was to avoid investing in projects that would only yield post-war excess capacity. The Department directed its investment expenditure to only those projects whose output the productive effort required. This would only occur when alternative sources of supply, ie, imports from Britain or the US, could not be found. In short, it avoided projects that would only prove wasteful of government funds. Thus, we see economic factors governing the Department's investment decisions.

Based on the war programme the Department envisioned in late 1940, there was simply insufficient demand to justify the mill's rehabilitation given its productive capacity. Higher than expected shipping losses in the winter and spring of 1941 necessitated revisions to the Canadian shipbuilding and repair programme. These revisions increased the domestic demand for steel plate to a degree that justified placing the mill back into production. It remained in production for as long as there was a wartime demand for its product. However, the Department considered it extraneous to the industry's desired post-war capacity. In accordance, the government saw to it that the mill closed following the end of the war and disposed of the machinery and equipment.

Economic considerations also extended to the investment decisions regarding the establishment of munitions plants. From the surviving records of West Coast Industries, one of

the Department's Crown Corporations established to help develop munitions productive capacity in Western Canada, I recover the investment criterion the Department used to select among various proposed plant configurations. Applying this same criterion to Trenton, I show that the Department consistently made its investment decisions regarding munitions plants and their configuration according to which one incurred the lowest average fixed cost (per shell to be produced). Thus, in making its investment decisions, the government sought to establish a plant scale that moved the firm along its average cost curve by seeking a plant configuration that would incur the lowest average fixed cost.

To further illustrate the point that the Department acted in a manner to minimize the economic costs involved with the war effort, I examine the behavior of its crown corporation, Citadel Merchandising. Charged with the task of procuring and allocating machine tools to munitions plants, the corporation worked with Trenton to reduce the costs of equipping its shell plant. Although its decisions concerning the choice of appropriate machinery and equipment were not always correct, by working closely with Trenton, it helped reduce the costs of equipping the company's shell plant, thereby helping to minimize the government's investment expenditure. The result is that economic factors played a dominant role in the government's investment decisions regarding munitions plants.

These last two essays clearly show the existence of economic factors in the Dominion government's strategic plan regarding the war effort. Political factors do not explain the investment and production decisions it made regarding Dosco and Trenton. Therefore, some of

the existing conclusions about the government's direction of the war effort must be amended. However, it remains for future research to determine whether political or economic factors influenced the government's wartime production and investment decisions concerning other industries.

Chapter 1: What ended the Canadian Depression? The Role of Fiscal and Monetary Policy in the Canadian Recovery

Section 1.1 Introduction

How important was the Second World War to the recovery of the Canadian economy from the Great Depression? Did it simply help finish a recovery already largely complete by September 1939 or did the Dominion government's war-related fiscal policy help finally close a large output gap still in existence? Was war-related fiscal policy even the main explanatory factor behind the recovery, if any, following Canada's entry into the war? Based on cursory examinations of unemployment rates and real output figures, numerous authors such as Bothwell, Drummond and English (1987) and Bliss (1987) conclude that the war was *the* event which finally ended the Depression in Canada. This conclusion, however, still leaves the important question of "How much did it matter?", unanswered. This question is an important one since, as Bliss notes, "If Canadians had not had to make shells, tanks, and fighter planes in the early 1940s, many of them would have prospered making electric irons and washing machines, television sets, automobiles and aeroplanes for civil aviation" (Bliss, 488) Bliss implicitly takes the view that the war did matter and a great deal since he also concludes a slower recovery and lingering unemployment would have ensued in its absence. This essay takes a more rigorous and empirical approach to the issue of the war's importance. Estimates of potential output figures for the Canadian economy allow us to examine the extent of the Canadian recovery by 1939 and assess what role monetary and fiscal policy played in the process of its completion.

Assessing the war's significance to the Canadian recovery is all the more pertinent given

the recent debate between Romer (1992) and Vernon (1994) over its role in the American recovery. In that debate, the importance of the war's occurrence and war-related fiscal policy to completing the recovery rests partially on the issue of when the output gap closed. Romer argued that war-related fiscal policy did not matter to the recovery since the American economy's output gap was all but closed on the eve of its entry into the war. In contrast, Vernon argued that a considerable output gap still existed in 1941 and proceeded to apportion the increase in real output to the effects of US federal government taxation and expenditure changes. Here, Canada would obviously serve as an instructive comparison. Betts, Bordo and Redish (BBR) (1996) stressed the similarity of the Depression experience between Canada and the US given the behaviour of aggregate measures of activity.[1] However, unlike the US, Canada entered the war only a week after Britain's declaration and this early entry may have sped its recovery. This view potentially assigns the war (and fiscal policy) a significant role in completion of the recovery, especially if a large output gap still existed in 1939. Provisional on the existence of an output gap in 1939, Canada's early entry provides a natural experiment to assess the war's importance and how the Canadian recovery differed from that of the US.

The potential output estimates reported below suggest that the Canadian recovery was less than half complete by 1939. A rapid recovery in output ensued in the following two years with the estimated gap closing sometime during 1941, only one year earlier than that selected by Vernon for the US economy. By repeating Romer's fiscal and monetary policy experiments, which require the calculation of fiscal and monetary multipliers for the Canadian economy, one can assess the relative importance of each to this rapid wartime recovery. Based on the

experiment's results, the Dominion government's war-related fiscal policy emerges as the most important explanatory factor behind the closure of the gap. Thus, this exercise confirms the traditional role assigned to the war in providing a quick end to the Depression through fiscal policy. In only two years, the Dominion government's war-related fiscal policy achieved what six years of peacetime economic growth could not. Monetary policy does not emerge as an important factor during the wartime recovery.

But what about the recovery prior to the war? In the absence of war-related fiscal policy, why did Canadian aggregate output only recover to the point where the output gap closed by slightly less than half? Did actual Dominion monetary and/or fiscal policy play a role in the recovery following the trough in aggregate output and how did it differ from the US? There is a large body of evidence indicating that neither fiscal nor monetary policy played any significant role in the recovery. McIvor (1958) comments on the complete lack of a Dominion monetary policy in the 1930s, especially during the downturn (1929-1933). Later on, Dominion monetary policy appears neutral in stance and the findings of Bordo and Redish (1987) suggest that the Bank of Canada's establishment did little to alter it. Consequently, monetary policy is thought to have played little role in the recovery before the war. With respect to fiscal policy, Perry (1955), McIvor, Struthers (1983), Gillespie (1991), and Bates (1939) all argue that the Dominion government's fiscal policy lacked anything by way of counter-cyclical measures and was outright contractionary.

Fortunately, the experiment's results can tell us something about the relative importance

of fiscal and monetary policy to the recovery before the war. Not surprisingly, monetary policy mattered little to the recovery. However, in stark contrast to the conclusions of those above, the experiment's results suggest that fiscal policy somehow made a significant contribution to the recovery before the war. This is a most curious finding. How could fiscal policy possibly matter to the recovery during the 1930s when there is clearly evidence for the almost complete absence of any counter-cyclical measures?

The answer to this seeming paradox appears to lie in a neglected instrument of contemporary fiscal policy, the Dominion government's tariff schedule. More contemporary researchers, such as Mackintosh (1964[1939]), Brecher (1957) and McDiarmid (1946), were well acquainted with the government's use of tariffs to affect domestic production and employment. Brecher distinguishes between two types of fiscal policy: external and internal fiscal policy. The former refers to the use of tariffs while the latter concerns the use of all other taxation and expenditure instruments. More recently, Temin (1991, 46) for instance, notes the well known result that a tariff's first-order effects are expansionary. However, as Eichengreen (1989) notes, the net effect of a tariff's imposition or increase may be contractionary if foreign countries introduce or raise their own tariffs in retaliation. The converse of this statement, that a tariff's removal or reduction in its rate may have an expansionary effect if it induces other countries to do the same, may also be true. The Dominion government did adjust its tariffs in response to changes in those imposed by foreign governments against Canadian exports. For instance, as McDonald, O'Brien and Callahan (1997) argue, the Bennett government's radical upward tariff revisions in 1930 and 1931 were in retaliation for the imposition of the American Smoot-Hawley

tariffs. Later, the Dominion government used the tariff as a bargaining tool in bi-lateral trade negotiations with its two major trading partners, Britain and the US to secure reciprocal reductions as Drummond and Hillmer (1988) note. In theory, lower British and American tariff rates on Canadian exports should have helped stimulate their growth in addition to the impetus given by rising foreign national incomes. Hence, the Dominion government's external fiscal policy, embodied within the behaviour of Dominion tariff rates, may have had stimulative effects on aggregate demand through its indirect effects on exports. A simulation, which involves the estimation of export demand equations for Canadian exports to Britain and the US, suggests that continuing high tariff rates throughout the later 1930s would have restrained the recovery in exports. Although data limitations place constraints on the strength of these findings, it is an important one nonetheless as Green and Sparks (1988) and Safarian (1970[1959]) conclude that exports were the major source of output growth following the trough in output until 1939. These findings fill an important gap identified by Green and Sparks, who point to the need for a detailed examination of the policy response by Canada's monetary and fiscal authorities to the Depression, an examination largely absent from recent work on the subject by Betts, Bordo and Redish (1996).

The results here also suggest that the nature of the recovery in Canada before the war was inherently different than that in the US. Romer and Vernon both agree that US monetary policy was probably the most important factor behind the American recovery until the start of rearmament expenditure. The generation of inflationary expectations and resulting fall in the real US interest rate spurred on investment and consumer durable expenditure. The Canadian

recovery stands in sharp contrast. Monetary policy was unimportant to the recovery, exports stimulated the recovery in real output and fiscal policy may have played some role in promoting the recovery. Also, the export-based nature of the Canadian recovery means that it depended on factors that were largely exogenous to the Canadian economy and policymakers, primarily foreign income.

To situate the issues this essay addresses, Section 1.2 reviews the existing literature on the proximate causes of the Depression in Canada. Traditional Keynesian-style explanations for the Depression in Canada still predominate and accord exports and international economic conditions a central role in causing the downturn and recovery. However, they do not explore the recovery in output beyond 1939. Sections 1.3.1 and 1.3.2 review the Dominion government's fiscal and monetary policy, respectively. They describe the consensus regarding the absence of counter-cyclical fiscal and monetary policy measures during the 1930s due to contemporary beliefs and lack of knowledge over their potential counter-cyclical role. Unfortunately, discussions about the effectiveness of fiscal and monetary policy during the early war years are largely absent from the literature which motivates this essay. The latter section develops an argument for the necessity to delineate Dominion fiscal policy along its internal and external lines based on Brecher's distinction and the need to include considerations of external policy measures in the analysis. It also provides a brief overview of the major bi-lateral trade agreements the Dominion government concluded with Britain and the US to highlight their possible stimulative effects.

Section 1.4 undertakes the task of constructing potential output estimates, the lack of

which hampers inferences about the degree of recovery achieved before war and the timing of its completion. Based on the selected series, and using additional information culled from Canadian unemployment rates, my estimates show a recovery that was about half complete by 1939 with the gap closing sometime in 1941. (The absence of quarterly figures on Canadian output makes a more accurate dating impossible.) Repeating Romer's calculation of monetary and fiscal policy multipliers in Section 1.5 and her policy experiments in Section 1.6 for Canada, confirms the traditional role and importance of war-related fiscal policy to the recovery's fast completion. These same experiments also suggest that Dominion fiscal policy was a positive force encouraging the recovery prior to the war, a role that stands in sharp contrast to existing opinions about its significance.

Section 1.7 explores the hypothesis about the significance of Dominion fiscal policy to the recovery in aggregate Canadian output before the war. Postulating that Dominion tariff rate reductions can explain fiscal policy's apparent importance in the absence of conventional counter-cyclical measures, I estimate partial equilibrium demand equations for exports to Britain and the US that include a measure of the government's external fiscal policy–the average Canadian tariff rate. While the inclusion of the exporting country's tariff rate is unorthodox, I consider this one method that can demonstrate how external fiscal policy measures factored into the recovery. A set of simulations demonstrates the importance of the government's participation in trade treaties with both countries that resulted in lower tariffs on Canadian exports, especially during the later 1930s.

The findings here suggest the possible existence of stimulative fiscal measures not only during the war but prior to 1939. Although they do nothing to diminish the importance of traditional explanations about the recovery prior to the war, they do serve to complement them. The traditional interpretation of the Canadian recovery's dependence on the performance of its exports should be amended to include the potential effects stemming from the government's external fiscal policy. In its absence, both exports and the recovery in real output would have lagged in the later 1930s, leaving an even larger output gap in 1939.

Section 1.2 The Downturn and Recovery

Traditional explanations for the Depression's origins in Canada rely heavily on events within the export sector and international economy as a whole, explanations Betts, Bordo and Redish (1993) describe as Keynesian in nature. Based on the Canadian economy's characterization as the 'quintessential small open economy', it is not hard to decipher the appeal made to this framework. Throughout the 1920s, exports accounted for approximately one-third of Canadian aggregate output (measured by GNP) on average so one cannot help but focus attention on events in the export sector and international economy to explain the Canadian Depression. Moreover, Canadian exports were highly concentrated by destination and type. In 1929, over half of all agricultural and vegetable product exports (primarily wheat) went to Britain which accounted for slightly over one-fifth of total exports. In that same year, 80 per cent of all wood and wood product (including newsprint) exports went to the US which also accounted for one-fifth of total exports. This specialization only served to increase the Canadian economy's vulnerability to fluctuations in international demand and prices and also explains why researchers

focus primarily on the behaviour of exports.

The use of the IS-LM-BP framework emerges, explicitly or otherwise, within the work of Safarian and Green and Sparks. Safarian's classic account of the Canadian Depression emphasizes that, given the Canadian economy's integration with the American economy in the financial and goods sector, a downturn in Canada was inevitable. The Canadian economy could not help but to follow the American economy into the downturn as the demand for its exports experienced a precipitous drop, lowering national income. With the decline in exports, investment opportunities in the export sector disappeared and domestic investment expenditure declined as a result. Safarian also argues that investment opportunities outside of the export sector were exhausted and combined with the export collapse to produce a dramatic fall in autonomous investment expenditure.

Like Safarian, Marcus (1954) also works implicitly within a Keynesian-style framework. For Marcus, exports of pulp and paper and wheat inexorably link the behaviour of aggregate Canadian output to international economic conditions to become its prime determinant. Marcus details the domestic events behind the decline of wheat exports to Britain occurring throughout 1929. Combined with falling newsprint and pulp and paper exports beginning in March of 1929 to the US, Canadian aggregate output entered an inexorable decline. Output of the iron and steel industry also began to decline in March, followed by domestic construction in April. The ultimate source for this decline in exports to the US, Marcus argues, was the US Federal Reserve's restrictive monetary policy. The resulting drop in American aggregate demand led to the

inevitable decline in Canadian exports to the US. On the basis of available output statistics, Marcus concludes that the Canadian economy was already in a recession when the Stock Market Crash occurred in October. Further declines in American aggregate demand following the Crash translated into falling Canadian exports and Canada 'followed' the US into the Depression.

A serious shortcoming to the work of Marcus and Safarian is the almost total lack of empirical evidence to support their conclusions. Green and Sparks make an important contribution with their formulation of a Mundell-Flemming model for the Canadian economy. Their model allows for the explicit determination of the relative importance of domestic and foreign factors to the Canadian downturn and recovery.[2] Using annual data they show that the foreign sector is a significant determinant of the behaviour of Canadian aggregate output. Exports provided the Canadian economy with its source of real income growth until 1929 when an adverse shift occurs in their export function. However, Green and Sparks' two chief explanatory variables for Canadian exports, US national income and the terms of trade, cannot account for this adverse shift. Instead, they speculate, the explanation for this shift may lie in the smaller wheat crop of 1929.

The Canadian wheat holdback in 1929 described by Marcus may also help to explain this fall in exports. Weather conditions in the late winter and spring of 1929 led to expectations of a smaller wheat crop that encouraged a holdback of existing Canadian wheat stocks by farmers, traders, millers and speculators in expectations of higher future prices. The premium recorded on Canadian wheat (based on average imported prices at Liverpool, England), which normally

averaged 10 cents per bushel, rose to between 16-18 cents during January and February of 1929 (Marcus, 55).[3] With the continued outlook for a poor crop, the premium rose through the summer of 1929, peaking at 42 cents in July and falling back to 23 cents per bushel by September (Marcus, 56). The holdback ended in the final months of 1929 when the lack of storage space forced sales.

The holdback's most obvious effects were a decline in wheat and wheat flour exports preceding the 1929 harvest. Table 1.1 shows the change in export volumes of wheat and wheat flour along with the premium on Canadian wheat, as calculated by Marcus. The consequences, however, were not confined to wheat exports or the goods sector. The demand for transportation services associated with the movement of wheat and wheat products fell, reflecting back on reduced earnings in the domestic transportation sector. The holdback even affected the domestic textile sector as the demand for cloth sacks fell. In late 1928, the Department of Finance reduced its rate charged on advances made to the chartered banks from 5 to 4.5 per cent. This drop, usually indicative of an easy money policy, occurred to reduce the costs of financing the movement and the storage of the 1928 crop. Marcus (54) claims that the financing requirements for the holdback, consisting of stocks built from the 1928 crop, then restricted the amount of domestic credit available for other uses through 1929.

The wheat holdback's consequences also complement Green and Sparks' results. Since they model exports solely as a function of foreign income and the terms of trade, their export function would capture the wheat holdback's economic effects as a shift. If so, then the

combination of the small crop and the holdback only serves to further emphasize the importance of wheat exports and exports in general in explaining the behaviour of Canadian aggregate output. Hence, Green and Sparks provide an important contribution to understanding the source for the Depression in Canada and the importance of the foreign sector.

Betts, Bordo and Redish (1993, 1996) take an alternative view towards the source of the Depression in Canada. They question the traditional interpretation of the Depression's origin in adverse US monetary policy moves propagating to economies elsewhere through financial and goods markets. Using a Mundell-Flemming type model, they examine the impact of idiosyncratic disturbances originating within the American economy on Canadian aggregate output, among other variables, to determine if such disturbances can indeed explain the behaviour of Canadian aggregate output during the 1930s. Postulating the existence of foreign and domestic, real and nominal shocks, Betts, Bordo and Redish attribute the 'onset, depth and duration' of the output collapse in Canada and the US to a permanent, real output shock common to both economies (Betts, Bordo and Redish 1996, 3) . The source of this supply shock, they speculate, could be the result of disturbances to the level of resources and to technology. They identify other real and nominal shocks of both a permanent or transitory nature that cannot account for the output collapse experienced by both economies. For example, a permanent common shock to velocity had no long-run effect on Canadian output. The behaviour of the domestic price level reflects a permanent nominal shock to the US money stock, transmitted to the Canadian money stock through the fixed exchange rate regime, but had no long-run effects on Canadian output. They also identify a set of real shocks that affected each economy on a purely temporary basis. Taken

together, their findings cast doubt on the traditional interpretation that the US downturn led to the Canadian downturn and also diminish the importance of US policy mistakes in its initiation.

Betts, Bordo and Redish further negate the role of the foreign sector as a source for the Depression in Canada since they find no role for the gold standard as a transmission agent for adverse shocks to aggregate output. This finding, they note, is counter to the role both Temin (1991) and Eichengreen (1992) assign to the gold standard for transmitting the Depression from the American economy to the rest of the world. Combined with the emphasis placed on the symmetrical movement in output and other aggregate variables across the two economies, which intuitively suggest the existence of a common shock, Betts, Bordo and Redish's findings tend to negate the importance of the foreign sector altogether. However, they qualify their results by noting that they cannot completely eliminate the hypothesis of an output collapse transmitted through export channels. Therefore, by their own admission, their results do not necessarily contradict that of Green and Sparks. Also, their specified aggregate expenditure function, which includes the real exchange rate and the terms of trade as explanatory variables, precludes any examination of what effect these variables had on exports and obscures how this thought to be important component affected aggregate output. Furthermore, the absence of monthly data on aggregate Canadian output necessitates the use of industrial production as a proxy. Consequently, what they really measure is the effect of real and nominal, temporary and permanent shocks on industrial production and not aggregate output per se. As such, their approach to explaining the Depression does not really admit a role for exports, except where industrial production is exported. Moreover, it does not even admit an examination of what

policy measures could have mitigated the fall in output and aided the recovery since Betts, Bordo and Redish do not specify a source for the supply shock–it simply happens and propagates through the economy with dramatic effects on output. Without knowledge of its source, one cannot even discern if monetary and/or fiscal policy measures would have been effective in the first place.

Hence, there are still sufficient grounds to believe that exports played an important role in explaining the origins of the fall in Canadian output. It did not just happen of its own accord and exports provided the transmission mechanism through which the Depression spread to Canada. But how important were exports to the recovery? As Green and Sparks show, rising exports explain most of the observed output growth during the 1930s; they were the factor behind the recovery before the war (Green and Sparks, 109-110). Their model's results show that exports provided the source of output growth following the trough in output. Their findings also confirm the observations of Safarian and Marcus, who argue for the export-based nature of the recovery. Table 1.2 shows how exports recovered to their 1929 levels by 1937 while investment expenditure and other components of national income remained depressed.

Unfortunately, the story of the Canadian recovery typically ends on this very note, that rising exports were *the* factor explaining the Canadian recovery in the 1930s. Based on national income data and the empirical results of Green and Sparks, one cannot refute this argument. In turn, this leads to the immediate conclusion that the forces behind the recovery to 1939 were largely exogenous to the Canadian economy. Recovery in Canada depended first and foremost on

the recovery of its major trading partners and rising foreign national incomes. Explanations for its completion are typically left to the simple occurrence of the Second World War with the Dominion government's war-related fiscal policy providing the necessary stimulus to aggregate demand. However, the important question of how much stimulation the economy required to complete its recovery remains unexplored. Furthermore, the importance of other factors affecting exports also remains relatively unexamined. This is a serious oversight since both Britain and the US raised their tariff levels, in some cases to prohibitive levels, against Canadian exports. The Dominion government's participation in bi-lateral trade negotiations and agreements lowering tariffs on Canadian exports must have had some effect on aggregate Canadian output. However, tariffs are a matter of government policy and this issue raises the larger question of what role fiscal and monetary policy played during the Depression in Canada. Did it help or hinder the downturn and recovery? To properly establish their respective roles, the next section reviews the available evidence concerning their use during the 1930s.

Section 1.3 Dominion Fiscal and Monetary during the 1930s

1.3.1 Monetary Policy

Although the sources of the downturn and eventual recovery may be subject to some debate, there is a clear consensus over the almost complete absence of counter-cyclical fiscal and monetary policy on the Dominion government's part during the Depression. McIvor (1958, 135) provides a damning assessment of the Dominion government's monetary policy prior to the formation of the Bank of Canada in 1935:

> The most fundamental criticism of Canadian monetary policy during the depression

> is that none existed. In its absence, various ad hoc measures appeared from time to time, invariably too late and too limited to be of real assistance in coping with the depression. Lacking a central bank, no conscious control of the over-all volume of money was attempted, nor indeed was the desirability of such control generally recognized until economic contraction had reached its most advanced stage.

The Dominion government's two attempts at expansionary monetary operations in 1932 and 1934 achieved mixed results, McIvor concludes. He notes the first attempt resulted in the chartered banks reducing their indebtedness to the Dominion government. Although he considers the second more successful, he also notes that the devaluation of the US dollar and recovery abroad also contributed to the upswing. Interest rate reductions started in 1933, beginning with a decline in municipal and farm loans rates. Although further interest rate reductions occurred over the next several years, Safarian (156) concludes they did little to stimulate investment as businesses took advantage of lower rates to refinance their existing debt. Hence, even with the lack of empirical evidence, monetary policy appeared to have little braking effect on the downturn by virtue of its very absence.

The Bank of Canada's establishment in 1935 did little to alter the role of monetary policy despite the easy money policy its establishment purportedly heralded. No one less than the Dominion Finance Minister Dunning himself articulated this policy stance during a speech in Parliament on monetary theories,

> Our policy has been and is an easy money policy which has resulted in an expansion of our credit base and of the volume credit in use at a rate which is believed to be in harmony with the best interest of the economic life of the nation. (Debates 1938, 1158)

Marcus also characterizes Dominion monetary policy as an easy money one. However, closer

inspection reveals that the Banks's appearance made little difference to the recovery. The Bank's extensive open-market operations were primarily a response to the Canadian economy's substantial seasonal fluctuations in the demand for credit and money, based on its large agricultural sector. Thus, the stance of Dominion monetary policy was accommodating, not stimulative. Bordo and Redish's (1987) findings bear out this observation. They show that the Bank's establishment did not alter the behaviour of the Canadian price level, exchange rate and the evolution of the money supply measures, M1 and M2.[4] They also conclude the Bank's establishment was the result of political and not economic motives for initiating counter-cyclical measures. Therefore, without a new monetary regime or the start of a interventionist-style monetary policy, the Bank played little role in stimulating the recovery. Yet, it remains to subject this hypothesis to a formal empirical test. As a preview, the results in Section 1.6 confirm this conclusion.

1.3.2 Fiscal Policy

The largely neutral nature of Dominion monetary policy during the 1930s stands in stark contrast to the Dominion government's misguided fiscal policy measures. Notable for not only the lack of deliberate counter-cyclical measures but the outright contractionary nature of those it did enact, the existing evidence indicates that Dominion fiscal policy intensified the downturn and hindered the recovery. As McIvor notes, within the Dominion government the principles and operation of counter-cyclical fiscal policy were little understood (McIvor, 141). Perry (293-294), McIvor (125), Struthers (1983, 60), and Gillespie (1991, 169-170) all argue that the goal of contemporary orthodox fiscal policy, actively pursued in Canada during the 1920s and 1930s,

was the balanced budget. Bates (1939) suggests that contemporary Dominion fiscal policy was passive, featured little counter-cyclical potential and served only to intensify the movements in aggregate output. Since tariffs and other impositions on imports provided the majority of the Dominion government's revenues, they were strongly pro-cyclical in nature. Coupled with the balanced budget rule, the government tended to raise expenditures and cut taxes during booms and vice versa during a downswing. Faced with falling revenues during a downswing and increased borrowing to cover current capital expenditures, the Dominion government reduced its capital expenditures exactly when they were needed the most, [5] (Bates, 77 and 86) Figures on total Dominion government capital expenditure, which fell from $190 million in 1929 to only $10 million by 1934, provide poignant evidence of this mechanism at work during the downturn.[6] (Bates, 77)

The Dominion government's Depression-era deficits, shown in Table 1.3, were, as McIvor (141) concludes, involuntary. Second only in magnitude to those experienced during the First World War, these annual deficits were in sharp contrast to the surpluses characteristic of the 1920s.[7] The rise in the annual deficit observed between 1930 and 1932 did not reflect an attempt at a deliberate counter-cyclical fiscal policy. They were the product of the government's ad hoc unemployment relief schemes and the Canadian National Railway's operating deficits. What Bates describes as the government's "ordinary" expenditures actually fell during this same period.[8] The public works projects funded by the Unemployment Relief Acts of 1930 and 1931 were, as Safarian (94) observes, designed to meet the immediate needs of the unemployed. Green and MacKinnon (1988, 385) note the public works consisted of relatively expensive, short-term

projects with the goal of maximising employment. The switch to a programme of direct relief in 1932 eliminated whatever unintentional counter-cyclical effects the public works programmes may have contained. Although MacKinnon (1990) observes the direct relief programme had the potential for work disincentive effects, thus hampering the recovery, she concludes that any such effects were small.[9]

The falling revenues and rising deficits described in Table 1.3 also conceal the contractionary nature of taxation measures the Dominion government enacted and the pro-cyclical nature of its budget practices. A brief enumeration of the changes to its sales tax and personal and corporate income taxes provides a clear demonstration of the contractionary stance of fiscal policy in the early 1930s. For instance, between 1929 and 1932, successive budgets raised the federal sales tax rate from 1 to 6 per cent (Perry, 268). In two consecutive years (1931 and 1932), the Dominion budgets raised personal income tax rates and lowered exemption amounts for individuals and families (Perry, 260-261). The latter budget even imposed a 5 per cent surcharge on individuals whose net incomes exceeded $5000 (Perry, 261). The Dominion's corporate income tax rate, set at 8 per cent in 1929, also underwent considerable upward revisions during this period, rising to 15 per cent by 1935. The 1932 budget introduced a 13 per cent tax rate on consolidated returns, rising to 17 per cent by 1935 (Perry, 256-257). From these measures, the government experienced mixed results in preserving or increasing its revenues: sales tax revenue rose significantly between 1930 and 1935 while corporate and personal income tax revenue remained virtually unchanged as corporate profits declined and unemployment rose. However, the effect on personal disposable income was clearly contractionary.

The defeat of Bennett's Conservative Party by Mackenzie King's Liberal Party in the 1935 election produced little immediate shift in the conduct of fiscal policy. With its first budget in 1936, King's Minister of Finance, Charles Dunning, pledged the continued allegiance of the Liberal government to the balanced budget doctrine. Decrying past and present deficits, Dunning's budget speech revealed that little in the way of stimulative measures could or should be expected from the Dominion government so long as the Liberals were in power,

> The magnitude of these deficits, and particularly of the latest one, is such that in my opinion few honourable members will be disposed to question the declared purpose of the government to end in the shortest practicable time the era of recurring deficits. ... We must make an immediate approach to a balanced budget. (Debates 1936, 2346-7)

Within the Liberal government, fiscal thought held that a balanced budget was the most effective solution it could provide to the continuing unemployment problem. Balanced budgets, declared Dunning, provided the best means to restore business confidence and the free market system would then restore output (Debates 1936, 2347-8). The government's economy measures continued with the warning that any new spending programmes meant spending cuts elsewhere. Furthermore, the budget raised the sales tax yet again, to 8 per cent, where it remained for the duration of the 1930s. The government was quite aware of potential counter-cyclical effects stemming from the increase but it regarded the rise insufficient to alter the general upward trend in business activity (Debates 1936, 2385).

Internal expansionary measures remained absent until 1939. Through 1936 and 1937, Dominion government expenditures remained virtually unchanged and coupled with improving revenues, as shown in Table 1.3, to reduce the deficit to more acceptable levels by 1938. Noting

the depressed levels of investment expenditure, the government initiated a series of tax changes and programmes designed to encourage private sector investment. They included tax breaks for home improvement and renovations, exemptions on construction materials for housing, and a series of measures to encourage investment in the Canadian mining sector.[10] However, as late as 1938, Dunning expressed the belief that "pump-priming" measures taken in other countries did not awaken the more normal and permanent motive forces which are essential to continuing prosperity (Debates 1938, 3899).[11] The budget of the following year marks a clear break with this philosophy and the fiscal policy goal of balanced budgets. Embracing the principles of deficit spending and the ability of counter-cyclical fiscal policy measures to aid the recovery, the Dominion's first 'Keynesian budget' (Bryce 1986, 119) contained a set of special public works expenditures authorized in the belief that "government expenditures cannot contract until the private sector is spending more freely" (Debates 1939, 3146). Perhaps more important was the distinct shift away from the belief that government spending, by raising the domestic interest rate, crowded out domestic investment (Debates 1939, 3147).

Thus far, this review of Dominion government fiscal policy clearly shows the lack of counter-cyclical measures and the belief in their inability to affect output present throughout most of the 1930s. However, it is incomplete since it focuses on only one aspect of contemporary fiscal policy. Brecher's evaluation of the government's Depression-era fiscal policy distinguishes between the internal and external realm in which it operated (Brecher, 221) . Internal fiscal policy consists of the taxation and expenditure instruments that occupy our conventional notions of fiscal policy and the discussion to this point. External fiscal policy refers to the government's use of

tariffs as a fiscal instrument. Not only do they provide the government with a source of revenue, but their potential stimulus to domestic employment and production is well known from the standard partial equilibrium analysis of a tariff's imposition. As such, tariffs represent a potential method by which a government can both promote employment and raise revenue. McDiarmid (1946, 272) considers this the 'traditional instrument' used to regulate the economy. Ignoring their use as such neglects an important aspect of contemporary fiscal policy especially since the maintenance of domestic employment was one of the avowed objectives behind the Bennett government's upward revisions of the tariff schedule in 1931 (Mackintosh, 166 and McDiarmid, 275).

The Bennett government's revisions granted Canadian manufacturers a considerable degree of protection against imports from outside Britain and other Commonwealth countries. Reflecting the retaliatory nature of Bennett's alterations, the tariff rate on all manufactures under the General and Treaty categories rose by 50 per cent between 1928 and 1933 (Mackintosh, 166). In contrast, manufactured goods imported from Britain fell under the Preferential category whose rates rose only slightly from 12 to 14 per cent.[12] Mackintosh observes the success of the tariff revisions in diverting consumer purchases away from foreign produced towards domestically produced goods, measured by a falling ratio of imports to the gross value of manufacturing, but concludes that the net employment effect was small since consumers simply reduced their consumption of the home goods due to the higher prices (Mackintosh,166-167). Comparison of employment indices for the textile and iron and steel industries between 1928 and 1933 demonstrates the mixed effects overall these revisions had on maintain domestic employment

levels. Textile industry employment fell by only 8.5 per cent while that in the iron and steel industry experienced a decline of almost one-third of its 1928 level. Overall, manufacturing employment fell by 27 per cent over this period.[13] Unfortunately, Mackintosh does not provide an indication of how much tariff revisions mattered to these employment changes; he merely presumes on the basis of employment figures that the net gain was small (Mackintosh, 166-167). However, with the overall decline in manufacturing employment and output, it does appear that as a stimulative measure during the downturn, the government's external policy was largely a failure.

Eichengreen (1989) provides something of a similar assessment for the role of the Smoot-Hawley tariff but in reverse. Noting the circularity in the argument of how the Smoot-Hawley tariff's imposition caused the American Depression and how the American Depression brought the tariff into existence, he considers how a tariff's initial expansionary effect will be offset partially, if not completely, by foreign countries erecting their own tariffs against the originating country's exports. For Canada, McDonald, O'Brien and Callahan recently argued that Bennett's upward revisions were a retaliatory response against the American Smoot-Hawley tariffs. Applying Peltzman's marginal voter model to the 1930 election results, the authors conclude that his promise to impose retaliatory tariffs provided the key to defeating the Liberal Party. Their conclusion overlooks the Liberal government's switch in 1930 towards a policy of retaliation against the US but this missed fact only adds to the argument about the retaliatory nature of the Dominion government's tariff revisions. The Liberal government's 1930 budget granted increased preference to imports from Britain and other Commonwealth countries while cancelling a series of reductions made on US imports over the previous eight years (McDiarmid, 273).[14]

Together, these findings serve to bolster Eichengreen's argument about the behaviour of tariff policy. For the US, Temin (1991, 46) considers the fall in American exports too small and the American economy's export sector itself too small to account for the majority of the fall in US output. Hence, the Smoot-Hawley tariff's net contractionary effects were minimal. Eichengreen also concludes that any macroeconomic effects of the tariff within the US were small.

Bennett's tariff increases did little to preserve the Dominion government's heady revenues of the 1920s. Collections of customs duties fell precipitously from $179.4 million in 1929 to $66.3 million in 1934, a figure characteristic of levels prior to the First World War (Perry, 626). Only in 1940 did customs duties collections return to their 1929 level. To offset this decline, the government enacted a special excise tax on all imports that generated only $4.9 million during its first year. The tripling of the rate in its second year of existence yielded substantially more revenue with collections rising to $13.4 million (Perry, 636). This tax remained in place for the remainder of the 1930s.

Protectionism and revenues were not the only motive behind Bennett's considerable revisions. Mackintosh identified the possibility of using the Dominion tariff structure as a bargaining device in future trade negotiations as a second objective. Although Bryce speculates that Bennett's adjustments were not intentionally set at such a high level so as to provide a tool for extracting reciprocal reductions in future negotiations, he observes that this was in fact Bennett and King actually did (Bryce, 87). Under this interpretation, the tariff becomes a fiscal instrument whereby the government sought to restore access for Canadian exports to markets in

Britain and the US through reciprocal trade agreements. This type of fiscal policy will have a very different transmission mechanism from that for internal fiscal policy. Where the effects of internal fiscal policy on aggregate output are primarily observable from changes in government expenditure, income and sales taxes, or public investment, external fiscal policy measures will affect aggregate output through their effect on exports and imports. Hence, one must examine the behaviour of exports in order to divine the success of external fiscal policy measures and provide a complete assessment of the Dominion government's contemporary fiscal policy. Focusing solely on changes in government expenditure do not reveal the full extent of its fiscal policy since this does not include tariff changes.[15]

Use of the Dominion tariff schedule as a bargaining tool during the 1930s began with the Ottawa Agreement of 1932. Signed with Britain at the Imperial Conference of that same year, the Dominion government implemented it in practice by raising the preference granted to British exports in the existing tariff schedules. It accomplished this through the reduction of existing duties on their exports and increasing those on imports from outside of Britain and the Commonwealth countries.[16] Britain granted Canadian exports similar concessions, raising the preference granted to some items under its existing tariff schedule and introducing a quota system on others.[17] The Agreement revived access for exports of certain primary products: timber, bacon, other food stuffs and raw materials to British markets (Perry, 281).[18] Its renewal in 1937 meant the continuation of much the same agreement.[19] The net effect of these agreements was to lower the average tariff rate (calculated as the ratio of tariff revenue to the value of dutiable imports) from its maximum of 29 per cent in 1932 to 23 per cent in 1938 (Canada Yearbook 1933

and 1940).

With respect to Canadian exports to the US, the Dominion government concluded a trade agreement with the American government in November 1935. This suffices as a second example to demonstrate the use of tariffs in the above described manner. Effective on 1 January 1936, the agreement reduced a number of American tariffs to rates at or below the Fordney-McCumber rates established in 1922. It also removed some of the Smoot-Hawley rates on agricultural products and also implemented a quota system (McDiarmid, 294). To reciprocate, Canada reduced its tariffs on American manufactured products, within the allowable constraints of the British Imperial preference system. This agreement helped reduce the average tariff rate (calculated as the ratio of tariff revenue to the value of dutiable imports) on Canadian imports from the US from its maximum of 29 per cent in 1934 to 23 per cent in 1936.

This review of Dominion government fiscal policy makes it clear that the principles of counter-cyclical measures were neither understood within the government nor embraced until at least 1939, six years after the trough in Canadian output. The goal of contemporary fiscal policy, which stretched across Conservative and Liberal governments, dictated the enactment of contractionary measures during any downturn in order to at least make a move towards a balanced budget. Hence, we observe contractionary fiscal policy measures during the downturn–falling expenditures and tax increases in a vain attempt to balance its budget. Continued expenditure restraint and further tax increases after 1933 creates the impression that Dominion fiscal policy provided contributed little to the output recovery until 1939 and the start

of the war.

An obvious question that arises is how the use of fiscal and monetary policy differed between the Canadian and US economy during the recovery and what role war-related fiscal policy assumes in completing the American recovery. This latter point was the centrepiece of a recent debate between Romer and Vernon. Romer argued that the completion of the US recovery, marked by full employment and the return of real output to its pre-Depression based trend value in 1942, was largely due to monetary policy in the 1930s. Fiscal policy, she claims, played little role due to the small output gap she estimates in existence at the war's start. Rapid growth in the US money supply, the consequence of deliberate policy actions and historical accidents, provided the means by which monetary forces propelled the American economy to its recovery. The transmission mechanism through which the expanding US money supply stimulated aggregate demand was the generation of inflationary expectations thereby leading to a fall in the real interest rate. In turn, fixed investment expenditure and consumer durable expenditures recovered, pulling the US economy out of the trough. Vernon concurs with Romer that 1942 marks the completion of the American recovery but argues that Second World War fiscal policies were important in closing the output gap. His estimates of the output gap at the end of 1940 show a recovery that was less than half complete so that the war-related fiscal policy must necessarily assume an important role. The year 1941 emerges as crucial to the recovery. He uses the tax and expenditure multipliers of the 1960s version of the MPS model to argue that 80 per cent of the increase in real GNP in 1941 is due to fiscal policy, primarily through increased federal expenditure. Furthermore, contrary to Romer, he argues that the sharp money supply

increases in 1941 were designed to accommodate the increase in US government expenditure. However, Vernon agrees with Romer that fiscal policy was of secondary importance to the American recovery between 1933 and 1940 and concedes that monetary policy, unintentional or otherwise, was the major stimulus.

Does the completion of Canada's recovery follow a similar pattern suggested by Vernon? War-related fiscal policy was obviously a significant factor in completing the recovery, but how significant was it? Did it complete a recovery almost finished or help the Canadian economy attain the majority of its recovery? And how much did the lack of counter-cyclical measures matter to the recovery during the 1930s? Did it significantly help or hinder the recovery in output in spite of these contractionary measures? There is also the question about whether or not the Dominion government's fiscal policy contributed to the fall in output by way of the contractionary measures it enacted during the downturn. And what can be said of monetary policy? Was it truly of no help to the recovery or was there a similar process at work in Canada like that in the US identified by Romer? It also remains unclear what role should be assigned to external fiscal policy in the recovery and an important question emerges: "Did lower Dominion tariffs stimulate Canadian exports?" If so, then the pre-war recovery relied to some extent on external fiscal policy measures and the process of recovery in Canada before the war differed fundamentally from what Romer finds for the US. However, without a potential output series for the Canadian economy during the Depression there is very little we can say about these questions.

The essay's remaining sections accomplish two tasks. First, I demonstrate the significance

of the Dominion government's war-related fiscal policy to the completion of the Canadian recovery. Second, having also shown the apparent importance of fiscal policy to the recovery before the war in the absence of stimulative internal fiscal policy, I establish an empirical connection between the government's external fiscal policy and the export recovery before the war. In order to proceed, it is first necessary to determine when the output gap closed for the Canadian economy.

Section 1.4 Timing of the Recovery

To answer the question of when the Depression ended in Canada requires the estimation of a potential output series. Comparing actual to potential output gives an estimate of the output gap for any given year. Closure of this gap marks the end of the Depression and the restoration of full-employment output. The fact that real output returned to its pre-Depression level (1929) by 1937 masks the uneven nature of the recovery across the various components of national expenditure. The figures in Table 1.2 show how investment spending by both the residential and non-residential sectors remained depressed throughout the late 1930s. Only expenditure on plant and equipment showed any appreciable improvement. Government expenditure returned to its 1929 level by 1937. Exports played an obvious role in aiding the recovery of real output; by 1937 they exceeded their 1929 level by 10 per cent. The definition of recovery as the attainment of 1929 income levels, however, ignores the growth in potential output that would have occurred in the downturn's absence and provides the true metric against which the timing of the recovery should be judged. Did potential output grow? Marcus comments that much of the recovery over the 1934-1936 period simply represented business operating its existing plant at a higher

capacity.[20] The lack of recovery in non-residential investment expenditure between 1933 and 1937 reflected the excess capacity within the economy. However, Safarian notes the continued growth of the Canadian labour force during the 1930s, reflecting an increase in the economy's potential productive capacity.

To construct a potential output series for Canada, I replicate Vernon's method of projecting an estimated logarithmic trend for real output past 1929. Vernon estimates these logarithmic trend lines and their underlying growth rates using year segments borrowed from DeLong and Summers (1988) (1892-1929, 1906-1929, and 1919-1929) and Romer (1923-1927).[21] Starting with the level of output in 1929, the last year before the downturn, the estimated growth rates applied over the 1930-1945 period yield estimates of how potential output would have grown in the absence of the Depression. Comparison of actual output to estimated potential output shows the shortfall in real output from its potential level and measures the output gap. To select the year segments for Canada, which feature a stable underlying trend rate of growth, I use the results of Evans and Quigley (1995). They concern themselves with refuting Inwood and Stengos' (1991) findings that there were only three exogenous shocks to the Canadian economy sufficiently powerful enough to alter the underlying trend rate of output growth: the Wheat Boom, the First World War, and the Second World War.[22] This produces a model of Canadian growth featuring four distinct periods: 1870-1896, 1896-1914, 1914-1939 and 1939-1985. Evans and Quigley identify a number of one, two and three break models that each produce a trend stationary univariate model of Canadian output and investment. For purposes here, they identify four periods starting with Confederation (and the availability of national income

data), the Wheat Boom, the First World War and the post First World War recession and ending in 1929, (1870-1929, 1896-1929, 1914-1929 and 1920-1929, respectively). Each period is consistent with a trend stationary characterisation of Canadian output.[23] This ensures that each period features a stable underlying trend growth rate of output. This method ignores the potential for the Depression as an economic event to alter the underlying trend rate of growth but the interest here lies in constructing a potential output series reflecting the continued growth of real output in the absence of the Depression.

Table 1.4 presents estimated potential GNP figures based on the four periods above and Table 1.5 reports the estimated output gap.[24] Each series reveals that the trough in output during the Depression occurred in 1933 with the estimated output gap ranging from 34 to 48 per cent. Estimates of the output gap for 1937, ranging from 20 to 44 per cent, show the degree to which the recovery was not yet complete.

Unfortunately, this method yields a range of estimates for the output gap in 1939 and the year in which it finally closed. To select the most accurate estimate of potential output, the actual output gap and the timing of its closure, I use additional information in the form of unemployment rates to discern in which year the Canadian economy returned to full employment. It is possible to eliminate immediately the series derived from the 1896-1929 and 1920-1929 trend growth rates from further consideration. Not only do they predict the existence of an output gap continuing well into the war, but they also show the existence of a small output gap in 1929, inconsistent with its usual interpretation as the peak year of the pre-Depression business cycle. The two

remaining series constructed from the 1870-1929 and 1914-1929 trend rate of growth indicates the closure of the output gap sometime in 1942 and 1941, respectively and indicate that full employment output occurred in either year. Since both series indicate that the Canadian economy operated above capacity in 1929 and 1942, the unemployment rates for 1929 and 1942 indicate a situation of over-full employment. Therefore, the actual unemployment rate reflecting full employment will be slightly higher than its actual rate for those two years.

Table 1.6 reports one estimate of the Canadian unemployment rate over the period in question. The rate in 1929 and 1942 of 3 per cent, it is argued, reflects over-full employment. Alternative estimates of Canadian unemployment rates during the same period also agree with this interpretation.[25] With the unemployment rate falling to its 1929 level by 1942, and the series based on the 1914-1929 trend rate of growth (column 3 of Table 1.5) showing the closure of the output gap during 1941, I conclude that full recovery occurred during this year. This interpretation is consistent with the average unemployment rate observed during 1941, reflecting full employment.[26] An alternative unemployment rate estimate, based on the Dominion Bureau of Statistics' survey of trade union unemployment and reported by Galenson and Zellner (1957), tends to confirm this finding.[27] If a situation of over-full employment existed in 1929, then the fall in the unemployment rate from 7.8 per cent in 1940 to 4.5 per cent in 1941 indicates that full employment, at least among trade union members, occurred sometime during 1941. If so, this indicates the output gap closed sometime during 1941. The selection of this series, where potential output grew at a rate of 3.2 per cent per year, results in an estimated output gap of 19 per cent on the eve of the Second World War.[28] Thus, the output gap, which stood at 34 per cent

in 1933 fell by only 45 per cent over the next six years revealing a slow peacetime recovery. In the following two years, 1940 and 1941, the Canadian economy completed the majority of its recovery. Canada's entry into the war did not spell an immediate end to the Depression. This serves to emphasize the Canadian war effort's limited nature until the summer of 1940.

Vernon's results show the American economy completed its recovery in 1942, a year later than Canada. However, this was only one year following its entry into the war. Increased rearmament expenditure in the year before it entered the war aided in its recovery. Therefore, entry into the war by itself was not a sufficient condition to guarantee a quick end to the Depression. The intensity of the war effort, reflected in a country's fiscal policy, affected the speed of recovery. How much it mattered to the Canadian recovery is the subject of the next section.

Section 1.5 Monetary and Fiscal Policy in the Recovery

The results of the previous section suggest that the Canadian economy completed the majority of its recovery in the two years following 1939. Intuitively, this suggests that the Dominion government's war-related fiscal policy had potent effects. After all, government expenditure rose by 250 per cent between 1939 and 1941, increasing from $7.7 billion to $19 billion. Its share of GNP also doubled from 17 to 34 per cent. However, the formal and relative importance of Dominion fiscal and monetary policies to this recovery process must be empirically established. In the absence of a large scale multi-equation macroeconomic model of the contemporary Canadian economy, I adopt Romer's method, described below, of calculating

monetary and fiscal multipliers. The advantage of this method is its simplicity in the absence of such models and, as will be shown below, the fact that it can yield robust estimates.

Romer's method assumes that an economy, on average, tends to grow at some normal rate, determined by the growth rates of the labour force, capital stock and technological progress. Deviations from this normal rate of growth in any particular year are due to real shocks that have an immediate impact on the growth rate, and monetary and fiscal policy changes that occur with one year's lag. These changes are defined as deviations from some normal practice or policy rule. More formally, the deviation of the economy's actual growth rate of output from its "normal" value year in t is:

$$\text{output change}_t=\beta_m(\text{monetary change})_{t-1}+\beta_f(\text{fiscal change})_{t-1}+\epsilon_t \quad (1.1)$$

where β_m and β_f are the monetary and fiscal multipliers respectively. The residual term, ϵ_t, incorporates the effect of supply or demand shocks and any self-corrective tendency of the economy after a cyclical downturn. To calculate the multipliers, it is necessary to first define normal values for each of the relevant variables and then select two different years to provide the data.

For the Canadian economy's normal growth rate, I use the average annual growth over the 1870-1929 period of 3.7 per cent, not that obtained for the 1914-1929 period. This switch is made to determine what effect deviations from normal fiscal policy had on the actual growth rate of Canadian output over the entire period where balanced budgets formed the fiscal policy rule. The period 1914-1929 encompasses two sub-periods marked by extremes: 1) the First World

War, where deficit spending was in full force and 2) the 1920s, where successive Dominion government budgets deliberately produced surpluses designed for debt reduction. Focusing on the 1870-1929 period helps determine the relationship between the growth rate of output and fiscal and monetary policy in the absence of such extremes that occurs by focusing on the long run. Given the discussion on contemporary fiscal policy above, I define normal fiscal policy to be a balanced budget and normal monetary policy as the annual growth rate of M1 over the 1870-1929, calculated as 4.3 per cent per annum.[29] (For details on data sources, see the data appendix.) With the norms thus established, unusual policy arises whenever the Dominion government runs a deficit or surplus or when the growth rate of M1 exceeds or falls below its historical average.

To obtain plausible estimates of β_m and β_f, one must choose two years in which real shocks affecting the growth rate of output are nil or at least relatively minor compared to monetary and fiscal policy deviations. Furthermore, Romer stresses that the monetary and fiscal policy changes must occur independently of the movements in real output; they cannot be an endogenous response to a rise or fall in output (Romer, 764). To calculate her multipliers for the American economy, she selects the years 1920 and 1937 where US monetary and fiscal policy moves occurred independently of events in the real economy, producing a recession. In 1920, the increase in the US federal government's surplus to GNP ratio (marking the move from a budget deficit to a budget surplus), reflected the end of the First World War. With respect to monetary policy, Romer considers the rise in the US Federal Reserve's discount rate during 1920 resulting from its lack of experience and knowledge about the lagged effect monetary policy has on output.

It was not a response to real events in the economy. The choice of 1937 arises from the introduction of social security taxes and the decision to finance a pension system. These were fiscal policy measures that did not reflect a response on the part of the American government to real events. The Federal Reserve's increase in the required reserve ratio, mandated to convert their excess reserves into required reserves, led to a contraction of the money supply as the banks wished to hold excess reserves in the first place. This monetary policy move occurred because the Federal Reserve misunderstood the bankers' motives; it was not a response to real events (Romer, 765).

On the basis of this criteria, one obvious date for Canada is a year early in the war where the change in output represented the stimulative effects of increased government expenditure. The offsetting effects of any adverse demand or supply shocks would be small compared to the deviation from a balanced budget.[30] More problematic is the large rise in M1 designed by the Bank of Canada to accommodate increased Dominion government expenditure–an endogenous response to expansionary fiscal policy. However, based on the value of the multiplier derived below, this does not appear to present a problem. On this basis, I chose 1941, the first full year of the accelerated war effort in Canada.[31]

The search for a second year yields 1928 for several reasons. Examining unemployment and inflation rates reveals little evidence of a demand or supply shock. Although there is a slight rise in the unemployment rate from 1.7 to 2.9 per cent, this appears to be a temporary deviation since the unemployment rate in 1926 is identical to that for 1928 and remains unchanged in 1929.

The implicit price output deflator, converted to a 1940 base year, fell by less than 1 per cent. Other price indices for major components of national expenditure and wholesale prices exhibit similar stability. Dominion fiscal policy's pro-cyclical nature discussed in Section 1.3.2 makes it difficult to argue that fiscal measures were ever independent of real events in the economy. However, the budget surpluses run throughout the 1920s represented the Dominion government's efforts to reduce its debt, swollen by the large deficits run during the First World War (Perry, 290-291). The government's concern over external solvency meant that prudent fiscal practice involved the production of annual surpluses and took precedence over balancing the budget exactly. Therefore, the surpluses the Dominion government ran during the 1920s would have occurred regardless of the position of the economy's position in the business cycle.

Monetary policy changes in 1928 are again more problematic. Courchene (1969, 390) considers the Canadian money supply to be demand determined over the 1926-1929 period as the chartered banks borrowed from the government to satisfy the demand for loans. Furthermore, Haubrich's (1990) Granger causality tests between national income and the money stock show the existence of a bi-directional relationship. These observations stemmed from Canada's return to the gold standard on 1 July 1926. As McIvor notes, there was no central bank in Canada to manage its operation and the Dominion government refused to assume the role of one in its absence (McIvor, 122). This absence, combined with the operation of the Dominion Finance Act of 1923 where chartered banks could maintain their reserves by pledging securities to the Minister of Finance and receive Dominion notes in return, meant that there was no domestic contraction of credit despite the balance of payments deficit and gold outflow. Chartered banks could, in effect,

transfer the gold flow to the government. As such, it becomes very difficult to argue that M1's behaviour in 1928 was independent of real output changes. However, since the estimated monetary policy multiplier is similar in value to Romer's this apparent endogeneity does not appear to bias the estimate

Substituting the relevant data for 1928 and 1941 into (1.1) and solving for β_m and β_f gives multipliers of 0.7 and -2.98 respectively. (The fiscal multiplier is negative because it is based on the surplus-to-GNP ratio and will have a contractionary effect.) Romer's estimated monetary policy multiplier for the US economy of 0.823 corresponds closely to my estimate. Therefore, the possible endogeneity discussed earlier with respect to Canadian money supply changes for both years does not appear to bias the estimate.[32] However, the estimate of Canada's fiscal policy multiplier is larger than Romer's estimate for the American economy of -0.233. Vernon criticizes Romer's method on the basis of its formulation; it inherently biases the fiscal multiplier downwards since policy changes only act with a lag and misses the immediate impact of government expenditure while capturing the contractionary effects of taxes that are more evenly spread out over time (Vernon, 864). While that criticism is no less valid here, the estimate compares favourably with fiscal multipliers obtained from post-war Canadian macroeconomic models and thus appears plausible.[33] Estimated real GNP impact multipliers range from a low of 0.96 (RDX2 model) to a high of 1.7 (CANDIDE model) and 1.87 (TRACE model). The third year for these models yield higher estimates ranging from 1.24 (TRACE model) to 2.73 (CANDIDE model) (Helliwell, Maxwell and Waslander 1979, 186-189). The comparatively large estimate I obtain is high but consistent with the result that third year multipliers are just as large, if

not larger than the impact multipliers. It is also calculated using a war year where the stimulative effects of fiscal policy were very potent and for a period where Canada operated under a fixed exchange rate regime.[34]

These multipliers have the following interpretation: a 1 per cent fall in the surplus-to-GNP ratio below normal policy (a balanced budget) raises the growth rate of output by almost 3 per cent above its historical rate, while a 1 per cent rise in the growth rate of M1 above its historical average raises the growth rate above normal by only 0.7 per cent. Together, they can estimate what effect policy deviations from "normal" practice have on raising (lowering) the growth rate of output above (below) its "normal" value in the following year. The next section quantifies this impact deviations have on the actual growth rate of output and their cumulative effect on the output level. The large budget deficits the Dominion government incurred as part of the war effort, representing a significant deviation from normal fiscal policy, are expected to the Canadian economy's quick recovery in 1940 and 1941.

Section 1.6 Policy Simulations

Romer uses her multipliers to investigate the contribution of fiscal and monetary policy to the American recovery in output during the 1930s. It is straightforward to adapt her experiments to the case of Canada and isolate the contribution of monetary and fiscal policy in the following manner. Each multiplier measures the effect that deviations from normal fiscal or monetary policy practice have on raising (lowering) the growth rate above (below) its historical average. Therefore, multiplying the actual deficit or surplus occurring in any given year by the fiscal policy

multiplier gives an estimate of the deficit's or surplus' impact on raising or lowering the growth rate above or below its average value in the following year. Likewise, if we take actual growth rate of M1 for any given year and subtract it from its historical average we are left with a measure of unusual monetary policy. Multiplying this figure by the monetary policy multiplier tells us how unusual monetary policy raises or lowers the growth rate of output above or below its historical value in the following year. Summing these two effects measures the total impact of unusual fiscal and/or monetary policy measures have on raising or lowering output growth in the following year.

To determine what effect following normal policy in one year has on output in the next, instead of what actually occurred, one need only subtract the estimated effects of unusual fiscal and/or monetary policy from the actual growth rate we observe. The remaining figure estimates what the growth rate would have been in the absence of a surplus or deficit or a growth rate of M1 that was above or below its historical average. Repeating this exercise over a number of sequential years yields a series of growth rates that can be used to construct an alternative path of real output. This reflects output levels in the absence of deviations from normal policy practice.

To isolate the contribution of monetary and fiscal policy to the American recovery Romer performs two experiments. First, she investigates the potential stimulative role of monetary policy by assuming that the growth rate of M1 takes on its historical value while fiscal policy follows its actual path of deficits and surpluses. This gives a series of estimated real output growth rates that isolates the contribution actual monetary policy alone made to raising or lowering the growth rate

of output above its historical average. The second experiment isolates the role fiscal policy played in the recovery by assuming that US federal government fiscal policy followed its normal practice of balanced budgets while the growth rate of M1 takes on its actual values. This yields a series of real output growth rates reflecting what effects the government's actual deficits or surpluses had on raising or lowering the growth rate above or below its historical value. This method also allows the assessment of the contribution monetary and fiscal policy made to the recovery before the war.

Romer's experiments for the US finds that fiscal policy mattered very little in the recovery due to its small value and the fact that during the 1930s, the deviation from normal fiscal policy were not large (Romer, 767-777). She notes that in the later 1930s, the US federal government actually ran a surplus and so fiscal policy may have slowed down the recovery. However, the size of her fiscal policy multiplier means that this effect would have been small and based on its size, there is really no scope for fiscal policy to play a potent force in the recovery. Romer does find a significant role for monetary policy due to the large increases in the money supply in the mid- and late 1930s as the growth rate of M1 deviated from normal by 10 per cent or more (Romer, 769-770). The transmission mechanism was the generation of inflationary expectations and a reduction in the real interest rate that stimulated investment and consumer durable expenditure (Romer, 775-780). As we shall see, the repetition of this experiment produces very different result for Canada.

Following the procedure outlined above, Figure 1.1 summarizes the results of these two

experiments for Canada. It shows the actual historical path of real GNP and the path it would have taken under "normal" monetary and fiscal policy. The similar output paths under normal and actual monetary policy confirm the earlier conclusions that monetary policy mattered little to the recovery. This conclusion does not extend to the case of fiscal policy. The output path constructed from the assumption of normal fiscal policy produces a considerable divergence from that reflecting actual fiscal policy. The experiment predicts that had normal fiscal policy prevailed during the downturn, the Canadian economy would have experienced a less severe fall in real output than actually occurred. Initially, this result may seem odd but testifies to the absence of counter-cyclical measures in the Dominion government's annual budgets and the outright contractionary nature of its fiscal policy during the early 1930s. Also, the early 1930s are years in which the error term of Romer's model will likely be large, reflecting the impact of other real events, such as the export collapse, on the Canadian economy's actual growth rate. A second result, and more important for immediate purposes, is the large divergence in output under "normal" and actual fiscal policy in the 1940s. This clearly demonstrates the importance of actual fiscal policy to the completion of the recovery in real output. Had Dominion fiscal policy followed a course of balanced budgets on into the early 1940s, the experiment predicts that output would have been considerably lower. One can therefore conclude that the war and the Dominion government's war-related fiscal policy mattered a great deal to the recovery in real output. The experiment predicts stagnant output during the 1940s without it.

The final result of this experiment suggests that if the Dominion government had attained its policy goal of a balanced budget during the 1930s, the consequences would have been a

stagnant level of output throughout the later 1930s. This is a problematic finding, as the deficit figures in Table 1.3 reveal, since in almost every year after 1933, the Dominion government made continual progress towards a balanced budget, marked by a falling deficit. With actual monetary policy providing little stimulus to real output and actual Dominion fiscal policy moving towards compliance with its rule, the actual rise in output is quite unexpected. Actual output should follow the path suggested by that for "normal" fiscal policy. Given the absence of any deliberate counter-cyclical policy on the part of the Dominion government, what then can explain the apparent importance of actual fiscal policy to the Canadian recovery? Does it simply reflect other real events affecting the economy entering the model through the error term or some other factor?

I argue that the answer to this paradox lies in the Dominion government's external fiscal policy measures, represented by its efforts to restore access to the markets of its two largest trading partners, Britain and the US, through a succession of bi-lateral trade agreements. These trade agreements produced lower tariffs on Canadian exports destined for and imports originating from these two countries. However, this requires an examination of the behaviour of exports in order to discern the existence of any stimulative effects. Changes in government expenditure will not pick up any potential stimulative effects on output stemming from the use of tariffs in this manner. Fortunately, Dominion tariff rates or the average tariff rate provide an observable variable that represents the government's conduct of its external fiscal policy. The next section uses measures of the Dominion government's average tariff rate in a series of export demand equations to assess what role external fiscal policy played in the recovery Canadian exports. If tariff rates emerge as a significant explanatory variable and with the expected sign, it will provide

evidence that the government's fiscal policy was not entirely devoid of stimulative attempts or measures.

Section 1.7 Assessing the Importance of External Fiscal Policy

To assess the role of the Dominion government's external fiscal policy in a quantitative manner, I use a partial equilibrium approach to model the demand for Canadian exports. The analysis that follows considers a counterfactual world where the Dominion government did not participate in bi-lateral trade negotiations aimed at reducing tariffs. It is expected that Canadian exports would have lagged in the absence of lower tariff rates despite increasing foreign demand. By incorporating a measure of the Dominion government's external fiscal policy into an export demand equation, one can then address the question of how changes in Dominion tariff rates affected exports, the apparent source behind the Canadian output recovery of the 1930s and by how much. One candidate for this measure would be a measure of the tariff imposed on Canadian exports by the importing country. However, I argue that this measure would miss the point of the exercise. What explains the level of tariff rates imposed against on Canadian exports and their changes during the recovery phase are the behaviour of the Dominion government's own tariff rates themselves. Without the reciprocal concessions the Dominion government made in bi-lateral trade negotiations, tariffs against Canadian exports would have remained unchanged. If so, then it is a measure of the Dominion government's external fiscal policy, captured by its tariff rates, that ultimately explain the effects of its efforts to liberalize Canada's trade with other countries. Lower foreign tariff rates are just the end product and not necessarily the cause.

The obvious candidate variable to capture external Dominion fiscal policy is the average tariff rate, typically calculated as the ratio of tariff revenue to the value of total imports or dutiable imports. However, as Irwin (1998) notes in his study of US import demand in the 1930s [35], this does not measure the true average tariff rate and there is no simple satisfactory way to measure it. The existence of specific duties, for instance, compounds the problem of determining the actual average tariff rate. Substitution effects will also bias this measure downward as individuals substitute either domestically produced goods or imported goods subject to a lower tariff rate in their consumption baskets. Irwin argued that it is more proper to think of the average tariff rate calculated in the above manner as a proxy for the average ad valorem tariff rate. Hence, for purposes here, I will construct the average tariff rate as the ratio of government tariff revenue to either the value of total imports or the total value of dutiable imports.[36]

Unlike the empirical approach of Green and Sparks and Betts, Bordo and Redish, I examine the behaviour of exports to Britain and the US separately. They each assume that the US economy and its aggregate variables, like national income, can effectively represent the impact of economic conditions in the rest of the world on the behaviour of total Canadian exports. However, only one-third of total Canadian exports went to the US in 1929. Therefore, this modelling approach, while empirically convenient, ignores factors and events affecting the remaining two-thirds. For instance, Britain was Canada's second largest trading partner, with a share in total exports only slightly below that of the US, and between 1933 and 1935 was its largest.[37] Its relatively shallow downturn and early recovery relative to the US may have mitigated the severity of the downturn in Canada.[38] Also, Marcus notes how European and

British rearmament increased the demand for Canadian non-ferrous metals, providing an impetus to the recovery in exports (Marcus, 137). In response, I disaggregate total exports by country and examine export demand by Britain and the US separately. Although I ignore exports to the rest of the world, these two countries account for anywhere from two-thirds to over three quarters of total Canadian exports during the period under examination. My analysis incorporates the impact of cross-country differences in terms of each country's recovery and what effect this had on the demand for Canadian exports.

Given the concentration of exports not only by destination but type, one could also disaggregate Canadian exports further based on type. An obvious decomposition would involve examining exports of wood products and newsprint to the US and wheat to Britain. However, this would require the construction of separate price indices for each product since the appropriate data do not currently exist. Also, the interest here lies in examining the behaviour of aggregate exports since Green and Sparks identify aggregate exports as providing the stimulus to real income growth during the pre-war recovery.

The demand for Canadian exports by Britain and the US is also thought to be a function of their price and the national income of the importing country besides the average Dominion tariff rate. With these variables in mind, the export demand equation takes on the following form:

$$X_{ti}=\beta_0+\beta_1 \ln Px_t+\beta_2 \ln GDP_{ti}+\beta_3 ATR_{ti}+e_{ti} \quad (1.2)$$

where i=Britain or the US, X_{ti} is the value of Canadian exports to either Britain or the US in year t, Px_t is the Canadian export price index, GDP_{ti} is the Gross Domestic Product of the importing

country and ATR_{it} is the average Canadian tariff rate on imports from the respective country. In the results below I also investigate the impact of using lagged values of foreign income and the average tariff rate.

I restrict attention to the 1926-1939 period and employ two measures of the average tariff rate. The first, ATR, is calculated as the ratio of tariff revenue to the value of dutiable imports only, and the second, ATR2, is the ratio of tariff revenue to all imports.[39] To mitigate the problems involved in converting to a common currency, I use Maddison's (1992) GDP figures for Britain and the US. I convert Canadian exports to an equivalent basis by developing crude conversion factors using Maddison's GDP figures for the Canada and Statistics Canada's historical estimates of Canadian GDP. (For details on the specific sources, see the data appendix.) However, Maddison's figures are available only on an annual basis and so this conversion method imposes a cost in terms of the frequency of the data that can be employed. Although there are still a sufficient number of degrees of freedom to permit estimation of the model, the number of data points is small and the standard errors will likely be large. This is an unavoidable consequence of the conversion method. It is important to note, however, that this frequency problem also plagues Green and Sparks who use annual data over the 1926-1939 period to estimate their consumption, export and import functions for their model.

Tables 1.7 and 1.8 report the estimated parameters for the US and British export demand equations, respectively. The estimated equations for each country display a high degree of fit with R^2 values ranging from 0.80 to 0.93. For both countries, national income has a positive and,

depending on the equation's exact specification, statistically significant effect on the demand for Canadian exports. This confirms the usual observation that recovery in Canadian exports depended on rising national income and the recovery of its two major trading partners. Otherwise, the recovery of exports and Canadian aggregate output following 1933 would have stagnated. Contrary to expectations, a positive relationship consistently emerges between the export price index and exports for each country; however, this is a statistically significant relationship only in Britain's case. One possible explanation for this result is the concentration by type of Canadian exports to either country. An aggregate price index may mask the movements in the smaller set of relevant prices for exports of wheat or paper products to Britain and the US, respectively.

The effect of the main variable of interest, the average Dominion tariff rate, is not firmly established. Depending on the demand equation's specification and average tariff rate measure employed, the variable sometimes emerges with the expected negative sign and statistical significance for each country. Introducing a lagged value of the average tariff rate into the equation tends to produce the anticipated negative and statistically significant effect. The introduction of lagged values of GDP into the US equations typically mean the expected sign and statistical significance disappear. For Britain, the inclusion of lagged output reduces the coefficient's statistical significance while it retains its negative sign. The US equations employing measures of the average tariff rate in the current period show the anticipated sign and a statistically significant coefficient depending on which tariff measure is used. When both current and lagged values of the tariff rate enter the equation, the results are also sensitive to the tariff

measure employed. For exports to the US, including current and lagged values of the average tariff rate measure, ATR2, still produces a negative effect. Measured by ATR, the average tariff rate in the current period appears with a positive coefficient. Using lagged values still produces a negative coefficient. For exports to Britain, including both current and lagged values of ATR2 produce negative coefficients without statistical significance.

Together, these results suggest that the government's external fiscal policy had a positive impact on exports. The negative relation between export demand by Britain and the US and the average Dominion tariff rate, regardless of the measure used, suggests that if tariffs in the 1930s had remained at their protectionist peak, exports and the Canadian recovery would have faltered. This would be equivalent to a world where the Dominion government did not engage in any bi-lateral trade agreements with Britain and the US and so continued their protectionist measures against Canadian exports. To assess the possible impact of such a policy, I perform the following simulation. I fix the Dominion average tariff rate at its highest level achieved during the 1930s while letting foreign national income and the export price index follow their historical paths. This produces a counterfactual path for Canadian exports reflecting the absence of any trade agreements with Britain or the US resulting in lower tariff rates. Such an experiment assumes that the Canadian economy was too small to have a significant impact on the level of income in Britain and the US through increased Canadian demand for British and American imports. This seems plausible because relative to Canada, the US was a large closed economy for which exports assumed little importance in aggregate growth performance. With respect to Britain, the Canadian economy was simply too small to matter.

Figures 1.2 and 1.3 plot the simulated and actual export figures for the US and Britain, respectively. Since I use actual instead of fitted values for Canadian exports to either country, the difference between the simulated and actual export levels will also reflect the presence of all other sources of error in the model, like an omitted variable. However, the fit of the model is very high and so any discrepancy induced by using the actual values should be small. The interest of this exercise also lies in determining how exports would have differed from their actual levels had tariff rates remained high. This requires the use of actual and not fitted values.

Actual exports to the US reached their trough in 1934. Simulated exports constructed from the parameter estimates of column (3) in Table 1.7, predict higher American demand than actual until 1937. After this year, actual exports continue to rise while simulated exports stagnate. Strong income growth in the US following the trough appears sufficient to offset the adverse effects of high tariff rates between 1934 and 1937. As the US economy slows down and enters a short-lived recession, simulated exports (reflecting the continued existence of high tariff levels) stagnate. Since the first US-Canadian trade treaty came into effect at the start of 1936, the stimulative effects of tariff reductions could only be expected to occur after this date. The simulated path for exports to the US suggests that, despite the continuing high tariff rates of the early 1930s, American income growth was sufficient to offset the effect of high tariffs. The parameter estimates obtained from using lagged values of the average tariff rate in the regression equation (column (2) of Table 1.7) predict an even stronger negative effect on exports to the US from the continuation of high tariff rates. Exports to the US stagnate after 1936 and fall considerably below actual levels in the absence of the Dominion government's lower tariff rates.

These findings suggest the importance of trade liberalisation measures to the recovery in Canadian exports to the US in the later 1930s.

The trough in exports to Britain also occurred in 1934. Based on the parameter estimates of columns (3) and (6) in Table 1.8, the counterfactual paths display a stronger divergence than that observed for the US. They show that, much like the US, strong British income growth between 1934 and 1936 is sufficient to raise export demand despite the presence of high Dominion tariff rates. After 1936, simulated British demand for Canadian exports begins to flag and fall between 1937 and 1939, in sharp contrast to actual exports. The divergence, which appears stronger based on the simulation using the ATR2 measure, suggests that the Dominion government's efforts at trade liberalisation efforts had a definite stimulative effect in the later 1930s. Without the disaggregation of Canadian exports by country as earlier proposed, the fall in exports to Britain on account of higher Dominion higher tariff rates would have gone unnoticed.

Although the extremely small sample size limits the strength of my conclusions, a consistent pattern of results emerges from the simulations. British and American export demand would likely have faltered in the later 1930s without the Dominion government's participation in bi-lateral trade agreements. Hence, the results suggest that the Dominion government's external fiscal policy in the later 1930s was stimulative and played some role in encouraging the recovery in exports. The historical record should be amended to include the possibility that stimulative Dominion fiscal policy did exist during the 1930s recovery, albeit of a slightly unusual kind. In its absence, exports to both countries would have lagged, slowing the overall recovery.

Section 1.8 Conclusion

This essay verifies a number of conjectures about the nature and timing of the Canadian recovery from the Great Depression, while also casting light on a hitherto neglected role played by Dominion fiscal policy prior to 1939. First, the potential output estimates of Section 1.4 suggest the existence of a large output gap in 1939 and reveal a recovery that was slightly less than half complete. In 1940 and 1941, the Canadian economy completed the majority of its recovery, closing the existing output gap and restoring full employment. Second, the results from repeating Romer's experiments for the Canadian economy suggest that, given the wide divergence between output paths under normal and actual fiscal policy, war-related fiscal policy was the most important factor behind the rapid completion of the recovery. This confirms the traditional significance accorded to the war in ending the Depression in Canada. Since it was the war that occasioned the Dominion government's unusual fiscal policy, a longer, slower recovery would have ensued if Canada had remained out of the war or its early phases. Third, monetary policy does not appear to play any role whatsoever in aiding the recovery both before and after the outbreak of war. Despite the contemporary articulations of an easy money policy, the similarity of the output paths under normal and actual monetary policy show its neutral, accommodative nature. Fourth, the Dominion government's external fiscal policy does appear to matter to the recovery in exports during the 1930s. The simulation results of Section 1.7 suggest that the Dominion government's participation in bi-lateral trade negotiations and agreements, lowering tariffs erected against Canadian exports in the early 1930s, aided the recovery in exports. This aid was particularly evident in the late 1930s. Hence, stimulative Dominion fiscal policy was not

altogether absent in the 1930s.

Although data limitations place a constraint on the strength of the findings in Section 1.7, constraints no less severe than those placed on Green and Sparks, the results suggest that the process of recovery differed somewhat between Canada and the US. Monetary policy, thought to play a large role in the American recovery before the war, does not emerge as a significant factor in the Canadian recovery. External Dominion fiscal policy appears to have influenced the recovery in Canadian exports in a positive way during the initial recovery phase but both Romer and Vernon agree that American fiscal policy played virtually no role in its recovery before the US entered the war. This points to a fundamental difference between the two economies in the recovery process before the war. However, war-related fiscal policy helped end the Depression in both countries. The apparent boost to exports the Dominion government's external fiscal policy provided suggests that the expansionary effects from tariff reductions can occur on a large scale. Although the strength of this effect depends on the destination of exports, it lends support to Eichengreen's hypothesis that tariff increases/decreases may have contractionary/expansionary effects based on retaliatory effects. This finding will obviously depend on how open an economy is to trade in the first place but Canada appears to be a prime candidate to observe this mechanism at work.

This essay's results also indicate that future research should continue to focus on the Dominion government's policy measures. Romer's method is but one with which to calculate fiscal and monetary policy multipliers for the Canadian economy and the issue should be subjected

to more rigorous methods. Future research should also strive to overcome the limitations the data impose on the analysis of Section 1.7, by increasing the frequency of observations from annual to quarterly.

In sharp contrast to the limited role the Dominion government was willing to assume during the 1930s, the end of the phoney war in the spring of 1940 placed demands upon the Dominion government for micro and macroeconomic management that it could not ignore. For the next 12 months, Canada became one of Britain's principal allies and munitions suppliers, a role that required the wholesale re-organization of the Canadian economy to place it on a war footing. This essay was devoted to examining some of the macroeconomic features of the Canadian economy around the time it entered the war. The remaining two chapters of the thesis examine problems confronting the Dominion government at the microeconomic level and how it overcame them.

Data Appendix

Three sources provided the data for the construction of fiscal and monetary multipliers. For the Dominion government's annual deficits on a calender year basis, Gillespie's (1991) Table B-1 provides the necessary figures. Angela Redish kindly provided the data for M1 on an annual basis prior to its publication in Metcalf, Redish, Shearer (1998). This article gives a full description of the development of the M1 series. Data for real output prior to 1926 comes from Urquhart (1988) and annual GDP figures are taken from Statistics Canada's *National Income and Expenditure Accounts Historical Edition* (1988) Table 2. I obtain the export price index from the same source (Table 7).

Maddison's Table C-16a in *Monitoring the World Economy* (1995) provided the GDP estimates for the US, Britain and Canada. Maddison reports these figures in 1990 Geary-Khamis dollars to facilitate international comparisons. To convert Canadian exports to an equivalent basis, I estimate a crude conversion factor based on comparing Maddison's GDP figures with those nominal figures for Canada. I apply the resulting conversion factor to the annual value of Canadian exports to Britain and the US. Annual editions of the *Canada Yearbook* contain figures on exports to both countries as well as the measures of the average tariff rate: tariff revenue as a proportion of dutiable imports and all imports.

Tables

Table 1.1.–Canadian wheat and wheat flour exports
(change from the quarter of the previous year)

1929	Premium[a] (US cents per bushel)	Wheat Exports (million bushels)	Flour Exports (thousands of barrels)
First Quarter	15.43	2.07	222.67
Second Quarter	4.03	0.49	83.67
Third Quarter	32.47	-16.57	-208.67
Fourth Quarter	15.47	-36.37	-518.67

a) Marcus calculates the premium as the difference between the average price of No. 1 and No. 3 Manitoba wheat prices at Liverpool and the average price of wheat imported into Great Britain.
b) Quarterly figures are based on monthly averages.
Source: Based on data contained in Marcus (Marcus, 58).

Table 1.2.-Recovery of GDP and its components relative to 1929 levels

(1929=100)

			Investment expenditure						
Year	GDP	Consumption	Business Investment (Fixed K)	Residential Construction	Non-residential Construction	Machinery and Equipment	Exports	Imports	Government
1926	83	77	62	90	52	58	95	75	84
1927	90	86	76	100	65	75	95	83	88
1928	99	94	91	106	87	87	107	93	89
1929	100	100	100	100	100	100	100	100	100
1930	96	96	82	78	81	83	86	86	110
1931	86	91	58	72	61	48	77	61	116
1932	78	84	30	37	30	26	71	47	112
1933	72	82	21	27	19	20	72	46	95
1934	80	87	27	33	22	29	81	53	101
1935	85	90	33	37	28	36	89	58	105
1936	89	94	40	41	35	44	107	67	106
1937	97	100	52	49	41	64	110	80	106
1938	99	99	50	51	38	62	99	71	120
1939	106	101	49	56	37	58	110	77	127

Source: calculated from Table 3 in Statistics Canada. *National Income and Expenditure Accounts Historical Edition*. Ottawa: Queen's Printer

Table 1.3.–Dominion government revenue and expenditure 1929-1939

	Expenditure (000,000's)	Revenue (000,000's)	Deficit (000,000's)	Expenditure 1929=100	Revenue 1929=100	Expenditure Growth[a]	Revenue Growth[a]
1929	$363.5	$447.4	-$83.9	100	100		
1930	395.2	439	-43.8	108.7	98.1	8%	-1.9%
1931	437.6	346.8	90.8	120.4	77.5	9.7	-26.6
1932	487.3	322.2	165	134.1	72	10.2	-7.6
1933	458	300.3	157.7	126	67.1	-6.4	-7.3
1934	446.9	313.4	133.5	123	70	-2.5	4.2
1935	466.2	350.1	116.1	128.2	78.3	4.1	10.5
1936	521.9	361.9	160	143.1	80.8	10.6	3.3
1937	520.3	442.4	77.9	143.1	98.9	-0.3	18.1
1938	520.4	502.7	17.7	143.2	112.4	0	12
1939	536.7	485.8	50.9	108.6	108.6	3	-3.5

Notes: a) Percentage change from the previous year.
Source: Irwin Gillespie, *Tax, Borrow and Spend*, Table B-1, 271.

Table 1.4.–Actual and potential real GNP projections 1929-1942
(millions of 1981 dollars)

		Potential Real GNP Estimates			
Year	Real GNP	1870-1929 Trend	1896-1929 Trend	1914-1929 Trend	1920-1929 Trend
1929	41,559	39,293	42,509	38,910	43,217
1930	39,788	40,769	44,385	40,183	46,074
1931	34,730	42,301	46,344	41,498	49,119
1932	31,129	43,890	48,390	42,856	52,365
1933	29,055	45,539	50,526	44,258	55,826
1934	32,583	47,250	52,756	45,707	59,516
1935	35,126	49,025	55,084	47,202	63,450
1936	36,684	50,867	57,516	48,747	67,643
1937	40,369	52,777	60,054	50,342	72,114
1938	40,701	54,760	62,705	51,990	76,880
1939	43,274	56,818	65,473	53,691	81,961
1940	49,881	58,952	68,363	55,448	87,378
1941	57,057	61,167	71,380	57,262	93,153
1942	67,643	63,465	74,531	59,136	99,310

Source: Actual GNP figures: Urquhart, M. C. 1988. Canadian Economic Growth 1870-1985, Institute for Economic Research, Discussion Paper No.734, Queen's University.

Table 1.5.–Actual GNP as a Percentage of Potential GNP

year	1870-1929 Trend	1896-1929 Trend	1914-1929 Trend	1920-1929 Trend
1929	+6.0%	-2.0%	+7.0%	-4.0%
1930	-2.0%	-10.0%	-1.0%	-14.0%
1931	-18.0%	-25.0%	-16.0%	-29.0%
1932	-29.0%	-36.0%	-27.0%	-41.0%
1933	-36.0%	-42.0%	-34.0%	-48.0%
1934	-31.0%	-38.0%	-29.0%	-45.0%
1935	-28.0%	-36.0%	-26.0%	-45.0%
1936	-28.0%	-36.0%	-25.0%	-46.0%
1937	-24.0%	-33.0%	-20.0%	-44.0%
1938	-26.0%	-35.0%	-22.0%	-47.0%
1939	-24.0%	-34.0%	-19.0%	-47.0%
1940	-15.0%	-27.0%	-10.0%	-43.0%
1941	-7.0%	-20.0%	0.0%	-39.0%
1942	+7.0	9.0%	+14.0	-32.0%

Note: A negative sign means that actual output is below potential. A positive sign means actual output is above potential.
Source: Calculated using GNP data in Table 2.

Table 1.6.–Estimated unemployment rates for selected years

year	1926	1927	1928	1929	1930	1937	1939	1940	1941	1942
4	2.9	1.7	2.9	2.9	9.1	9.1	11.3	9.2	4.4	3

Source: calculated from Table 75 in: Statistics Canada. *National Income and Expenditure Accounts Historical Edition*. Ottawa: Queen's Printer

Table 1.7.–Regression results: US export demand equations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-20.34	-17.07	-6.08	-10.10	-68.97	-15.41	-14.79	-33.14	-42.81
	(5.55)*	(6.34)*	(8.91)	(13.16)	(10.71)	(12.14)	(6.60)*	(7.39)*	(10.41)*
ln Px_t		0.44	0.32	0.34	0.90	0.35	0.21	0.56	0.82
		(0.42)	(0.35)	(0.46)	(0.21)	(0.56)	(0.44)	(0.33)	(0.38)*
$lnGDP_t$	2.19	1.86	1.13	1.40	1.55	1.72	1.73	0.95	1.35
	(0.39)*	(0.50)*	(0.62)	(0.91)	(0.37)	(0.79)*	(0.50)*	(0.43)*	(0.52)*
$lnGDP_{t-1}$					3.70			1.97	2.16
					(0.58)			(0.62)*	(0.61)*
$lnATR_t$			-8.01	-4.89	15.14				
			(3.56)*	(7.99)	(4.54)				
$lnATR_{t-1}$	-5.22	-4.65		-2.14	-0.13				
	(2.20)*	(2.25)*		(4.72)	(1.96)				
$lnATR2_t$						-5.29			7.11
						(8.06)			(5.59)
$lnATR2_{t-1}$							-8.08	2.20	1.49
							(3.66)*	(4.12)	(4.01)
N	13	13	14	13	13	14	13	13	13
standard error	0.139	0.138	0.130	0.144	0.59	0.157	0.136	0.96	0.092
Durbin-Watson	1.91	1.97	2.19	2.06	2.79	1.75	1.83	2.58	2.72
R^2	0.85	0.85	0.86	0.84	0.97	0.80	0.86	0.93	0.93

note: A * indicates statistical significance at the 5% level. ATR measures the average tariff rate as the ratio of tariff revenue to the value of dutiable imports only. ATR2 measures the average tariff rate as the ratio of tariff revenues to the value of all imports.

Table 1.8.–Regression results: Britain's export demand

	(1)*	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-22.12	-20.72	-14.56	-19.35	-18.84	-2.90	-6.84	-12.78	-10.15
	(16.20)	(3.80)*	(4.00)*	(4.98)	(5.09)*	(6.97)	(14.12)	(10.38)	(15.52)
ln Px_t		1.67	1.50	1.61	1.58	1.89	1.73	1.66	1.66
		(0.25)*	(0.25)*	(0.30)	(0.31)*	(0.17)*	(0.21)*	(0.17)	(0.25)*
$lnGDP_t$	2.44	1.96	1.59	1.89	2.63	0.53	0.87	1.35	1.77
	(1.30)**	(0.29)*	(0.29)*	(0.34)	(0.91)*	(0.54)	(1.12)	(0.81)	(1.80)
$lnGDP_{t-1}$					-0.79				-0.63
					(0.89)				(0.97)
$lnATR_t$			-4.13	-1.28	-1.00				
			(2.14)**	(2.80)	(2.86)				
$lnATR_{t-1}$	-1.04	0.21		0.30	0.32				
	(3.10)	(2.02)		(2.12)	(2.15)				
$lnATR2_t$						-3.25	-1.30		-0.65
						(1.35)*	(2.01)		(2.31)
$lnATR2_{t-1}$							-1.39	-1.53	-1.26
							(1.99)	(1.91)	(2.07)
N	13	13	14	13	13	14	13	13	13
standard error	0.164	0.089	0.096	0.093	0.095	0.089	0.089	0.086	0.090
Durbin-Watson	1.3	2.11	1.91	2.07	2.39	2.24	2.34	2.28	2.51
R^2	0.56	0.91	0.9	0.90	0.9	0.92	0.91	0.92	0.9

note: A * and ** indicate statistical significance at the 5% and 10% level of significance respectively. ATR measures the average tariff rate as the ratio of tariff revenue to the value of dutiable imports only. ATR2 measures the average tariff rate as the ratio of tariff revenues to the value of all imports.
a) Corrected for first order autocorrelation. Durbin-Watson statistic reported for original regression.

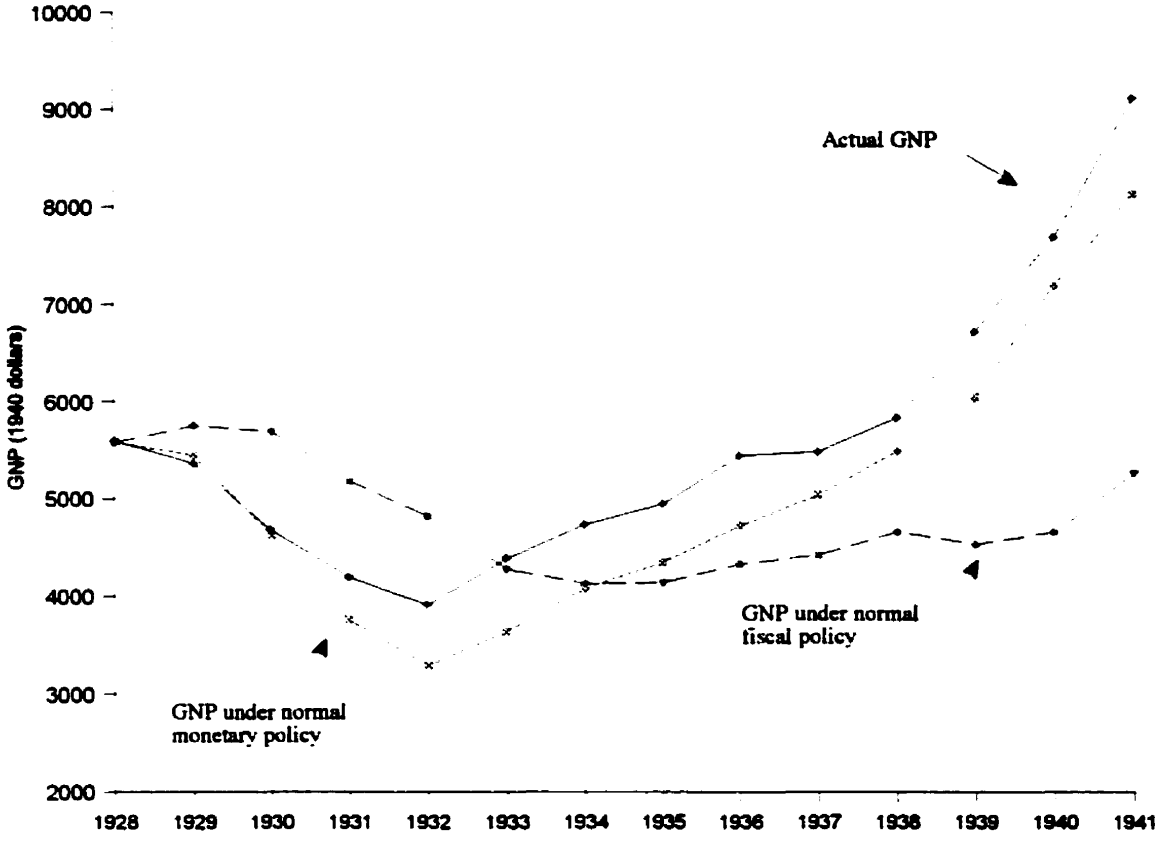

Figure 1.1. Output paths under "normal" and actual fiscal and monetary policy.

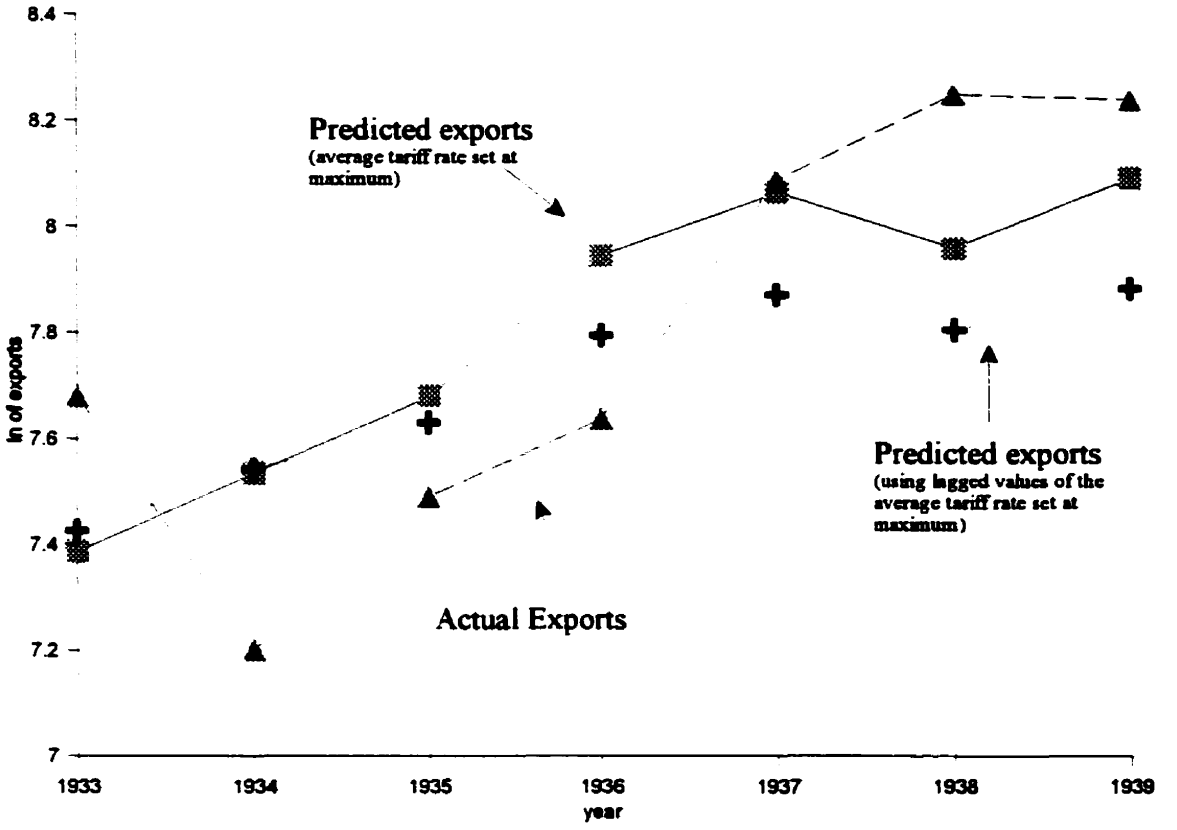

Figure 1.2. Actual and simulated exports to the US. The average tariff rate is measured as the ratio of tariff revenue to the value of dutiable imports only.

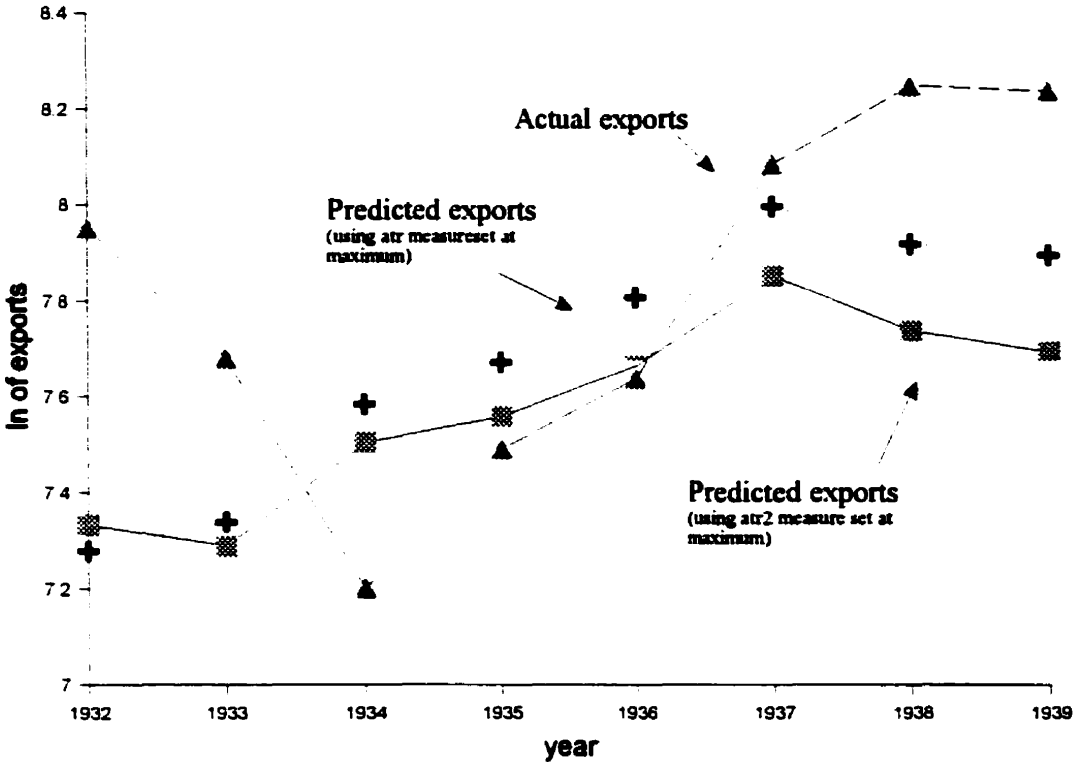

Figure 1.3. Actual and simulated exports to Britain. ATR measures the average tariff rate as the ratio of tariff revenue to the value of dutiable imports only. ATR2 measures the average tariff rate as the ratio of tariff revenue to the value of all imports.

Endnotes

1. This statement follows from the observations of Betts, Bordo and Redish (1996, 2). They note the remarkably similar experience of the Canadian and US economies based on the following observations: 1) output fell by about one-third between 1929 and 1933, 2) output returned to its 1929 level by 1937 in both countries, 3) private investment fell by approximately three-quarters between 1929 and 1933. The paths of nominal variables such as M1, velocities and wholesale prices were also virtually identical.

2. Green and Sparks identify two channels through which the Canadian economy is affected by external developments. The first is the direct effect from spending by other countries on exports. The second is an indirect effect from the domestic asset markets as a balance of payments surplus leads to an increase in the domestic money supply.

3. Far from a homogeneous good, the demand for Canadian wheat by European millers and a general shortage of high quality grades gave Canadian wheat producers and sellers considerable market power with respect to its price (Marcus, 55). This market power is evident with the rising premium recorded on Canadian wheat detailed later in the text.

4. Bordo and Redish (413-414) do find evidence of a structural break in the M1 series in March 1935. They conclude, however, that this is due to a change in the reporting techniques for currency in circulation.

5. Imports fell to half their 1929 level by 1933. Correspondingly, revenue from customs duties fell from $187.2 million to $70.1 million over the same period. Likewise, revenue from excise duties fell from $63.7 million to $37.8 million. (All data taken from Perry, Table 6, 626.)

6. Bates provides a list of other public investment expenditures that fell casualty to the Dominion government's attempts to improve its budgetary position. In 1930, capital expenditures on canals totalled $9.8 million, docks and terminals: $3.1 million, building expenditures: $2.7 million, and harbour improvements: $1 million. By 1936, expenditure in each category fell to negligible levels. Only river improvements remained untouched over this period (Bates, 86).

7. Between 1914 and 1918 the Dominion debt rose from $286.9 million to $1320.6 million, measured on a calender year basis (Gillespie, 271). Demobilisation costs helped produce further deficits in the fiscal years 1919 and 1920. By 1920, the Dominion debt rose to $1795.1 million. In response, the Dominion government engaged in a deliberate policy of debt reduction through the 1920s (Perry, 290). By 1929, the Dominion government's annual budget surpluses lowered the debt to $1368.7 million, a level consistent with that at the war's end.

8. Bates makes a useful distinction between the Dominion government's ordinary expenditures and those special to the Depression. His division shows ordinary expenditures falling from $378 million in 1930 to $341 million by 1933. Depression expenditures rise over the same period from $41 million in 1930 to $95 million by 1933. He classifies the Canadian National Railway's operating deficits as special Depression expenditures that generally accounts for two-thirds of this

total. The figures in the table below summarize their behaviour. Amounts are in the millions of dollars, and based on the fiscal year ending December 31.

	1930	1931	1932	1933	1934	1935	1936
Ordinary	$378	$364	$344	$341	$349	$362	$377
Depression	41	111	100	95	109	151	140
Total current expenditure	419	475	444	436	458	513	517

Source: Bates (1939, 84).

9. MacKinnon's conclusion about the absence of major work disincentive effects stems from her observation under the relief system that, "Payments were low and means tested and the recipients' activities closely monitored . . . Once on relief, the incentive to take casual jobs was low, but the possible penalty for refusing available work was large. Overall, the former effect was probably more important than the latter, but the work disincentive of relief was smaller than that for [a system of unemployment] insurance" (MacKinnon, 79).

10. More specifically, there was the provision of guaranteed loans under the Home Improvement Plan and the National Housing Act's low mortgage rates. To encourage investment in the mining sector, new mines were exempt from income tax in the first three years of their existence (Bryce 1986, 120).

11. Bryce provides a discussion of the 1938 budget preparation where Keynesian measures were first proposed (Bryce, 115-177). The report of the National Employment Commission, released in April 1938, proposed a public works expenditure programme that would have involved deficit financing along the lines of a Keynesian-style counter-cyclical programme. The Cabinet debated the estimates over a six week period between 1 April and 20 May. The eventual compromise and acceptance of a much smaller expenditure programme that actually marked the Dominion government's first shift, however minor, towards counter-cyclical fiscal policy.

12. These figures mask the highly uneven nature of the increases across different industries and categories. For instance, on total textile products, the Preferential rate rose from 17 to 21 per cent while the Treaty and General rate rose from 23 to 39 per cent and 28 to 45 per cent, respectively. The primary iron and steel industry received comparatively minor increases, the tariff rate under the Preferential category rising from 9 to 10 per cent while the Treaty and General rate rose from 17 to 26 per cent and 15 to 19 per cent, respectively. In contrast, the Preferential tariff rate on machinery fell from 13 to 11 per cent between 1928 and 1933 while rising from 20 to 22 per cent and 21 to 27 per cent in the Treaty and General categories, respectively. A similar pattern repeated itself concerning agricultural implements. These rates, taken from Mackintosh (Mackintosh, 156), Table 17 are calculated as the equivalent ad valorem rates and are unweighted.

13. The decline in employment mirror those experienced concerning output. Safarian notes that output volume of the domestic textile industry fell by 10 per cent over the 1929-1932 period. The iron and steel industry, which also received considerable protection under the tariff increases, experienced a drop of over 60 per cent (Safarian, 94). Safarian observes that this pattern of employment/output decline repeated itself where the production of producer and consumer durables were concerned.

14. Bryce considers the retaliation to be a measured response enacted through countervailing duties and observes that Dunning's revisions only strengthened the discriminatory nature of the Dominion government's tariff structure against American imports (Bryce, 86).

15. Under such a measure, government revenue and hence expenditure may actually decline, if not replaced by other revenue sources. The taxation measures reviewed earlier show the Dominion government's attempts to bolster its revenues. Of course, there is also the observation that reduced trade barriers may increase domestic imports by an equal or even greater amount than the increase in exports leaving real output, as measured by GDP for instance, unchanged. However, the figures on import levels in Table 1.2 show how they remained below their 1929 throughout the 1930s.

16. The Agreement made a total of 223 changes to the Dominion government's existing tariff schedule. The following table shows the mixture of tariff increases and reductions used to secure preferences for British goods:

reduction of British preferential rate	81
increase in intermediate or general rate or both	89
reduction in British preferential rate accompanied by general or intermediate rate increase or both	49
reduction in all rates	2
increase in all rates	1
reductions in British preferential and intermediate rates	1
Total	223

Source: Annett (1948, 67).

17. Annett (1948, 65) summarizes Britain's concessions in the agreement: 1) free entry granted to all Empire products coming in free under Britain's Import Duties Act continued; 2) guaranteed preference margins for the duration of the agreement; 3) Continued free entry for imports of certain foodstuffs and raw materials from the Empire and new or revised duties for those of foreign origin; 3) implementation of a quota system for meat imports; 4) The prohibition of import into Britain from foreign states whose price policy frustrated the preference effects created by the existing tariff structure.

18. Annett lists the following goods that the Agreement's guaranteed margin of preference would affect the most: canned salmon, fresh and frozen fish, asbestos, timber, lead and zinc (Annett, 66).

19. The increased preference granted to imports originating within the British Commonwealth under the Ottawa Agreement and other bi-lateral agreements signed in 1932 may have simply led to trade diversion rather than trade creation. Indeed, Britain's temporary displacement of the US as Canada's primary destination for exports between 1933 and 1935 seems to confirm this fact. However, the American economy also experienced a more severe Depression, with national income falling sharper than that in the Britain. Therefore, the temporary displacement may have simply been due to the greater fall in American national income.

20. Detailed capacity utilisation figures for Canadian manufacturers, let alone the entire economy, do not exist. On the basis of limited information, Safarian states that both the iron and steel industry and the pulp and paper industry were still operating below capacity in 1937.

21. Romer constructs her estimates of potential GNP based on the American economy's trend growth rate over the 1923-1927 period, a period that Vernon rejects as inappropriate.

22. Their desire is also to refute the use of Perron's (1989) segmented trend methodology to distinguish which historical events are powerful enough in the first place to alter the underlying trend growth rate and chose among competing univariate models of growth.

23. The first period is derived from Serletis (1992) and the remaining three are from Evans and Quigley (1995).

24. The estimated growth rates are 3.7, 4.4, 3.2 and 6.6 per cent for the 1870-1929, 1896-1929, 1914-1929, and 1920-1929 periods, respectively.

25. Galenson and Zellner (1957) provide several estimates of Canadian unemployment rates for this period. While the estimated annual rates vary depending on the series, their co-movements are identical. The consequence is that while the estimated full employment rate of unemployment will depend on the series used, the timing of full employment will not.

26. Vernon also uses this same assumption for the American economy, that any potential output series should reflect 1929 as a year of slightly over full employment.

27. This estimate of the unemployment rate is based on returns tabulated from Canadian trade unions. Coverage was not always complete and, given the nature of the group surveyed, it is more sensitive to the business cycle. Also, this estimate will tend to be higher based on the group of occupations surveyed. Galenson and Zellner also note other problems with measure. In particular, trade union membership will expand and contract according to the phase of the business cycle. Although this hampers its effectiveness somewhat, it is still felt that this estimate of the unemployment rate is a useful indicator for the timing of full employment due to its movement over the business cycle and its close correlation with other estimates.

28. The small rise in the output gap in 1938 was due to the effects of the American recession on the Canadian economy.

29. It is important to note that this exercise does not use the full employment concept of the budget deficit. Romer does not use this measure since it treats falling government revenues during a recession as part of normal policy and not activist measures. Since the review of Dominion fiscal policy earlier showed the Dominion government's preference, like that of the American government, for raising taxes during the downturn in an attempt to stabilize its revenues. Using a full employment budget deficit measure would be inappropriate (Romer,762).

30. One could argue that the Second World War represented an aggregate demand shock to the Canadian economy. However, this overlooks the fact that such a shock was transmitted to the economy through fiscal policy and increased Dominion government expenditure for the war effort. Ultimately, it was the change in fiscal policy that raised real output.

31. Known as the Phoney War, the period between September 1939 and June 1940 was remarkable for its 'business as usual' approach to the war effort. The remaining two essays explore the significance of the events during the summer of 1940 with respect to their impact on the war effort. In particular, the third essay provides an overview of the limited nature of the Canadian war effort between September 1939 and June 1940 through the limited amounts of war work available and the near competitive process that existed for munitions contracts.

32. Indeed, with respect to the problem posed by monetary policy in 1928, it is possible to argue that the chartered banks fostered money creation in response to the demand for loans. This perhaps would have helped propel the economy along its expansion in the later 1920s.

33. These multipliers are based on 'a sustained injection of public spending in the Canadian economy' described in De Bever et al. (1979). The actual amount is valued at $400 million in 1961 prices. Other important variables were handled in the following manner. The behaviour of the money supply and exchange rate were assumed to follow their historical values in the CANDIDE experiment. The monetary policy reaction function was suppressed in the RDX2 model. Exchange rate determination remained exogenous in the other models.

34. To provide a further check of the estimates, I perform a sensitivity analysis by fixing one of the two original base years and then use the data for the year before and after. Unfortunately, the estimates are quite sensitive to the chosen year. Only the combination of 1928 and 1942 yields a set of multipliers consistent with the estimate used in the text. However, variations in the estimates also provide evidence that real shocks to the economy in those years drove the deviations in output growth from its historical average. The most valid estimates occur when the residual term is small relative to the policy changes and the policy measures are exogenous to output. The multipliers using 1929 may reflect the government's decision to halt the unrestricted convertibility of Dominion notes into gold to stem the gold drain the charter banks transferred to the government under the Finance Act's operation (McIvor, 123). Those using 1926 may reflect monetary events surrounding the return of Canada to the gold standard. Finally, the multipliers based using the year 1940 reflect the Dominion's government's budget of 1939 that contained a

set of special expenditures marking its first attempt at performing counter-cyclical fiscal policy in response to lagging growth. Such a move was an endogenous response to the existing conditions.

Fixed Year	1928			1941		
	1940	1941	1942	1927	1928	1929
Fiscal Multiplier	3.09	-2.98	-3.51	0.89	-2.98	0.62
Monetary Multiplier	1.59	0.7	0.43	-1	0.7	-3.86

35. Irwin's work, besides providing justification for using the average tariff rate based on the method described in the text, is not relevant to the main thrust of this essay. He investigates the impact of the Smoot-Hawley tariff increases on American import demand to apportion the decline in demand to the tariff itself and the combination of specific duties and deflation that raised the effective tariff rate.

36. One protectionist measure that the average tariff rate cannot capture of course is the prohibition on the import of a particular product by a country.

37. Britain and the US vied with one another as the primary destination of Canadian exports. In the early 1920s, approximately 40 per cent of Canada's exports went to each country. Britain's share of Canadian exports continuously declined throughout the 1920s to become the second most important market by 1929. This decline did not diminish its overall importance as a destination. In 1929, one-third of Canada's exports went to Britain, only slightly behind the US share of 37 per cent. (All export data taken from the Canada Yearbook.)

38. Romer (1993) cites statistics on the change in industrial production across different countries that support this observation. In 1993, the US experienced the largest fall in industrial production while Britain's was comparatively minor. The US also experienced the most extreme peak to trough change while again Britain's was comparatively minor. Finally, in 1933, the US recorded the strongest recovery with Britain, by the same measure, lagging somewhat.

39. I obtain figures for the average Canadian tariff rate from the *Canada Yearbook*. It also provides data on the annual value of exports to Britain and the US.

Chapter 2: The Dominion Steel and Coal Company and the Government's Wartime Control of the Iron and Steel Industry, 1939-1945

2.1 Introduction

The increasing capital intensity of warfare generated by technological advances following the end of the First World War meant that a sufficient supply of steel in both quantity and types was critical to successfully implementing a government's strategic plan for victory. Steel was an essential input into the manufacture of all types of munitions: cargo and naval ships, tanks and armoured vehicles, guns and ammunition. However, it was also an essential input into the production of many consumer and capital goods and structures (as structural steel). The very existence of the Dominion government's strategic plan for victory threw these two uses in conflict with one another. Steel could either be used in one sector or another, not both. This conflict did not present the need for government control of the industry so long as Canadian domestic capacity and imports were sufficient to supply the demands of both the civilian and war sector. The war's limited nature until the spring and summer of 1940, marking the acceleration of the Canadian war effort, created little need for government control beyond an informal request for producers to hold the line on prices. Thus, for the war's initial ten months, the 'Big Three' Canadian primary iron and steel firms, the Dominion Steel and Coal Company (Dosco), Algoma and the Steel Company of Canada (Stelco) enjoyed freedom from the rigid controls that came to characterize the wartime economy.

The impetus for government control followed on the heels of the allied evacuation of Dunkirk. The task of re-equipping of Britain's army and preparing other allied forces for a much larger war effort than originally expected placed the Canadian industry squarely at the forefront of

nation's war effort. Government control became vital as planners expected any excess capacity remaining in the Canadian industry to quickly disappear and would confront them with the basic economic problem of scarcity. Steel could enter the production of either consumer goods or munitions but not both. Construction of war plant and equipment and increased capital goods demand only served to create additional demand further compounding the problem. The increased demand for steel products of all types also confronted the government with the problem of how to plan the industry's expansion, especially when imports could not supply excess domestic demand. American companies were the source for the primary industry's capital goods and US dollars were becoming increasingly scarce. Plant expansion also required other resources that, once committed to the primary industry's expansion, could not be used to develop increased industrial capacity elsewhere. Moreover, there was the problem that developing new plant might create post-war excess capacity.

To deal with these problems, the Dominion government, under the authority of the War Measures Act, established Steel Control in June 1940 as an agency of the Department of Munitions and Supply and invested it with the powers to "conserve, coordinate and regulate the steel resources of Canada" (De N. Kennedy 1950, 209).[40] Under the direction of C. D. Howe, the Minister responsible for the Department, Steel Control gave the Dominion government almost complete control over Canadian steel makers. The Department's munition contracts, restrictions on civilian consumption and other controls dictated the pattern of steel production. If the government met with resistance, Steel Control had the powers to direct production at the level of the individual firm. Firms could no longer determine the products they produced, how they produced them, or the price for which they sold. Investment also fell under government control.

Firms could not initiate plant expansion without government approval. Even profits fell under government control to avoid perceptions of profiteering. Never before had the Dominion government attempted to command and control an industry at so detailed a level. Nevertheless, the government's strategic plan for victory, coupled with changing strategic conditions during the spring and summer of 1940, now required direct control despite its lack of experience at such matters. Given the government's obvious inexperience with controls aimed at replacing the market and its incentives, the inevitable questions arises of how successful was its wartime direction of the industry?

The hubristic environment following the allied victory prevented a contemporary critical analysis of the government's efforts at control, let alone a serious inquiry about the issue of success. De N. Kennedy's account certainly considers the efforts of Steel Control and the Department a success. After all, government control of the industry helped win the war! Kilbourn (1960) also considers the government's planning and control efforts a success but his employment by Stelco to write the history on which he bases his judgement compromises his objectivity. These 'booster' accounts judge success largely based on Steel Control's ability to overcome steel shortages, maximize production witnessed by aggregate production figures and plan investment accordingly. However, they both provide little insight into how the Department actually arrived at its decisions and whether economic factors like prices and production costs mattered. On the other hand, the realist accounts like McDowall (1984) and Forbes (1986) provide a glimpse that all was not well within the wartime industry. On the basis of the Department's and Steel Control's own investigations, he attacks Dosco, which was apparently on the verge of financial collapse, for its poor wartime performance. A costly, inefficient producer,

only government subsidies and the exigencies of war production allowed the company to remain in operation. C. D. Howe even directed steel control officials to use the company as little as possible, expressing an open preference for purchasing supplies from the US. However, this does not alter McDowall's conclusion, reached through the perspective of Algoma's owner, that government control of the industry was successful since he faults Dosco's management for its problems, not government control. Forbes takes an opposite stance with respect to the government's wartime performance and directly criticizes the Department's treatment Dosco. Its absolute control over new plant investment allowed the Department to discriminate against Dosco in favour of its Ontario counterparts, Algoma and Stelco, based on the preferences of the planners. In turn, this reflected the political gains the governing Liberal party could reap from developing Central Canadian industry ahead that of other regions. Only after a production crisis emerged would the government direct funds for new plant towards the Dosco. In the process, Canadian war production suffered. The apparent dominance of political factors in the Dominion government's strategic synthesis and decision-making process means the government's success at control must be qualified or at least downgraded. McDowall, however, notes the Dominion government's desperate wish to avoid wartime plant expansion that would lead to excess capacity once the war ended–an economic consideration. He also identifies a ministerial directive based on economic factors. Hence, government discrimination against Dosco may be more apparent than real. The Department's investment and production decisions may instead reflect the existence and dominance of rational planning criteria based economic factors, like production costs, in the government's strategic synthesis and plan governing its direction of the industry.

Lost in the discussion is what the true definition of success should be. The particular

conjunction of facts that: 1) Canada emerged from the war as a victor and 2) steel production rose during the war, is not enough to substantiate claims of successful government control. Success, it is argued in the introduction, depends on how well the government achieved its own strategic aims and what it wanted to achieve through its strategic plan. This first requires the researcher to identify clearly what the government's strategic aims were. This identification then simplifies the task of discerning whether political or economic factors dominated the strategic synthesis and decisions made to achieve these aims. McDowall identifies one of the government's aims concerning wartime plant expansion–the government's desire to avoid the development of post-war excess capacity. This aim also indicates that economic factors dominated the Department's decisions. Forbes, however, provides evidence that political factors dominated the Department's investment and production decisions based on the strategic aim of developing Central Canadian industry first. Without resolving this conflict, which requires a search for other strategic aims, the question of success will remain open to debate.

Fortunately, the same company McDowall criticizes also provides the perfect opportunity to investigate the very issue of success and establish the importance of economic factors. Although there is scant information on Steel Control and its operations within the National Archives of Canada's holdings of the Department's records, one file that is present concerns Steel Control's investment and production decisions regarding Dosco. This file combined with the Beaton Institute's (located in Sydney, Cape Breton) holdings of the company's records prior to 1967, which include wartime monthly cost and production records, internal reports and correspondence with the Department and Steel Control makes it possible to further investigate the issue of success. By doing so, it is possible to discern what the government's other strategic aims

regarding the industry were and determine that economic factors dominated the Department's decisions.

Section 2.2 provides a more thorough introduction to these issues surrounding the government's wartime control of the industry with a literature review. It surveys what is currently known about the governments wartime control of the industry and highlights the issues that motivate this essay. Section 2.3.1 reports and discusses Dosco's official wartime profit figures, figures which show the company turning a profit in each year of the war. It also reveals how these profits were more apparent than real. Company records show that its steel plant incurred operating losses that were well in excess of its reported profits. These losses occurred as war contracts redirected the plant's sales towards the price controlled domestic market and profitable exports of iron ore to Germany ceased. Section 2.3.2 details the variety of subventions the government paid to the company throughout the war to effect the reported profit figures and ensure the steel plant's continued operation.

Section 2.3.3 presents a stylized model to explain the plant's losses and details the government's attempts to minimize them. Under the Dominion government's price controls, the plant fell victim to the 'squeeze', where rising input prices reduced or eliminated a firm's profit margin. The government attempted to minimize the company's losses and its own liability for covering them through a price adjustment that would curtail production at the plant. Dosco frustrated the government's efforts by locating other work for its operations. The Department allowed the plant's operations to continue uninterrupted and displays that government control was neither complete nor did it wish to exert its full powers of control.

Section 2.3.4 supplies the evidence that rising input prices were the source of the squeeze. Pig iron was the plant's primary input into steel ingot production used to produce the plant's final output. Monthly data from company records show the intimate connection between pig iron production costs and the costs of its three material inputs: coke, ore and limestone. As the price of these three inputs, especially iron ore, soared, the plant's pig iron production costs increased dramatically. Section 2.3.5 examines the two factors behind the rising price of the company's ore and limestone inputs: their location and German U-boats. Drawing its limestone and iron ore from Newfoundland sources, their water transport across the Cabot Strait to Sydney, Cape Breton exposed ships to the continual threat of a U-boat attack, increasing costs. In the fall of 1942, two separate U-boat attacks occurred in the harbour adjacent to the company's ore mines. To ensure the continued operation of Dosco's furnaces in 1943, Dosco and Steel Control developed an alternative local ore supply. The alternative supply, Bathurst ore (so called because it was mined in Bathurst county, New Brunswick) utilised throughout 1943, featured the secure overland route between the mine and the blast furnace sought by the company and Steel Control. It allowed pig iron production to continue uninterrupted but proved a costly source and raised the price of the plant's primary input into steel production further helping to contribute to the squeeze.

Section 2.3.6 initiates a quantitative exploration of the production problems posed by the steel plant's material inputs. By calculating the charge, or the amount of coke, ore and limestone required to produce one ton of pig iron, I show how Dosco's use of Bathurst ore, in combination with Wabana, reduced the yield of its blast furnaces and led to higher slag production compared to the company's normal practice of using Wabana only. In other words, to produce one ton of

pig iron, the company had to charge more coke, ore and limestone than its normal practice dictated, raising production costs. I also show how the Mesabi or Lake ores available to Stelco and Algoma occasioned both lower slag production and higher yields than Dosco. These results stem from Bathurst ore's lower iron content and both Wabana and Bathurst ore's highly siliceous nature relative to that used by Stelco and Algoma. Hence, these figures provide a ready explanation for the perception of Dosco's lower productivity among Canadian steel firms. Dosco's iron ore was less productive than that used by Central Canadian firms. Bathurst ore only made matters worse.

Section 2.3.7 adapts the stochastic frontier production function methodology to assess the impact that deteriorating material input quality and increased labour turnover had on the plant's blast furnace productivity. Charge calculations cannot capture a number of additional problems the use of siliceous ores pose to efficient blast furnace operation. The company also had to cope with increased labour turnover during the war, another potential source for negative effects on operating efficiency. The econometric results show that declining material input quality has a negative effect on furnace efficiency. Surprisingly, the results also suggest that increased labour turnover helped improve furnace efficiency. A series of simulations confirms the impact declining material input quality during the war had on the plant's blast furnace efficiency. It contributed to rising inefficiency at one furnace and erased the productivity gains that would have occurred at the other. These results show that, given their source, the production plant's declining productivity and operating losses were largely beyond the company's and/or government's ability to control. Section 2.3.8 provides a summary of the essay's first section.

Section 2.4 addresses the issue of the industry's wartime expansion. Based on the government's concern to avoid creating post-war excess capacity, Dosco's steel plate mill provides the perfect case study of the rational planning principles behind the Department's investment decisions. Section 2.4.1 outlines the plate mill's origin. Dosco had a steel plate mill in its possession dating from the Dominion government's attempt towards the end of the First World War to establish a domestic source of steel plate. Shut down by the company in 1920 due to a lack of market demand for its product, it lay in a state of disuse for the next two decades. Although the war appeared to provide the company with the perfect excuse to rehabilitate the mill at government expense, the government would not fund its redevelopment unless sufficient disposition could be found for its product.

Section 2.4.2 details the development of two opportunities that could have led to the mill's rehabilitation. Based on Britain's interest in contracting tank production to Canada, the Department initiated an engineering study in June 1940 to ascertain the mill's potential for rolling armour plate. Later that fall, a government delegation that toured Dosco's Sydney steel plant recommended its rehabilitation to produce steel plate for the domestic shipbuilding programme. In the first case, British plans for armoured vehicle manufacture in Canada evaporated in the fall. The failure to find a sufficient market for the mill's potential output of ship's plate ended the second scheme. Insufficient demand for the mill's product meant that it would continue to remain in mothballs.

Armed with the results of the engineering study, Dosco created its own proposal for rehabilitating the mill based on its perceptions of the country's need for steel plate. Section 2.4.3

discusses the company's preparation of its proposal and the eventual rejection by the Department. Based on the production forecasts of late 1940, Stelco's new plate mill provided the Canadian war programme with sufficient capacity for its steel plate needs This decision did not reflect a government bias in its allocation of wartime investment. It was the result of the Department's calculated decision to avoid the development of what would have only been excess capacity in the industry, not just in wartime but peacetime as well.

Section 2.4.4 looks at how events in spring of 1941 undermined the wisdom of the Department's earlier decision not to rehabilitate the mill. Higher than expected shipping losses and the consequent revisions to the Canadian shipbuilding programme increased the Department's requirements of steel plate to the point where imports could not fill the gap between supply by Stelco's mill and domestic demand. Thus, only when sufficient domestic demand existed would the government proceed with an investment in new capacity, avoiding unnecessary expenditure and reflecting an economic basis for its decision. Sections 2.4.5 discusses the project's financial terms which gave the government half-ownership and part control of Dosco's mill.

The mill proved a financial disaster for the company. Section 2.4.6 reveals how the company's errors in estimating the mill's production costs led to a negotiated price with the Department that failed to cover the mill's actual costs. Although the ultimate reasons for this error are unknown, losses on the mill's operation quickly mounted. Once known to the Department, however, these losses prompted Steel Control's efforts to shut down the mill reflecting economic motives behind its production decisions. As discussed in Section 2.3.3, these efforts met with a degree of success. With the mill's unprofitable operation and the company's

overall financial position, it could not meet its obligations to repay the government under the terms of the capital assistance contract. Consequently, ownership of the mill reverted to government hands. Thus, the mill's post-war fate, the subject of Section 2.4.7, was entirely for the government to decide. The Department of Reconstruction and Supply eventually sold the mill and its equipment in accordance with the principle to avoid. Section 2.4.8 summarises the second part of the essay and Section 2.5 is the conclusion.

On the basis of the research presented below, this essay argues that the government's wartime control of the industry was indeed successful based on how well it achieved its strategic aims. This essay also argues that economic factors dominated the Dominion government's strategic synthesis that dictated its strategic plan governing control of the primary iron and steel industry. One strategic aim identified below was its desire to undertake the war effort and initiate the industry's output expansion in an efficient manner at the lowest possible cost. To do so, it attempted to replicate the market mechanisms Steel Control replaced and allocate production in a least cost manner. Once the Department's and Steel Control's planners were aware of steel plate production cost differentials between Canadian steel producers, it could rank producers based on their production costs and proceeded to allocate production accordingly. As the producer with the highest production costs, Steel Control placed Dosco at the bottom of the list and so it received the least production. This reflected the government's attempt to curtail Dosco's steel production and reduce its operating losses. By doing so, the government would reduce its own liability for covering them and free resources for use elsewhere.

Another strategic aim examined below was government's desire to avoid the development

of post-war excess capacity that wartime plant expansion might create. This again reflects the dominance of economic factors in the Department's strategic synthesis. By investing in projects only when absolutely necessary, the government helped minimize the creation of potential post-war excess capacity. It also helped the government to attain its strategic aim of cost minimization by avoiding extraneous investment. Even when conditions made investment in Dosco's mill necessary, it only allocated sufficient funds to equip the mill for its immediate task of producing ship's plate. Once the war was over, it was readily apparent the mill's existence represented excess capacity. In accordance with its strategic aim, the government shut the mill down and disposed of the equipment. Hence, in its role as planner for the post-war period and with respect to the steel plate capacity of the industry, the government achieved this aim.

The existence of these strategic aims explains the government's treatment of Dosco. As a high cost producer of steel plate and other products, Dosco would receive the least amount of war work. Its operating losses meant the government would attempt to curtail its operation to minimize costs. When the government finally rehabilitated the mill, it only provided sufficient funds to equip it with the capacity to produce steel plate. Dosco's mill was also a stand-alone unit and had no other obvious, immediate use except for the production of steel plate. Economic and not political factors dictated the government's treatment of the company.

The price and productivity of Dosco's material inputs placed a constraint on how well the government could achieve its aim to minimize costs. They also lead to the conclusion that Dosco cannot be wholly faulted for its financial performance during the war. The rise in material input costs that eliminated Dosco's profit margins were largely beyond Dosco's and the government's

capacity to control. Steel production had to be maintained and the threatened disruption in the supply of iron ore required the use of an expensive substitute, one that was also less efficient for pig iron production. Therefore, while the government's subsidization of Dosco may appear contrary to its aim of cost minimization, it reflected the existence of another strategic aim: to maintain and maximize steel production. This aim took temporary precedence over the cost minimization one. However, it is clear that the Department made a consistent effort in its production decisions to always achieve the dominant aim and in this respect, it was quite successful.

Together, these strategic aims outlined above and the Dominion government's efforts to achieve them were consistent with an effort to achieve Milward's true strategic aim of outproducing the enemy. Canada's iron and steel industry was minuscule compared to that of the Axis and other Allied countries. It could never hope to outproduce them on its own so it would have to participate in a much larger effort and maximize the output of its own primary iron and steel industry. The government strove for economic efficiency in its allocation of production, the best way in which it could maximize the industry's output and that of the Canadian war effort. German U-boats and troubles with Dosco's material inputs may have made the government's task a more difficult one but the nature of these constraints, it performed its task as planner very well.

Section 2.2 Literature review

Wartime production figures for the primary industry's two basic outputs, pig iron and steel ingots, provide the traditional evidence previous researchers use to declare the government's

wartime control of the industry a success. Over the 1942-1945 period, pig iron production averaged around 1.7 million tons per year, double its 1939 figure of 846 thousand tons and that of the previous two years. Steel ingot production averaged 2.7 million tons between 1942 and 1945, up from 1.9 million tons in 1939 and 1.3 million tons in 1938. (All production figures are obtained from the Dominion Bureau of Statistics *Production of Iron and Steel in Canada, Monthly Report*.) The mere fact these production figures coincided with a period of direct government control, coupled with Canada's role as a victor, apparently show the Dominion government's ability to successfully direct the industry and overall war effort.

Accounts judging the success of government control on this basis fall into the "booster" category. De N. Kennedy's account of Steel Control in the Department's official history certainly considers the government's control efforts successful. Produced shortly after the war, it draws heavily on the preliminary history Steel Control's staff prepared in 1943, so an objective, critical account can hardly be expected.[41] They are primarily self-congratulatory narratives describing wartime plant expansions, the surmounting of steel shortages and are very complimentary to those in industry and government. Unfortunately, both sources provide little insight into the specifics of production problems, how they were overcome and what operational rationale Steel Control and the Department used in planning production. However, they do indicate the presence of economic factors that influenced the Department's investment decisions. Stating there was little time for the dubious experiments establishing plant far removed from the existing base of the 'Big Three' firms entailed, the Department and Steel Control made their investment decisions based on which projects could produce the greatest amount of steel in the shortest possible time for the lowest possible cost, provided the company was a reliable producer (Steel Control, 75). Neither

source, however, provides an example of how the Department employed these criteria in its decisions.

Company histories provide one potentially objective source to investigate the Department's decisions and evaluate its work. Unfortunately, Kilbourn's (1960) chapter on Stelco's wartime experience in *The Elements Combined* falls into the above booster category. Commissioned by Stelco to write a company history, it is not surprising that Kilbourn relates a happy account of the Department's wartime production and investment controls. It provides anecdotes, a lengthy description of the scrap steel shortage and praises Stelco's success at production scheduling. However, Kilbourn provides no indication of how the Department, Steel Control, or Stelco actually made their production and investment decisions or whether economic or political factors played a role in these decisions. The success of government control rests largely on Canada's emergence as a victor.

McDowall's history of Algoma and its owners is far more useful. As a "realist" account, it provides a more thorough and critical investigation of the Department's activities and the wartime industry. Viewed from the perspective of Sir James Dunn, Algoma's owner, McDowall considers the government's wartime control of the industry a success. Dunn openly expressed a preference for Steel Control to continue its regulation of the industry after the war and 'as far into the future as I can see' (McDowall, 210). In contrast to the booster accounts McDowall also provides a glimpse that all was not well within the wartime industry. In particular, Dosco caused the government a considerable amount of trouble and performed poorly enough to spark several investigations into its operations. Drawing on a 1944 investigation, performed by T. F. Rahilly,

Algoma's former general manager, McDowall paints a very unflattering portrait of the company, comparing it to the performance of Algoma,

> Whereas Dunn and Algoma seized every opportunity thrown up by the 'steel crisis', Dosco's lethargic response to wartime incentives irritated Howe to such a point that he unofficially directed Steel Control to 'use that company to the minimum extent possible even if we have to buy the steel in the United States'. A subsequent departmental inquiry concluded that the Dosco plant as a whole reflects a degree of disorganization, suffered from 'bad' costs, and was in danger of collapse without government aid. (McDowall, 200)

Unfortunately, McDowall does not delve further into the company's history to provide examples of its lethargic responses or a definition of 'bad' costs. Presumably, the term 'bad' costs refers to the company's costs of production that were sufficiently high to encourage the Department to seek out alternative steel supplies in the US. This action suggests that economic factors–steel prices and production costs mattered to the government and that the Department and Steel Control used an economic rationale to plan production. Furthermore, the source of Dosco's troubles was not government control. McDowall implicitly faults Dosco's management for its lethargic responses and poor wartime performance, although one is still left to speculate about the precise nature and source of its 'bad' costs. What were they? Does 'bad costs' have a specific economic meaning? How could a company whose output was a vital input into war production be in danger of collapse? Despite Dosco's important position in Canadian history as the country's first industrial conglomerate, there has yet to be written a history of its operations that could shed further light on these issues.

Drawing on much the same source material as McDowall, Forbes finds considerable fault with government's wartime direction of the industry. Writing within the context of regional wartime economic development, Forbes bases his conclusions on the investment and production

decisions the Department made regarding Maritime firms. Dosco's steel plant, Forbes observes, received the least amount of new plant and equipment under the government's capital assistance programme that funded the industry's wartime expansion. The apparent discrimination against Dosco was symptomatic of a larger systemic bias within the Dominion government favoring industry in Central Canada, especially Ontario. This bias resulted from the government's master plan to effect a closer integration of Canadian industry with its US counterpart:

> The government's policies regarding coal, steel, shipbuilding, ship repair and general manufacturing industries in the Maritimes formed a consistent pattern. For more than a year into the war C. D. Howe and his controllers withheld government funds for the modernization and expansion of Maritime industries while labour was drawn to Ontario and Quebec or into the armed forces. ... [They] often appeared to be following an agenda for industrialisation based on their perception of the Canada's needs after the war. Their vision of a centralised manufacturing complex closely integrated with the United States apparently did not include the Maritimes in any significant role. (Forbes, 4)

Forbes cites a number of examples in the coal, iron and steel and shipbuilding industry where the government chose to invest in Central Canadian firms over their Maritime counterparts. With respect to Dosco's steel plant, Forbes cites examples from Rahilly's report where he found productivity differences in favour of Algoma resulting from the installation of new government funded plant and equipment. Since investment fell under strict government control and supervision, its intervention and not company management made Dosco's steel plant less efficient (Forbes, 22). Forbes also examines the government's decisions regarding the rehabilitation of Dosco's steel plate mill. Mothballed since the end of the First World War, the Department initially passed it over in favour of a mill under construction at Stelco. Forbes considers the Department's rejection of Dosco's proposals to place the mill back into production as a prime example of the government's discrimination towards Maritime firms. Only when a shortage of plate became critical did the government proceed with the mill's rehabilitation. For Forbes, these

decisions meant that production suffered and government control was not as successful as the booster accounts or McDowall would have one believe.

Forbes argument may have some merit. Replacing the market with a planning agency and market incentives with controls introduces the potential for a planner's preferences to dictate the allocation of investment and production. This is especially true if politicians and business executives themselves become the planners; political factors could easily dominate the decision-making process. For Forbes, the Department's favouring of industry in Central Canada reflected the potential political gains the Liberal Party could capture, the placation of the Montreal metropolis whose industries fell under government control and, especially in the case of the primary iron and steel industry, Howe's personal friendship with Sir James Dunn. In short, political factors dominated the Department's investment and production decisions.

McDowall agrees with Forbes claim that the Department's production and investment decisions governing the industry's expansion reflected the Minister's own preferences (and those of Algoma's owner, Sir James Dunn). However, it was for an entirely different set of reasons:

> Howe believed that Canadian steel should build up a well-rounded basic capacity and specialize only in those areas for which there was sufficient demand to warrant efficient and profitable production. What Canada could not undertake should be left to foreign producers, whose imports could be balanced by exports of Canadian surplus production or raw materials. For both men this entailed the thoroughgoing orientation of the Canadian steel economy towards mutual dependency on American iron and steel. (McDowall, 194)

Read properly, McDowall states that the Department's planning rationale for the industry's wartime expansion was to avoid investment in plant and equipment that, while proving profitable to operate during the war, would only result in excess capacity at the end. When domestic

wartime shortages made investment in new capacity unavoidable, Steel Control's official history claims that it and the Department judged the merit of individual projects on the basis of which producer could produce the greatest amount of steel in the shortest possible time at the lowest cost. The consequence of this policy, Steel Control and De N. Kennedy conclude, is that it concentrated activity in centres with existing capacity since additional equipment most often balanced out and fully utilised the producer's existing plant (De N. Kennedy, 226). However, they provide no specific examples to validate this claim and conclusion. Consequently, there appears to be two competing positions on the dominant factor behind the Department's decisions based on conflicting evidence about the government's strategic aims. One states the government's strategic aim was to concentrate industry in Central Canada based on political considerations. The alternative view states that economic factors governed the Department's decisions and shaped a strategic aim concerning expansion. Which of these two positions more accurately reflect the dominant factor and strategic aims of the government? How did Dosco fare in the government's investment and production decisions as a result? Do other factors explain the decisions the Department made?

Both McDowall and Forbes are selective in the evidence they use from Rahilly's report and the Department's investigations into Dosco's steel plant. For example, McDowall's use of Rahilly's observation that, "The plant as a whole reflects a degree of disorganization."[42], is only one small statement in a report that focused primarily on the production problems and cost disadvantage posed by the plant's material inputs, especially the coke and iron ore, used for iron and steel manufacture.[43] Contrary to the impression McDowall creates, Rahilly found Dosco's department superintendents to be of average or above average quality. Noting the plant's

unsatisfactory labour situation, with chronic absenteeism and frequent work stoppages disrupting production, Rahilly does not even apportion any significant blame to company management, noting that previous acts of government intervention have place the company in its current position.[44] Forbes and McDowall also pay little attention to the findings of Steel Control's second investigation in 1944 its financial advisor (F. H. Brown) performed. Concerned with explaining to the minister Dosco's high production costs relative to Algoma, this report also failed to fault the steel plant's management for Dosco's financial troubles: "In my judgement the operating officials at Sydney, in particular Anson, the General Manager, are throughly competent, experienced and completely devoted to the success of the business and its operation at low cost."[45] Brown devoted a large portion of his report to quantifying what effects the plant's material input quality had on its production costs and what effects the government's wartime price controls had on the company's financial position. Absolution of company and plant management continued in an engineering consultant's study the Department commissioned which expressed "admiration for the ability shown in coping with the most difficult raw materials in use in any large steel plant on the American continent."[46] While Forbes briefly mentions Dosco's usage of low grade ore, he does not explore the consequences.

The impact of the Maritime region's resource base on the productivity and profitability of its iron and steel industry is not an uncommon theme in the literature on regional economic development. Even Nova Scotia's provincial government was aware of the deleterious effects of Dosco's material inputs on its productivity and costs. A wartime provincial economic commission, the Dawson Report (Nova Scotia 1944) identifies quality of Dosco's iron ore and coke and the resulting costs of production as a significant impediment to the company's financial

performance and future. Inwood (1992, 50) notes the Londonderry ironworks suffered from both ore supply and quality problems leading to bankruptcy in 1910. In a comparative study over the 1890-1920 period, Inwood (1986) identifies the price and productivity of the coke and ore used by the Nova Scotia Steel and Coal Company (NSSC) as a fundamental handicap for the firm vis-à-vis its central Canadian counterpart Stelco. He argues that NSSC's profit margins were lower than that of Stelco's and probably failed to cover capital costs (Inwood 1986, 268). One source for NSSC's lower margins was its higher raw material costs for iron ore and coke. Inwood also argues that the quality of NSSC's raw materials were inferior to that of Stelco's: its iron ore from the Wabana ore fields of Bell Island, Newfoundland featured a high silica content and the coal used for coke was not an ideal metallurgical coke due to is chemical composition and physical strength (Inwood 1986, 272-279). The inferior quality of NSSC's iron ore and coke meant lower productivity, higher production costs and reduced margins. Wabana ore featured a higher silica content than the American ore Stelco used. This higher silica content required more flux than Stelco's ore to smelt, raising fuel requirements and helped to increase costs.

Frank (1977) details the merger of NSSC in 1920 with other Nova Scotian steel firms that created the British Empire Steel Company (Besco) and its eventual failure. The company's debt structure imposed fixed costs that Besco could not cover and the company floundered throughout its short existence between 1920 and 1928. Dosco emerged from the reorganization that followed to inherit all of NSSC's assets including its sources for the raw materials used in steel production. Obviously, Dosco also inherited the consequences of using these material inputs. This raises the obvious, unexplored question of whether or not Dosco's material input quality can explain the 'bad costs' to which McDowall referred. If so, what was the precise nature of the

impact of Dosco's material inputs on its wartime operations? Did it reduced the wartime profitability of the firm? How did the Department cope with this problem?

Prim and McCarthy (1995) note how Dosco experienced further problems concerning the supply of its material inputs on account of the war. They detail the events of two separate U-boat attacks in the fall of 1942 on the anchorage and loading piers adjacent to Dosco's ore mines on Bell Island, Newfoundland. On the morning of September 5 1942, the German U-boat U-513 sunk two iron ore carriers at the anchorage (Prim and McCarthy, 106-107). This attack, followed by another in November that sank one carrier and damaged a loading pier (Prim and McCarthy, 108-110), prompted Dosco and Steel Control to seek out and develop an alternative ore supply to ensure the continued operation of Dosco's furnaces through 1943. Although De N Kennedy's history of the Department and Steel Control's draft account mention this event, neither source fully explores the consequences of its use. Forbes does mention the threat U-boats posed to Dosco's supply lines but incorrectly states that Dosco never used its alternative supply (Forbes, 24). Government reports reveal this alternative supply, Bathurst ore, to feature a higher silica content than that of Wabana (New Brunswick 1951, 14-16). Dosco's production and costs must surely have suffered as a result but how much? Can this event help explain McDowall's 'bad costs' and the company's financial troubles? Were there any other economic effects from the German U-boats presence?

Booster accounts cannot provide an adequate understanding of the principles at work guiding the Department's wartime production and investment decisions. Nor can they provide an adequate judgement of the government's success at control of the industry. Canada could have

just as easily emerged as a defeated party. Although there is some suggestion that economic factors mattered, the lack of examples and the rather imprecise criteria they specify do not make it apparent what motivation the Department followed in its decision-making. The realist accounts are more critical of the government and industry but there is no consensus whether or not government control was successful. Nor do they provide conclusive evidence on whether economic or political factors dominated the government's strategic synthesis. For Forbes, government control was not successful since it treated firms unequally across regions. What could possibly constitute an equitable basis for treatment? How much capital assistance each company received from the government? If so, it would always be possible to detect the presence of discrimination based on the researcher's perceived needs of the company. From Forbes' viewpoint the government's war effort could have been more successful had the company received more government money.

Success can only be judged on the basis of how well the government achieved its own strategic aims. One aim that emerges in this essay is how the government attempted to minimize the economic costs of the war effort through its allocation of production. Another is the desire to minimize plant expansion and avoid the possible development of post-war excess capacity. Maximizing steel production at times is a third. In keeping with these aims, the government shuffled production among Canadian steel firms in a least cost manner, avoided investing in projects until absolutely necessary, subsidized Dosco's operation and disposed of Dosco's plate mill after the war. These actions reflect the dominance of economic factors such as efficiency, costs and prices in the government's strategic synthesis.

It is also clear that in order to gain a full understanding of wartime problems and decisions, one must also examine the resource constraints under which firms in the primary industry had to operate. Dosco did lose money on account of the war effort and required government subsidies to remain in operation. However, this reflected the temporary dominance of the government's strategic aim to maximize steel production which temporarily overrode its aim of minimizing costs. This meant Dosco had to use Bathurst ore and incur the consequences. In turn, this constraint in the choice of material inputs and the resulting losses were largely beyond the capacity of the company and government to control. The government could enact preventative measures against German U-boats but it could not stop their actions and consequences outright. However, by striving to meet both these aims of minimizing the costs and maximizing production, the Dominion government also sought to achieve the correct strategic aim of outproducing the enemy. Therefore, government control of the industry was very successful.

2.3 Government Controls and Dosco's Production

2.3.1 Dosco's Wartime Profits and Losses

Dosco's production problems gained the attention of Department officials through the operating losses the company experienced on its steel plant. Such losses seem puzzling at first given Dosco's net reported profit figures in Table 2.1. Those for Algoma and Stelco are shown for comparison. Apparently, the wartime economy provided the Canadian primary iron and steel firms with a profitable experience. That profits did not exceed their 1937 or 1938 levels testifies to the effectiveness of the Dominion government's Excess Profits Tax (EPT). The EPT's structure limited a firm's wartime profits to some "normal" peacetime level, consistent with that

obtained over the immediate prewar period.[47] The EPT not only raised substantial revenue, it, more importantly, helped avoid a repeat of the Canadian public perceptions of profiteering that occurred during the First World War. In reality, however, the EPT was hardly necessary to limit Algoma's and Dosco's wartime profit levels. Government subsidies provided both companies, and especially Dosco, with the necessary revenue to report the profits listed in Table 2.1.

In reality, Dosco's Sydney steel plant suffered heavy financial losses for most of the war. Profitable in 1939 and 1940, figures in Table 2.2 reveal that Sydney's financial losses quickly mounted during the next two years and peaked in 1943. Comparison of this pattern with figures in Table 2.3 shows the correlation between the Sydney plant's financial results and the distribution of its steel sales. In the late 1930s, domestic sales averaged about a fifth of total sales volume whereas export sales, consisting of rolled products to Britain and steel rails throughout the Commonwealth, accounted for almost half. The Dominion government's munitions programme disrupted Dosco's peacetime pattern of sales. Government controls and the wartime loss of foreign markets reduced export volumes and redirected sales to the domestic market, demonstrated by the rising volume of domestic and inter-company sales. The plant's operating losses peaked in 1943 when 90 per cent of the plant's output went to domestic and inter-company sales and export sales fell to only 3 per cent of total sales volume. Operating losses fell dramatically during the last two years of the war with the decline in domestic and inter-company sales and the resumption of the company's profitable export sales.[48] Meagre profits on coke and ore sales could not offset the large losses experienced on steel sales.[49]

2.3.2 Operating Assistance Paid to the Company

To provide the appearance of profitability and maintain production at the plant, the Dominion government provided various subventions to Dosco, consisting of three types of payments listed in Table 2.4. The first was a "Coal Bonus," received by the company since 1930 for Cape Breton coal converted into coke for use at Sydney.[50] The annual value of this payment peaked in 1942 at 170 per cent of its 1939 level. To compensate Dosco for rising transportation costs due to war risk insurance and other factors discussed below, the government provided a transportation subvention for costs in excess of their pre-war levels. Annual payments, listed in Table 2.4, peaked in 1943 at $3.8 million, over twice the 1941 value and almost four times the 1945 level. Despite their combined value, these two payments proved insufficient to cover the plant's operating losses and so starting in 1943, the government provided a third subvention to allow the company to secure a profit level consistent with its pre-war levels. The value of this subsidy in 1943 amounted to $5.8 million, declining to $1.9 million by 1945. In total, the Dominion government paid Dosco $25.2 million in wartime subventions. Including capital assistance to fund plant expansion raises this total of the government's wartime financial assistance paid to Dosco to $29.3 million whereas the company's total reported profits were $7.4 million.

2.3.3 Wartime Price Controls, the Squeeze and Government Controls

How did such a situation arise? Dosco fell victim to the squeeze, a phenomenon of the Dominion government's wartime price control measures.[51] Beginning in September 1939, the Dominion government's various price control schemes simply froze the retail prices of the company's products.[52] In many instances, these prices were at levels set by Dosco, Algoma and Stelco in July 1938. However, with the exception of wage control policies starting in December

1941, the Dominion government made no attempt to control input prices despite their expected inflation. In the wake of a frozen retail price, such inflation would squeeze profit margins or eliminate them altogether. The Department and Steel Control defended this method in the case of the primary iron and steel industry by arguing "that by maximum production, overhead was being spread out over a greater volume of sales" (Steel Control, 73). Obviously from the figures in Table 2.2, increased production did not offset the increased operating costs incurred by Dosco. Figure 2.1 presents a stylized depiction of Dosco's problem. The company's average cost curve for 1939, AC, is drawn, with the small domestic market and short production run, it produces at point A with average costs AC_{1939}, below its minimum efficient scale. Production at this point is still profitable since average costs are below the unit selling price. Wartime inflation of input prices would shift Dosco's average cost upwards to AC' with the potential to squeeze the company's profit margins given the fixed market price. However, the government expected increased production would lower average costs to AC_{1941} thus avoiding a squeeze on profits. Point B reflects this situation and shows an increase in company profits. From above, we know that any scale economies at the Sydney plant were insufficient to offset the actual increases in input prices, reflected by the position of the curve AC''. The resulting average costs of production, AC'_{1941}, for a firm producing at point C were well above the market price resulting in the observed losses. The average cost curve, AC', pertains more to the experience of Stelco and, to a lesser extent, Algoma. Dosco's rising material input prices coupled with the redirection of the company's sales a price-controlled domestic market meant that operating losses were inevitable.

Government price controls applied to the entire range of products produced by the

primary industry even though the bulk of its output consisted of semi-finished steel forms–rods, bars, billets, sheets and plates serving as material inputs into the production of both civilian goods and munitions. In a strict sense, these semi-finished products were not retail goods but government controllers classified them as component materials so they fell under established price controls. The price ceilings on steel products helped reinforce those on all retail civilian goods where they served as a material input. Munitions, however, did not fall under established price controls and their manufacture occurred under cost-plus contracts guaranteed to cover the costs of production, whatever they were, and provide a small per-unit profit. Hence, input prices could reflect the true costs of production. After investigating the Sydney plant's operations in 1944, the Department estimated that approximately half of its output went to the civilian sector and the other half to the munitions sector.[53] Steel Control's financial advisor admitted there was little possibility for upward price adjustments on Sydney's products destined for the production of civilian goods since they would run counter to established price ceilings.[54] In this instance, the government would subsidize the producer through the Wartime Prices and Trade Board or the Commodity Price Stabilization Corporation. Although Steel Control recognized that semi-finished steel forms entering the production of munitions fell under established ceilings based on a strict interpretation of the regulations, it was willing to allow upwards adjustments, even for a high cost producer like Sydney, where it could be shown they entered munitions production. In fact, the Department's financial advisor, F. H. Brown, preferred price increases to a direct subsidy.[55] This led to the Department's and Steel Control's attempt to control Sydney's operation through a price adjustment.

Price adjustments on steel products entering munitions production provided one method

where the government, through Steel Control could direct, or at least attempt to direct, production by the domestic steel makers. Dosco's plate mill, which the government rehabilitated to meet the wartime demand for steel plate used in the construction of ship's hulls, provides the best example. The mill operated at a substantial loss during 1942 and 1943. Wartime Shipbuilding Limited, the government's Crown Corporation formed to construct merchant ships, was the sole purchaser of the mill's product. Although the price received by Dosco for its steel plate over these two years is unknown, correspondence between Wartime Shipbuilding Limited and the Department quotes a price of $57.37 per ton for the first-half of 1944.[56] In actual practice, however, this price did not represent a break-even figure. Errors in the company's estimates of the mill's operating costs, discussed in Section 2.4.6, meant that losses on the mill's operation quickly mounted. Based on the break-even price for the first six months of 1944 of $68.31 per ton versus the $57.37 the company actually received, Steel Control estimated that Dosco lost $400 000 on the plate mill's operation in the first eight months of 1944 alone .[57] If the company's estimates of the mill's operating costs had proved realistic, this price would have represented a profit of $5 per ton.[58]

To remedy the situation, in August 1944 the Department raised the price of Dosco's steel plate to $75 per ton on new and existing orders. Since this was a product which the Department could clearly identify as entering war production, this increase did not run counter to the government's price controls. To cover the mill's operating losses in the first eight months of 1944, The Department forced a retroactive price increase on Wartime Shipbuilding, raising it to the break even level of $68.31 per ton. In response, Wartime Shipbuilding promptly cancelled all existing orders for the company's steel plate since it could obtain the same product for

substantially lower prices from Dofasco or Stelco at $50 and $51 per ton, respectively.[59] (Steel Control priced Stelco's plate rolled from Algoma steel slightly higher at $56 per ton due to transport costs and Algoma's higher ingot cost.[60]) Purchasing steel plate from either Central Canadian company yielded substantial savings for Wartime Shipbuilding and relieved the Department from covering the mill's operating losses.

Both Steel Control and the Department expected Wartime Shipbuilding's cancellation of its orders to lead to the curtailment of operations in Dosco's No. 1 open hearth department, a set of ten 50 ton open hearth furnaces dating from the plant's original construction in 1900.[61] Table 2.12 shows the operation of these small furnaces entailed higher labour and heating costs than those found in the company's newer No. 2 open hearth department. Dosco intended their replacement during the 1940s but the war, coupled with the time constraints on the construction of new furnaces and the urgent demands of domestic munitions production, necessitated their continued operation. Noting that the cost of steel ingot, for all practical purposes, established the profit or loss in the operation of a steel plant, Steel Control's investigations during August 1944 identified the company's operation of the No. 1 open hearth department operation as a significant contributing factor to the steel plant's losses, estimating that its operation added $1.1 million per year to the company's annual loss.[62] Furthermore, Steel Control's investigation estimated a ingot cost differential between Dosco and Central Canadian firms ranging from $20 to $25 per ton. Curtailing the department's operation would effect considerable savings to the Dominion government by reducing the company's required subsidy. These findings and the Department's experience with the company's plate mill led Howe to issue an unofficial directive that the Department should endeavour "to use this company to the minimum extent possible even if we

have to buy steel in the US."[63] Steel Control's financial advisor later qualified Howe's statement, attaching the proviso that he was unaware that actual US price greatly exceeded that of Dosco's.[64] However, what mattered was that supplies were available more cheaply from other Canadian firms. The net effect of the directive was to place Dosco at the bottom of the list for the remainder of the war when allocating war orders for steel products, including steel plates, among Canadian steel firms.

Dosco managed to thwart the Department's and Steel Control's designs for the company by procuring other work. The mill continued to roll plate past the expected October 1944 closure date for an unknown customer, while the ill-famed open hearth department produced steel ingot for a British order of blooms and billets.[65] The plate mill briefly resumed production for Wartime Shipbuilding between February and August 1945. With the plate mills at Dofasco and Stelco operating at capacity, the Department had no choice but to turn to Dosco and pay the higher cost. With the end of the war and no further orders, the mill, whose fate Section 2.4.7 explores, ceased production.

The example of steel plate production suffices to show that, contingent upon the knowledge of production costs, the Department and Steel Control allocated production among the Canadian steel makers in a least cost fashion. With this cost-based hierarchy, the Department and Steel Control moved down a list of firms as production consumed the capacity of the cheapest producing firm, Stelco, towards the most expensive producer, Dosco, and eventually the US, as witnessed by the situation in the winter of 1945. Only when capacity constraints became binding at Stelco and Dofsaco did the Department turn to Dosco. Presumably, this finding

extends to the production of other steel products. This finding shows that economic factors did matter in the government's production decisions. Costs of production governed allocation among Canadian producers and decisions about whether or not it was desirable to let Dosco's No. 1 open hearth department remain in production. Hence, the government wished to minimize the economic costs associated with the industry's output expansion the war effort occassioned. But government control of the industry was not complete. Rather than force the closure of Dosco's open hearth operations and curtail its steel production directly, Steel Control chose an indirect method to direct production. Dosco's successful attempts at maintaining production shows the absence of complete government control and total submersion of market mechanisms.

2.3.4 Dosco's Material Inputs

The above analysis suggests that we look to the behaviour of input prices to explain Dosco's difficulties. What particular product should receive attention? Steel Control's investigations into Dosco's Sydney plant found costs of steel ingot production significantly higher than at the Central Canadian firms. There were also significant differences in the proportion and costs of the raw materials charged to the open hearth furnaces for steel ingot manufacture. A limited local scrap steel supply meant Dosco had to use pig iron as its primary raw material for steel production. As a consequence, pig iron production costs largely determined steel ingot production costs.[66] To find the most important source of variations in the company's steel ingot production costs, one must then examine the behaviour of pig iron production costs. Figure 2.3 shows the evolution of pig iron's per ton production cost over the course of the war. Also shown are the per ton labour and material input costs which establishes the intimate connection between material input and output costs. Labour forms only a relatively small proportion of pig iron

production costs. Figure 2.2 examines the prices of the three principal material inputs: coke, ore, and limestone over the course of the war. Dosco experienced significant inflation with respect to each one. The price of iron ore, which averaged $2.68 per ton over the January 1939 to April 1940 period, rose sharply thereafter and peaked in January 1943 at $13.35 per ton. Its price fell through 1943 and averaged $5 per ton for the remainder of the war, almost double its prewar figure. While the price of coke experienced a comparatively minor increase of approximately 20 per cent between 1939 and 1945, limestone doubled in price by 1945.

2.3.5 Sources of the Material Input Price Inflation

This pattern of material input price behaviour resulted from the location of Dosco's ore mines, its limestone quarry, and the German U-boat presence in the North Atlantic. Iron ore for the company's blast furnaces came from the Wabana ore field on Bell Island, Newfoundland. Dosco quarried its limestone at Prot-au-Port, Newfoundland. Transportation of both materials across the Cabot Strait exposed shipping to threat of U-boat attacks and war risk insurance raised shipping costs significantly. Related to the U-boat threat, the Dominion government stationed troops in February 1941 on Bell Island for the duration of the war and charged Dosco for the cost of their provisions. In spite of their presence, the German U-boat U-513 sank two ore carriers on the morning of September 5 1942, at the Wabana anchorage adjacent to Bell Island (Prim and McCarthy, 106-107). Another attack followed in November that sank one and damaged a loading pier. Dosco had to cover the pier's entire repair cost. Labour costs at its ore mines and limestone quarry rose significantly as the Newfoundland government simply imitated wage increases mandated by the Canadian War Labour Board throughout the War.[67] Other wartime events that contributed to increased ore costs included the replacement by 1942 of Dosco's peacetime ore

carrier fleet, consisting of two full-time and one part-time carriers, with thirteen small, slow ships as the company's regular fleet was commandeered for use elsewhere. These smaller ore carriers meant slower unloading rates, higher labour costs and increased unloading and stocking expenses at Sydney which entered the ore's production costs.[68]

The U-boat attack on the Wabana anchorage and the company's loading piers touched off an important series of events. The continual threat of U-boat attacks and the company's inadequate wartime ore-carrier fleet meant uncertainty over whether it would have a sufficient supply of ore to feed the Sydney plant's blast furnaces. Bell island's ore mines were the lone source of iron ore for Dosco's blast furnaces that comprised one-third of Canada's wartime pig iron production capacity. To ensure the continued supply of pig iron through 1943, Dosco and the government sought to develop another source of ore within the region. An ore body located in Bathurst county, New Brunswick represented the only alternative supply within the Atlantic region.[69] Shipments of Bathurst ore to Sydney started in January 1943 and lasted for twelve months. Bathurst ore proved costly to extract because it required the rehabilitation and laying of new railway track. Moreover, the Bathurst ore mines required the purchase and erection of all the necessary plant and equipment since it was last worked in the 1910s and was long since abandoned as a profitable venture. These shipments explain the dramatic rise in ore prices experienced by Dosco and provide an explanation for the plant's dismal financial performance during 1943, the year in which it experienced its largest operating loss. The high production cost of pig iron in 1943 led to higher steel ingot costs which meant higher costs for the plant's finished and semi-finished steel products. As the U-boat activity lessened through 1943, normal supplies of Wabana ore resumed, the price of iron ore fell and pig iron production costs declined

accordingly.

The above explains the divergence in pig iron production costs between Dosco and the Central Canadian firms observed during the war. Using Algoma for comparison's sake and focussing on pig iron, Table 2.5 shows that Dosco's pig iron production cost in 1939 of $14.18 per ton was less than Algoma's $17.28 per ton. Table 2.5 also shows that Dosco's coke, ore and limestone price increases between 1939 and 1941 helped eliminate this differential. Algoma's coke, ore and limestone originated from American sources and their transportation across the Great Lakes spared Algoma (and Stelco) any U-boat threat. The comparatively high cost of shipping across the Cabot Strait is evident as Wabana ore and limestone costs increased by 80 per cent and 65 per cent respectively.[70] By 1941, these factors pushed Dosco's production cost to $18.38 per ton, almost equal to Algoma's $18.50 per ton.[71] As the problems outlined above developed, Dosco's per ton production costs rose to $22.90 per ton while Algoma's fell slightly to $17.63 per ton. Over the next two years, rising costs at Algoma and a slight decrease at Dosco roughly restored the prewar competitive positions of the two firms with respect to pig iron production.

These events help to explain the poor wartime financial performance of Dosco's Sydney plant but the issue of efficiency remains to be addressed. Following the plant's large operating losses in 1943, Steel Control's investigations into Sydney discovered the impact of material input quality on costs and efficiency at the plant. They revealed that Wabana ore was not an ideal ore for the manufacture of pig iron due to its high silica content. Bathurst ore, the substitute used to augment Dosco's supplies during 1943, was even more siliceous in nature and its use explains the

decline in blast furnace efficiency experienced by the company.

2.3.6 Production Problems Posed by Bathurst Ore Use

Why does an ore's silica content matter for blast furnace efficiency? A blast furnace reduces iron ore to elemental iron and separates it from the gangue. The gangue consists of silica, SiO_2; alumina, Al_2O_3; lime, CaO; phosphorous as P_2O_5; sulphur as SO_2; and other trace compounds. The reduction process occurs when carbon, either by itself or as carbon monoxide, CO, supplied by the oxidation of coke enters into contact with the ore. The hot air blast speeds the rate of reaction and reduces the amount of coke required to produce a ton of pig iron. Limestone provides a flux that fuses with the gangue and other impurities to produce slag. The heat supplied by the combustion of the coke melts the elemental iron and the slag which floats upon the iron and the furnace is tapped at regular intervals to draw off the molten slag and pig iron separately. Ores with a high silica and/or alumina content produce more slag and requires more limestone to flux the impurities. This, in turn, requires more coke to provide the heat to melt the iron and produce the molten slag.[72] Large volumes of slag production pose several problems for the efficient operation of a blast furnace. Once the furnace is blown in, production is a continuous process of charging the materials and tapping the slag and iron at regular intervals. Where slag volumes are high, furnaces are more prone to several difficulties that stop production.[73]

The content analysis figures in Table 2.6 show that Wabana ore featured a relatively high silica content. The Lake ores from the Mesabi ore range available to Stelco and Algoma display a much lower silica content. Brazilian ore, a high grade ore Dosco used in its open hearth furnaces

before the war also weighs in as a low silica ore. Unfortunately for Dosco, Bathurst ore was even more siliceous than Wabana and its iron content was slightly lower. The immediate consequence of this fact was that the average productivity of Bathurst ore, measured by its iron content, was lower than Wabana. However, the silica content also has an impact on the productivity of the blast furnace and is an important determinant of the quality of the ore.

To demonstrate this two-fold effect of a lower iron content and a higher silica content. I calculate the charge required to manufacture a ton of basic pig iron at Sydney based on select combinations of the above listed ores. The results in Table 2.7 show that a charge using only Wabana ore produces a yield of 36 per cent while a 75/25 mixture of Bathurst and Wabana ore reduces the yield by 3 per cent. A hypothetical example, based on a charge using 100 per cent Lake Superior ore and reflective of the normal operating practice at Stelco or Algoma, estimates the yield at 39 per cent while use of Brazilian ore in the same 75/25 mixture yields 41 per cent iron. More importantly, estimated slag production varies significantly with the silica content of the ore(s) entering the furnace. Slag production from a Wabana+Bathurst charge is almost twice that created by the use of Lake ores. Even a Wabana-only charge results in substantially more slag production per ton of iron. Actual figures from Dosco and Algoma in the last two rows confirm not only the robustness of my calculations but also the existence of a comparative advantage conferred upon users of the Lake ores. The slightly higher yield for Algoma is also due to its superior coke quality.

These figures provide a further explanation as to the inevitability of the operating losses Dosco experienced on its steel plant. Faced with an input whose relative price is rising, the firm

should choose to substitute cheaper inputs for the more expensive factor of production. This factor substitution maintains the allocative efficiency of the firm where all factors of production are paid the value of their marginal product. In the case of pig iron production, however, there exists a technical relationship among the material inputs required to manufacture a ton of pig iron. It is not possible to substitute coke, labour or capital for iron ore if the price of iron ore is rising, especially in the short run. Rising material input prices produce an inevitable rise in production costs for the firm unless technological change or some other substitution possibility exists. In this case, if the resulting average cost of production is greater than the market price, then the rational course of action for the firm is to shut down. Yet, the essential need for steel during the war resulted in Dosco's subsidized operation.

By the 1940s pig iron production had developed into a highly capital intensive process but labour was still an important determinant of furnace operating efficiency and productivity. Bertin, Bresnahan and Raff (1996) identify three main functions for workers once a furnace entered production: process control, tending the capital, and materials handling. Reduced efficiency on the part of labour at any one of these three tasks impairs overall furnace efficiency. Both operator experience and the proper coordination of unskilled labour involved in tapping the furnace, also gained through experience, are important for the smooth operation of the furnace and fundamental for efficient production. Hence, increased labour turnover bringing in new, inexperienced workers will be detrimental to efficiency unless the replacement workers are better trained or qualified than those leaving and so compensate for these effects. Figures in Table 2.8 reveal that as employment grew from slightly over 4000 in the summer of 1939 to 6000 individuals by mid-1943, turnover rose from 8 per cent to 42 per cent of the workforce. Turnover

doubled between 1941 and 1942 alone. Although never responsible for the majority of workers leaving, turnover due to military enlistments, call-ups or reinstatements is still significant. In 1942, the military claimed 42 per cent of turnover and at least one-third during 1941 and 1943.

These charge calculations and turnover rates demonstrate the potential for reduced labour and resource efficiency to affect Dosco's blast furnace efficiency. To establish a definite connection we require a means to measure inefficiency or declining productivity on account of these factors. The stochastic frontier methodology allows the explicit measurement of inefficiency and with an appropriate extension I define below, assesses the impact of labour and material inputs on furnace efficiency. This allows us to determine the behaviour of the Dosco's blast furnace inefficiency and the relative importance of factors governing its behaviour.

2.3.7 Econometric Analysis of Dosco's Production Problems

2.3.7.1 The Model

Of the two types of inefficiency, technical and allocative, the former is clearly of interest to the present problem.[74] The exact technical relationships among the three principal material inputs described above means the allocative inefficiency of the company is not at issue. What is at issue is the effects of changing material input quality on the firm when production must continue. Technical inefficiency defined in the present setting is simply the distance by which actual output falls short of the frontier; it represents a firm's inability to convert the greatest amount of input to output. Random events beyond the firm's control, such as equipment failure or luck, adds a stochastic element to the actual placement of the frontier. The stochastic frontier production function, developed by Aigner et al (1977) and others, incorporates a firm's own inefficiency and

purely random events into an estimable production function represented as:

$$y = \alpha + X'\beta + v - u \tag{2.1}$$

where a single output, y, is produced with a vector of inputs, X. Inefficiency is represented by a one sided error term, -u, so that output lies on or below the frontier, defined by inputs and technology. The symmetric error term, v, represents the random events that make the actual placement of the frontier stochastic in nature.

Application of (2.1) to time series or panel data involves a very restrictive assumption on the behaviour of inefficiency over time. In the context of cross-sectional data, the original formulation of the stochastic frontier model, inefficiency varies across only firms:

$$y_i = \alpha + x_i\beta + \epsilon_i \quad \text{for i} = 1,....,N \tag{2.2}$$

where $\epsilon_i=v_i-u_i$, To implement (2.2), one specifies a particular distribution for u_i[75] and derives observation specific estimates of u_i representing inefficiency based on the results of Jondrow et al (1982). With panel data (2.2) is written as: :

$$y_{it} = \alpha + X'_{it}\beta + v_i - u_i \text{ for i} = 1,....N, \text{ t} = 1,....,T$$

where all variables are as defined above. Such a specification assumes that inefficiency is invariant with respect to time. The economic implication is that firms have little or no ability to respond to inefficiency over time as it is purely a random event. Applying the productivity interpretation of Cornwell et al (1990) to u_{it}, implies that a firm experiences no systematic productivity growth. Obviously, as t increases, this assumption is increasingly untenable.

Cornwell et al. (1990) relax the assumption of time-invariance by imposing an explicit structure on u_{it} that allows it to vary across time and firms. As an extension of the fixed effects

framework, they model u_{it} as a quadratic function of time:

$$u_{it} = \theta_{i1} + \theta_{i2}t + \theta_{i3}t^2. \qquad (2.3)$$

This parameterisation produces a measure of u_{it} variable across time and firms. The term θ_{i1} captures the conventional fixed effect producing unit-specific intercepts. The last two terms of (3) allow for the time variance of inefficiency across firms and a simple F-test on the coefficients θ_{i2} and θ_{i3} determines the validity of this assumption.

This specification, however, tells us little about what effects other variables thought to influence inefficiency might have; only the passage of time and a fixed effect explain its behaviour. The omission of a relevant variable in (2.3) would produce biased estimates of θ_{i2} and θ_{i3} that, in turn, bias estimates of u_{it}. In our case, the discussion above indicates strong reason to expect variations in blast furnace efficiency based on material input quality and labour turnover. Thus, I modify equation (2.3) to incorporate a variable reflecting resource quality and labour turnover.

Incorporating this measure of quality, labour turnover and the specification of time-variant inefficiency into (2.3), I now write the model in (2.2) as:

$$y_{it} = \sum_{i=1}^{N} \theta_{i1} D_i + \sum_{i=1}^{N} \theta_{i2} D_i t + \sum_{i=1}^{N} \theta_{i3} D_i t^2 + \sum_{i=1}^{N} \gamma_{i1} D_i q_{it} + \sum_{i=1}^{N} \gamma_{i2} D_i \, turnover_t + X'_{it}\beta + v_{it} \qquad (2.4)$$

where i indexes the blast furnace, the subscript t represents the month, D_i is the dummy variable for each furnace, y_{it} represents pig iron output in gross tons, t represents a linear time trend variable, X_{it} is a vector of inputs and v_{it} is the symmetric disturbance term. Capital, labour and raw materials form the three inputs into the production function. The variable, q_{it}, represents a

measure of raw material quality which I define as the amount of limestone required to produce a ton of pig iron. Why choose this as the particular quality variable? The particular problem with Bathurst ore was its excessive silica content requiring a high limestone input to flux the impurities creating large amounts of slag in the process. As the ore quality deteriorates, producing a ton of pig iron requires successively larger amounts of limestone. The natural logs of these variables are used in the equation. The variable turnover measures the total number of removals from the payroll at Sydney as a percentage of total employment.

It is important to note that the main goal of estimating (2.4) is measuring u_{it} by estimating its three parameters, θ_{i1}, θ_{i2}, θ_{i3}. Returns to scale, substitution elasticities, and technological change are all of secondary importance to obtaining a measure of inefficiency. Concern over the production function's specification also assumes a less important role relative to modelling inefficiency. Based on Hekman's (1978) study of the westward movement in the location of the American iron and steel industry, I use a Cobb-Douglas production function.[76] In his study, Hekman initially specified and estimated a translog cost function to model industry supply. Subsequent F-tests on the estimated equation suggested that a Cobb-Douglas production function was the appropriate dual.[77] Therefore, I use the Cobb-Douglas specification and focus on the matter of estimating u_{it} which is of primary interest.

2.3.7.2 The Data

I derive the data for the estimation of (2.4) from monthly production and cost statements produced by Dosco's accounting department detailing expenditure on inputs. Total monthly

labour costs deflated by the Dominion Bureau of Statistics producer price index for pig iron measures the real labour input. Since the basic producing unit, the blast furnace, and associated equipment (blowing engines and power plant for instance) represent durable inputs that are not consumed over the course of the period under study, it is appropriate to measure the capital input in a user cost manner: the sum of depreciation, repair expenditures and a measure of the opportunity cost of capital. Broek et al. (1980) and Kumbhakar and Hjalmarsson (1993) use this approach to examine the technical efficiency of the Swedish dairy industry and Swedish dairy farms, respectively. More recently, Diewert and Nakamura (1999) use this same approach in examining best-practice efficiency among electric generating companies. Dosco's accounting figures record the monthly depreciation and repair expenditures for each furnace but not interest charges. Given the problems of identifying an appropriate rate of interest to measure the opportunity cost of capital during the war, I use only the sum of monthly depreciation and repair expenditure by each furnace to measure the capital input. The consequences of this omission are likely to be small since capital inputs were small relative to the other inputs entering production.[78] The total quantity of coke, limestone and ore charged to the furnace represents the material input. The monthly records also state the ore, coke and limestone required for each ton of pig produced which provides information for the quality variable.

Measures of labour turnover are available on an annual basis only and at the aggregate plant level. Obviously, such figures in the present setting serve as a proxy for the true measure. Turnover rates within the blast furnace department that are similar to plant level rates will reduce any deleterious effects of this assumption. Higher turnover rates are expected to have a negative effect on productivity. A low turnover rate would leave an experienced workforce in place and

obviate the need to train and coordinate new workers with respect to furnace operating practice.

The physical differences between Sydney's blast furnaces in terms of size and age provides sufficient grounds for the existence of heterogeneity within the plant. To reflect this, I do not estimate a plant level production function and instead opt for constructing a panel data set since I have production data on each of the blast furnaces. Construction of a balanced panel covering the entire 1939-45 period is impossible given the production schedule occasioned by wartime events. Only one of Dosco's three original furnaces, furnace No. 1, remained in use throughout the War.[79] Furnace No. 8, blown in on April 1939, produced iron continuously until November 1943. Furnace No. 7 started production in December 1939 and remained in blast until January 1943. Limitation of Bathurst ore use to 1943 dictates construction of a panel consisting of furnaces 1 and 8 covering the April 1939 to November 1943 period. Although it does not include a period following the use of Bathurst ore, panel observations prior to its use establishes Dosco's inefficiency with respect to normal practice. The panel may appear small in terms of the number of producing units but these two furnaces represented approximately 20 per cent of Canadian pig iron capacity. Concerning the issue of heterogeneity, No. 1 was larger and newer than No. 8; they were not identical to one another.

2.3.7.3 Results

Table 2.9 reports OLS estimates of the full model specified in (2.4). Variations on the model in (2.4) examine the sensitivity of parameter estimates to variations in the specification of u_{it}. Each model displays a high degree of fit to the data with R^2 values that exceed 0.95. Omitting the quality, turnover and the time variables only serves to reduce the fit. In each regression, all

input coefficients are positive and statistically significant and do not vary with different specifications. Table 2.10 reports F-statistics for the following series of hypothesis tests: 1) constant returns to scale, 2) the existence of inefficiency at each furnace, 3) time variant inefficiency at each furnace and 4) a joint test of significance on the quality and turnover variables for each furnace. The test for constant returns to scale fails to accept the null at the level α=.05. Returns to scale appear small as the three input coefficients sum only to 1.1 on the full model, a figure constant across differing specifications of u_{it}. This complements Hekman's finding of constant returns to scale for American steel production over the 1921-72 period. Bertin, Bresnahan and Raff find significant short-run increasing returns to *labour* with respect to American blast furnaces during the 1930s due to short production runs. Short runs spread out indivisible labour inputs connected with a furnace's startup or shutdown over fewer units of output.[80] Unlike the 1930s, Dosco's blast furnaces operated continuously at full capacity during the war, limiting the scope for any such returns to scale. The remaining tests concern specification of the inefficiency term. A joint test of significance on all inefficiency parameters rejects the null, indicating that some form of inefficiency existed at both blast furnaces. To examine its precise nature, within the confines of the model, I test for time-variant inefficiency and find it exists only for furnace No.1. Furnace No. 8 displays no systematic variation in inefficiency over time, even if the specification of u_{it} omits the quality variable as column two of Table 2.9 reveals. However, omitting the quality variable obscures the effect of time on inefficiency as only the quadratic term is statistically significant. The first regression in Table 2.9 assumes inefficiency as a conventional fixed effect. It is both statistically significant and similar across both furnaces.

The quality variable emerges with the predicted negative slope coefficient that is

statistically significant for both furnaces. As the amount of limestone required to produce a ton of pig iron increases, the negative coefficient implies a decrease in u_{it} raising inefficiency. The labour resource variable is estimated to have a positive and statistically significant slope coefficient implying that higher turnover rates actually improve efficiency. At first this result appears puzzling but there are several plausible explanations for it. The high labour turnover rate may have had a cleansing effect on the quality of the workforce. That is, less productive workers left on their own account for less strenuous opportunities elsewhere, left the labour force altogether or entered military service. If the high turnover rate was due to industrial-related illness, then new employees would be healthier and more productive. Employment offices established in 1940 and 1941 under the Unemployment Insurance Act of 1940 helped to create a more efficient matching process between a worker's qualifications and the employer's need (Department of Reconstruction and Supply 1947, ch. 2). The Dominion government also provided relocation assistance to workers increasing labour mobility and increased the potential pool of qualified labour available to employers (Department of Reconstruction and Supply, ch.2) Finally, the Directorate of National Selective Service organized in 1942 gave the Department of Labour almost complete control over the allocation of labour among employers (Department of Reconstruction and Supply, ch.2). Such control would allow the direction of only the best workers to employers. While this finding is nonetheless intriguing, it is not essential to the results and remains a topic for future research.

2.3.7.4 Predicted and Simulated Productivity

The goal of this exercise is to show the behaviour of inefficiency during the first four years of the war and what effects, if any, Bathurst ore and labour turnover had on furnace efficiency.

To do so, I perform the following simulation. Using parameter estimates from the full model, an estimate of u_{it}, representing inefficiency for each observation, is given by,

$$u_{it} = \theta_{i1} + \theta_{i2}t + \theta_{i3}t^2 + \gamma_{i1}lnstone_{it} + \gamma_{i2}turnover_t \qquad (2.5)$$

where i indexes the blast furnace. The average value of *lnstone* prior to January 1943 reflects limestone requirements under normal practice when Dosco's furnaces used only Wabana ore. Fixing the value of *lnstone* to this average while leaving the other variables free to vary produces a simulated series of u_{it} reflecting furnace inefficiency in 1943 if regular supplies of Wabana ore had been available. A second simulation fixes the value of *lnstone* at its pre-1943 average and the labour turnover at its 1939 level to create a series that assumes the war never happened.

Figures 2.4 and 2.5 plot the estimated and simulated absolute values of u_{it} for this base case. The estimated series obtained from actual data reveals the most inefficient observations occurring in 1943 for both furnaces. In the case of furnace No. 1, after experiencing a marginal decline, inefficiency would have risen anyway even if Wabana ore use had continued. Furnace No. 8 displays only a slight rise in efficiency during this period relative to its estimated values. However, these graphs alone cannot attribute the effects of Bathurst ore use on wartime furnace inefficiency since labour turnover is assumed constant at its 1939 level.

To isolate the effect of the decline in material input quality, I allow labour turnover to assume its actual values while fixing that of *lnstone*. Although high labour turnover rates help reduce inefficiency at both furnaces, the simulations depicted in Figures 2.6 and 2.7 reveal a fundamental difference in its pattern between the two furnaces. Simulated inefficiency now falls through time at furnace No. 8 while furnace No. 1 continues to display an unmistakable rise

starting sometime in 1941. It is readily apparent that Dosco's use of Bathurst ore made a bad situation worse for furnace No. 1 by further raising inefficiency. More significant is the impact of its use on the operation of furnace No. 8, where inefficiency would have actually declined with rising labour turnover. Given the exogenous nature of the U-boat threat that necessitated its use, the decline in furnace efficiency was beyond Dosco's capacity to control.

2.3.8 Summary of Findings of Part One

The first part of this essay provided a close examination of Dosco's wartime experience with government price controls, material input supply problems and their impact on the plant's productive capacity. Despite the company's reported profit figures, the company experienced large operating losses on its steel plant and required government subsidies to remain in production. This resulted from the combination of wartime price controls, rising material input costs and the re-direction of the company's output for sale on the domestic market. These factors together squeezed and eliminated the company's profit margin. The government, however, acted to curtail Dosco's operations once the peak of demand passed following 1943 in an attempt to minimize the company's losses and costs associated the plant's production. The Department and Steel Control engineered a price adjustment on steel plate to reallocate production among Canadian firms on a least cost basis. This helped the government minimize the economic costs of the war effort. This desire to minimize economic costs emerges as one of the government's strategic aims.

The company's rising material input costs and the use of a high cost alternative ore in 1943 resulted from a combination of factors. German U-boats effectively threatened to disrupt a

sufficient supply of iron ore from reaching Dosco's blast furnaces at Sydney. Stelco and Algoma, with the security of their Great Lakes transportation routes for their material inputs, avoided these problems plaguing Dosco. More expensive and less productive than Wabana ore, the substitute Bathurst ore raised the company's production costs of pig iron and reduced its productivity. However, given the Canadian war programme's need for steel and government controls, the company had but little choice to use it and incur the consequences. Therefore, maximizing steel production emerges as the government's second strategic aim. Why else would the government have subsidized Dosco's operations to the extent it did given the other strategic aim to minimize the costs associated with the war effort? Subsidizing Dosco to ensure production continued at its steel plant must have been necessary. This fact also shows that for a time at least, maximizing steel production was the government's dominant aim. As a result, the government would cover the company's losses originating from its use and those incurred on account of where its iron ore and limestone were located.

2.4 Dosco's Wartime Plant Expansion: The Plate Mill

The second part of the essay is concerned with an investigation into the rehabilitation of Dosco's plate mill. As an example of industrial development on account of the war effort, the mill provides an opportunity to investigate the principles Steel Control and the Department used to make their decisions and how they interacted with producers. I will show that the rehabilitation of Dosco's plate mill corresponded to the accurate perception on the part of the Department and Steel Control officials of a purely transitory increase in demand. The initial delay in approving the project did not reflect a regional bias on the part of the government's planners. Instead, this delay resulted from the simple fact that there was no need for its product. Imports of steel plate and the

expected production from Stelco's mill already under construction were considered sufficient to supply domestic requirements based on the production programme envisioned in 1940. Alterations in the Canadian naval and merchant vessel construction programme in early 1941 increasing the government's requirements and restricted imports from the US created sufficient domestic demand for steel plate to warrant the mill's rehabilitation. Steel Control and the Department considered the mill's rehabilitation an exigency; it did not factor into their post-war plans for the industry. Imports before the war were sufficient for Canadian needs and they would prove sufficient after it.

2.4.1 The Origin of Dosco's plate mill

Dosco's plate mill originated from the worldwide shortage in shipping space expected to develop following the end of the First World War. To meet the expected post-war boom in demand for shipping and help replace the shipping capacity lost through enemy action during the war, the Dominion government funded the creation and construction of a domestic merchant marine service. Described as an 'all Canadian renaissance' in shipbuilding, the government spread the construction work across several Canadian shipyards. However, Canadian shipyards had to purchase steel plate for hull construction from American sources since there was no Canadian iron and steel producer with the necessary plant and equipment to produce steel plate in sections large enough for ship construction. The Dominion government hoped that its construction programme might induce a Canadian firm to erect a plate mill but there was little incentive on the part of a Canadian firm. The US government fixed the price of ships plate, based on that paid by the United States Shipping Board, below what Canadian shipyards would pay on the open market.[81] Without some form of government assistance, therefore, the likelihood of a Canadian firm

erecting its own plate mill was low.

Recognizing the situation, the Dominion government contracted the Dominion Iron and Steel Company (Disco), one of Dosco's predecessors, on 2 April 1918 to construct and operate a plate mill producing ship's plate. The government assisted Disco with the mill's construction cost by admitting all necessary machinery to Canada duty free while the company incurred the actual construction costs.[82] The contract also provided the company with a guaranteed demand and price for the mill's product: the government agreed to purchase 250 thousand tons (gross) (254 thousand tonnes) of plate to be delivered at a rate of 50 thousand tons (gross) (51 thousand tonnes) per year at a price of $4.15 per 100lbs (45.5 kgs).[83] The mill started production on 11 February 1920 and ran for only twelve months, producing 43,613 tons (gross) (44, 311 tonnes) of ship's plate, when the government cancelled the contract for the following reasons. First, after the end of the First World War, as McCracken (1932, 156) notes, the price of imported American ship's plate declined dramatically. Although the government and Disco negotiated a reduction in the contract price to $3.65 per 100lbs (45.5 kgs), there was still a substantial differential since US plate could be purchased for $2.75 per 100lbs (45.5 kgs). Second, there was the matter of timing: Disco's plate mill started production after Canadian shipyards constructed a majority of the vessels the government ordered using imported plate. Third, the expected worldwide shortage of shipping failed to materialise. In the face of these changes, the contract remained in force with the government obliged to purchase 250 thousand tons above market prices for which no use, apparent or otherwise, existed. Disco sued the government for breach of contract and, based on an out of court settlement, recovered $4 million after legal expenses.

Both domestic and international factors combined to make the shutdown of the plate mill permanent.[84] Expectations of a post-war shortage of shipping space were instead realised as a worldwide glut that persisted during the 1920s. The resulting excess capacity worldwide meant little new vessel construction was likely on the immediate horizon, aside from the fact that ship's plate could be purchased from the US for a lesser price. The recession following the short post-war boom in Canada and the small domestic market for steel plate meant there was little domestic demand for such a specialised product so the company sought to convert the mill to roll other steel shapes. Technical reasons prevented its conversion into a slab mill.[85] A second proposal to convert it into a blooming mill in 1923 failed on account of the estimated $1 million cost, an amount which management was "not at all disposed to consider at the present time, if at all."[86] As testimony to the industry's and the company's difficulties, the mill remained in situ for the next two decades, scavenged for spare parts while machinery for the production of tie plates and mine arches were installed in its building.

2.4.2 Initial Expansion Plans

Until the summer of 1940, domestic war production placed few extraordinary demands upon Canadian primary iron and steel firms. Utilisation of existing productive capacity increased steadily through the winter and spring of 1940 but absent was the need for investment to expand existing operations or diversify product lines. Steel plate was an important input into the production of cargo or naval vessels, a vital component in any ship repair programme and, as armour plate, necessary for the production any armoured fighting vehicles. The almost complete absence in Canada of these three activities during the interwar period meant that only a few steel plate mills existed in Canada. These plate mills were often part of a much larger installation at a

steel plant designed to produce steel sheets or tin plate. Moreover, they could not fabricate steel plate into a width useful for ship construction. For example, Dofasco's mill, which produced steel sheets for eventual fabrication into tin plate, could roll plate up to 78 inches (198 cm) in width. The plate mill at the Eastern Car Company Limited, a Dosco subsidiary, produced steel plate to a maximum width of 48 inches (122 cm) used to construct rail cars. In contrast, Dosco's mothballed mill could roll plate up to 110 inches (280 cm) in width. Fortunately for the Dominion government, a plate mill under construction at Stelco in 1940 could roll steel plate up to 100 inches (254 cm) in width. Originally intended as part of a steel sheet mill, its scheduled completion by the spring of 1941 provided the Department and Steel Control with a source of domestic supply to augment imports from Britain and the US. Dosco's mill appeared extraneous to the needs of the Department and domestic war production.

The needs of the British Army presented Dosco with its first opportunity to revive the plate mill. Based on a request from the British War Office, the Department began to investigate the possibility of producing tanks in Canada, which necessitated the domestic production of armour plate. Steel Control solicited Dosco's officials in July 1940, who initiated an engineering study into the feasibility of reconditioning its plate mill for such a purpose while retaining the ability to produce ship's plate. Steel Control and Department officials were certain that a national steel shortage would occur sometime in 1941. Lacking sufficient technical expertise within Steel Control in June 1940, the Department commissioned the Arthur G. McKee Company, an American engineering consulting firm, to study the situation. (The same company also performed the study of Dosco's plate mill.) The Department asked the company to estimate civilian and war requirements of iron and steel in 1941, estimate the capacities of domestic iron and steel

producing firms, and summarize the shortages created by any difference between capacities and demands. It was also to advise the government how to remedy the shortage through investment in new capacity and the rationalization of existing production and capacity. These two studies required the remainder of 1940 to complete. The delay in the completion of the two reports left Steel Control and the Department with little information as to the productive capacity of Canadian firms. To aid in the interim, the Department formed a delegation, notable for its absence of any Steel Control representatives, which toured Dosco's maritime iron and steel plants during the first week of October 1940. The delegates, who expressed expectations of a domestic steel plate shortage by March 1941, indicated their unqualified intention to recommend the rehabilitation of the plate mill as soon as possible, despite the fact that its capacity would more than meet immediate and future demands. Upon returning to Ottawa, however, the delegation qualified its recommendation with the provision that the Department required a foreign outlet for the disposal of plate in excess of Canada's requirements in order to proceed with the rehabilitation.[87] The project had the support of Frank M. Ross (Director of Naval Supply), who noted that steel plate is required in both peace and war and that steel plate production would allow Dosco to diversify its product line.[88] Ross identified Britain as the obvious outlet for exports and the British Purchasing Mission in Ottawa dispatched a cable to London inquiring if there was interest in purchasing a "substantial tonnage of plate available for export." Although the contents of the reply are unknown, there appears to have been little interest on the part of the British for importing steel plate. This absence of a foreign demand for the mill's product hindered efforts by the company to place the mill back into production.

2.4.3 Dosco's Rehabilitation Attempts: November 1940-January 1941

Prospects for the mill's rehabilitation dimmed further during the fall of 1940 when the original plan to manufacture tanks fell victim to the fluid nature of Britain's munitions demands. By the completion date of the consultant's report on the mill's rehabilitation, the anticipated demand for armour plate had evaporated. Company officials, however, used the information in the report to formulate their own designs for the mill's rehabilitation. Working through the month of November 1940, they concocted three proposals that would provide the Sydney plant once again with the capacity to produce steel plate. By conscious design, the company omitted any reference to armour plate production in their plans:

1) Recondition the existing equipment to roll sheared plate. Cost= $2.85 million.

2) Same as (1) and add the capacity to produce universal plate.[89] Cost= $3.5 million.

3) Replace the current setup with a new universal mill using existing equipment where possible. Cost= $4.3 million.

Dosco chose to submit the second proposal to the Minister in January 1941. The Dominion government was asked to finance the entire project. Upon completion, Dosco would immediately repay $902 thousand and the cost of the structures required to house the other equipment already installed in the plate mill building, leaving the government with a 50 per cent interest in the mill. Ownership of the mill would revert to the company through an arrangement where the Dominion government could withdraw half of the depreciation charged to the mill and its profits until it had been repaid. Dosco's submission of the proposal coincided with the release of the McKee company's preliminary report into the projected Canadian steel shortage. The report recommended rehabilitation of the company's plate mill but for an entirely different set of reasons. Unlike the delegation that toured Dosco's facilities in the fall, the report did not forecast a domestic steel plate shortage during 1941. With total domestic steel plate requirements during

1941 estimated at 66,850 tons (gross) (67, 919 tonnes), the capacity of Stelco's plate mill, scheduled to begin production in April 1941, and estimated US imports were ample for Canadian needs.[90] The shipbuilding programme alone accounted for approximately two-thirds of this total, 42 thousand tons (gross) (42.6 thousand tonnes), well within the Stelco's mill estimated productive capacity of 200 thousand tons (gross) (203.2 thousand tonnes) per year.[91] Evidence of Stelco's capacity to satiate domestic demand is the fact that three shift operation of the new mill did not commence until the summer of 1941.

Why did the consultant's report recommend the plate mill's rehabilitation? First, the report found a severe imbalance between Dosco's annual melting capacity of 600 thousand tons (gross) (610 thousand tonnes) and its blooming mill capacity of only 420 thousand tons (gross) (426.7 thousand tonnes).[92] If placed back into production, the plate mill could roll ingot into semi-finished steel forms, absorbing the surplus ingots and relieving pressure on Dosco's blooming and billet mills. Second, the report expressed a general preference for exporting semi-finished steel products rather than steel ingots in order to retain the scrap generated by the rolling process. In particular, the production of steel plate generated a considerable quantity of scrap. Dosco's exports of steel ingots to Britain for further conversion accentuated the shortage facing the company and increased its reliance on pig iron as the primary input into steel production.[93] Although the report made minor mention that future imports of steel plate from the US would become increasingly uncertain as the American rearmament programme continued, this did not factor into the report's support for its rehabilitation.

Domestic demand for steel plate, however, did not appear sufficient to warrant its

rehabilitation based on the Canadian war production programme the Department envisioned in late 1940. For example, the fall 1940 version of the Canadian Corvette construction programme called for the construction of 80 ships, each requiring 700 tons (net) (770 tonnes) of steel plate. Therefore, the programme's total requirements of 56 thousand tons (net) (61.6 thousand tons) was well within Stelco's annual capacity. Planners in the Department and Steel Control did not have a potential basis, therefore, for considering its rehabilitation and considered the Stelco mill sufficient to supply not only the forecast 1941 direct Canadian war requirements but those for the remainder of the war.[94]

On this basis and not surprisingly, the Minister rejected Dosco's proposal in January 1941 on the grounds that the government was not "justified in financing further expansion of any branch of the steel industry at present."[95] Even considering the post-war possibilities for its product, there appears little grounds for its rehabilitation. Statistics on the pre-war consumption of steel plate show the direct war requirements of steel plate estimated for 1941 were approximately double the 17,037 tons (net) (18,740.7 tonnes) of plate used in 1939 (Dominion Bureau of Statistics 1939, 3) Imports from Britain and the US largely supplied domestic demands, a pattern the Department expected to continue once the war ended. With the small domestic market and uncertain export prospects, rehabilitating Dosco's plate mill would only result in substantial excess capacity in the post-war economy. Approval of such a project would run counter to the Department's guiding principle for the industry's overall wartime expansion: to meet the immediate needs of the war program and not invest in projects of a specialized nature that would result in post-war excess capacity. For the sake of comparison, Stelco's plate mill, originally designed as part of a continuous sheet mill, was a planned investment initiated before

the war; it did not intend to fabricate steel plate for the Canadian market (Steel Control, 48). However, the design of the sheet mill meant it was straightforward to convert it for the manufacture of steel plate. In keeping with the Department's plant expansion policy, Stelco's production of steel plate would last only as long as the war.

Other perceived drawbacks existed with Dosco's proposal that demonstrate Steel Control's investment criteria at work. One was the lack of sufficient electrical power at Sydney to operate the mill. The Sydney plant generated its own electrical power and in 1940 there was sufficient capacity to operate existing plant and equipment. If rehabilitated, the mill could only operate on a single shift basis by scheduling production so that it did not run simultaneously with the rail and blooming mill.[96] Installation of an additional boiler at the company's power plant would alleviate this constraint but take approximately 12 months to complete. To operate the mill on a three shift basis required installing a new generating unit that would require 20 months to complete. In contrast, Stelco had access to sufficient electrical power to operate their mill on a three shift basis. Based on Steel Control's criteria for financing new plant expansions, Dosco's proposal had both the elements of time and cost against it. The rejection reflected the operation of an economic rationale and calculations. It was not part of some Dominion government plot to deprive the Maritime primary iron and steel firm of new investment and war work based on a political rationale or the personal preferences of the Department's planners.

2.4.4 Altered War Demands and the Plate Mill's Rehabilitation

Events during the winter of 1941, soon after the Department's rejection of Dosco's proposal, provided the necessary conditions for the rehabilitation of Dosco's plate mill to

proceed. The most important factor was the substantial loss of allied ships during the Winter of 1941. In March alone, enemy action sunk 119 vessels with a gross tonnage of 489,299 tons, representing almost one-fourth the annual building capacity of the UK and over half the merchant tonnage on order in Canada and the US (De N. Kennedy, 490). In response, the British Technical Merchant Shipbuilding Mission increased its order of 10 thousand ton cargo ships placed with Canadian shipyards in December 1940 from twenty-six to eighty-eight and placed a new order for five 4700 ton cargo ships. With respect to the naval shipbuilding programme, the British Mission ordered an additional 16 corvettes and drew up a new construction programme for another 15 corvettes and 111 frigates.[97] These significant additions to the Canadian naval and merchant shipbuilding programme, caused by exogenous factors, created sufficient domestic demand for steel plate to warrant the rehabilitation of Dosco's plate mill. The impetus to place Dosco's mill back into production received further momentum from the structure of the Canadian production programme. The Department and Steel Control chose Dofasco as the Dominion's primary producer of armour plate. The slower rolling rates required to fabricate armour plate curtailed production at Dofasco's plate mill by more than half its rated output.[98] Rehabilitating Dosco's mill represented the only way of replacing the decline in domestic capacity due to the slower rolling rate and meeting the increased demand due to the revisions in the shipbuilding programme. During the first six months of 1941 it also became apparent to Steel Control that reliance on US and British imports to fulfill increasing domestic demands was increasingly untenable. Once it became apparent to Steel Control and the Department that imports could not fill the gap between domestic demand and supply, the Department authorised the mill's rehabilitation during the summer of 1941, allocating its eventual entire output to shipyards in Eastern Canada. Estimated to take 8 months to complete, there were some notable differences between the company's and

the Department's version of the project. The approved version did not include the machinery and equipment that would allow the mill to produce universal plate as the company desired, since this would have taken an estimated 15 months to complete. With the immediate need for ship's plate, this lag was too long. To ensure compliance with the Department's decision, Dosco would only receive enough funds and the authorization to order the machinery and equipment necessary to produce ship's plate. The project also included the construction of a new open hearth furnace to provide sufficient steel ingot for the mill.

2.4.5 The Government's Capital Assistance to Rehabilitate the Mill

Funded by a capital assistance contract, where the government and the company would share the project's costs, the financial terms of the project were more favourable to Dosco than those contained in its original proposal. The company would spend the first $1 million of the estimated $4.75 million cost of the project. The government advanced Dosco funds to cover the next $3 million and assumed 80 per cent of the remaining cost itself. The Dominion government's capital assistance was not a complete gift even though the company would be left with a fully operational plate mill after the war. Steel Control assessed the post-war value of the mill at one-half the project's estimated cost, $2.375 million. This amount would be repaid to the government by the company at a rate of $475 thousand per year, without interest, once the mill started production.[99] Although the project's favourable terms are perhaps indicative of the government's need for the project, bearing most of the up-front costs allowed Steel Control to dictate what form the rehabilitated plate mill would take and circumvent any designs the company had for the mill. It also allowed the government to make the minimum expenditure necessary to place the mill back into production. The trade-off was obvious but it presented Dosco with the only

opportunity to recondition its plate mill and possibly diversify its product line. Without the support or approval of Steel Control and the Department (and the guaranteed demand for the mill's product), Dosco simply could not proceed on its own. With delays due to bottlenecks at firms supplying the mill's components, production started in April 1942. Despite the company's enthusiasm for the project and guaranteed disposition for its product, the mill's proved unprofitable to operate.

2.4.6 The Mill's Operating History: 1942-1945

As a profitable wartime venture, Dosco's plate mill proved a failure. The mill operated at a loss for most of its production history as the price the Department set for its product proved insufficient to cover the average cost of production. The Department based its initial price on estimated production costs furnished by the company. In turn, Dosco established these estimates by using the mill's actual operating costs from April and May 1920 and adjusting these figures using pre-war and actual 1941 factor prices. Table 2.11 records selected estimated production cost items to compare them with actual annual operating costs over the 1942-45 period. Dosco's estimates concerning labour and material costs proved remarkably accurate. However, the mill's operating costs soon diverged from these estimates and those from its operation in 1920. What produced this divergence?

The company's main error lay with its conversion cost estimates, the difference between the material cost of the steel entering the mill and the final cost of the steel plate. From the available production records, two sources for this divergence can be identified. First, for some unknown reason Dosco erred in omitting expenditure on coke oven gas for the mill from its

original cost estimates. Based on annual figures, expenditure for this item varied from $2 to $4 per ton of plate produced. Second, Dosco underestimated the mill's administrative and repair costs. Expenditures for these two items were, on average, one-third higher than their original estimates, raising the actual cost of production. Material costs do not appear a significant factor in producing this divergence.

Once the mill's losses became evident to Steel Control and the Department, officials engineered the price increase discussed in Section 2.3.3 leading to Wartime Shipbuilding's cancellation in late 1944 of its orders placed with Dosco. The peak of Canadian war production had passed and ship repairs were the only remaining major source of demand for steel plate. In February 1945, the demand for steel plate increased temporarily and the Department had to turn to Dosco as a source of supply. Neither imports nor production from Stelco or Dofsaco could meet the demand. Steel Control, however, could not minimize the amount of work Dosco received since Dofasco's mill could not produce plate to a sufficient width. Although this situation prevented the Department from allocating Dosco the least amount of work possible, the Department still strived to minimize the costs of doing so.

To ignore the constraints the Department faced in its decision to authorize the mill's rehabilitation in 1941 would lead to the conclusion that the government should not have proceeded with the project on economic grounds. However, the sudden revision of the Canadian shipbuilding programme in the spring of that year, coupled with the uncertainty over future imports from the US left the government no choice but to proceed with the project. The company did have the incentive to underestimate the mill's production costs in order to make the

project more attractive but production costs appeared to matter little in the decision to rehabilitate the mill. Without the output from Dosco's mill, the domestic shipbuilding programme would have suffered since Stelco's mill alone could not supply the increase in domestic demand. So the government undertook the project with the bare minimum of equipment necessary to place the mill back into production. This reflected the government's primary desire to avoid the development of postwar excess capacity while conserving on capital expenditure. Once the mill's losses came to light and sufficient capacity existed elsewhere, Steel Control and the Department readily sought to transfer production elsewhere. In the end, the entire affair simply reflects the exigencies of wartime production.

2.4.7 The Plate Mill's Post-War Fate

In its role as a post-war planning agency, the Department never considered the plate mill as part of Dosco's post-war plant. Department officials considered the mill's rehabilitation as a "matter of war emergency and ceasing to be useful after the War."[100] Rahilly's investigation concluded there was "little, if any, post-war value in it.[101] The domestic consumption of ship's plate in shipbuilding and repair industry averaged one-tenth of its wartime levels for the remainder of the 1940s, displaying the transitory nature of the wartime increase in demand.

There were other potential uses for the plate mill. A provincial government study on the post-war economy, the *Report of the Royal Commission on Provincial Development and Rehabilitation*, recommended the installation of a sheet-mill at Sydney, similar to that at Stelco, where the plate mill would form an integral component. However, even if such a project was viable, the mill's fate was not Dosco's to decide. The company's operating losses during the war

left it unable to make its annual payment to the government for the mill's rehabilitation. Once it became apparent to the Department that such payments would never be forthcoming, it cancelled the company's liability in return for the mill's title of ownership.[102] This ended Dosco's direct control over and interest in its operation. For two years following August 1945, Dosco maintained the mill at the government's expense while the War Assets Corporation sold off its equipment in a piecemeal fashion. In September 1947, the Corporation purchased the remaining equipment from Dosco and sold it to a Texan steel firm. This marked the end of the plate mill's existence at Sydney.

2.4.8 Summary of Part 2

Dosco's plate mill represents a clear example how the Dominion government and its planning agencies dealt with a transitory increase in the demand for a specialised steel product. Rehabilitated and used only when necessary for the conduct of the war effort, the plate mill was quickly removed from production once its operation was discovered to be uneconomic. For some unknown reason, Dosco's management erred in their estimated cost figures so that price set by the government could not cover the resulting average cost of production. The subsidies provided to the company made any correction unnecessary and Dosco's management was probably aware of what would happen once Steel Control discovered the mill's losses. The eventual correction led to the cancellation of Wartime Shipbuilding's orders. Unable to meet the obligations of the capital assistance contract, ownership of the mill reverted to the Department who, according to the preferences established by the Minister, disposed of it following the war. Given the lack of domestic demand and the cost history of the mill, this action appeared prudent. The profitable post-war operation of the mill appeared most unlikely.

2.5 Conclusion

Booster accounts of the government's wartime control of the primary iron and steel industry obscure the issue of its success at directing the industry by their focus on Canada's role as a victor Realist accounts differ on the nature of the government's strategic aims regarding the industry and whether economic or political factors dominated the strategic synthesis. In order to judge success, there must first exist clear strategic aims that are obtainable by the government's strategic plan. By examining Dosco's wartime operations in detail, this essay identified three main aims regarding the wartime industry: 1) to minimize the economic costs associated with increasing the industry's output in account of the war effort; 2) to avoid the development of post-war excess capacity on account of wartime plant expansion; and 3) to maximize the industry's steel production. These strategic aims were part of the Dominion government's overall strategic plan to help out-produce the Axis powers.

Although the price and productivity of Dosco's material inputs imposed serious constraints on the government's ability to direct the industry at the lowest possible cost, the Dominion government still achieved these aims very well. Steel Control and the Department strove for an efficient allocation of steel plate production among Canadian firms on a least cost basis, once they knew of production cost differentials among the domestic producers. The government attempted to curtail Dosco's steel production when it was not in conflict with the third aim. The government also undertook plant expansion only when domestic shortages materialized to avoid unnecessary investment expenditure. This released government funds and resources for use elsewhere in Canadian war production. When the wartime demand for steel plate disappeared, the government removed Dosco's plate mill from production and the domestic

market. The government made a consistent set of choices in accordance with these strategic aims.

Dosco's inefficient operation and financial losses were a direct consequence of the third aim. If the Dominion government was to achieve its aim of maximizing production, then Dosco had to use a more expensive, less efficient ore when German U-boats threatened to restrict its normal supplies. This meant the government had to subsidize Dosco in order to ensure production continued. Therefore, blaming Dosco's management for its losses is difficult since production fell under government control. But it is also difficult to blame the government entirely for Dosco's losses as well. Neither party could truly control the German U-boats that were ultimately responsible for the company's increasingly inefficient operation and high costs of production. The fact that German U-boats had any impact at all on the company's operations simply reflected the location of its ore mine and limestone quarry. A low cost source for both material inputs before the war, they would prove so once again after the war.

The strategic aims uncovered here show that economic factors played a well-defined, dominant role in the Dominion government's strategic synthesis and plan governing the primary iron and steel industry. If economic factors did not dominate then the Department would have allowed Dosco's plate mill to remain in place, it would not have allocated production in a least cost manner and it would show little concern about whether or not it subsidized Dosco's operations. Considerations of excess capacity and the post-war market for steel in Canada would also have been of little concern. Therefore, the results here do not substantiate Forbes conclusion that political factors dominated the government's strategic synthesis regarding the industry, especially regarding its investment decisions. Regional balance in the expansion of the industry

was not one of the government's strategic aims.

By choosing to act in a manner consistent with cost minimization and striving to allocate resources efficiently, the government conserved on resources that could be allocated for use elsewhere within the Canadian war economy. In this fashion, the government made a consistent effort to achieve its true strategic aim of helping to outproduce the enemy. In this sense, the Dominion government's control of the industry was very successful.

One obvious question that emerges is whether the dominance of economic factors in strategic synthesis extended to other industries or was the primary iron and steel industry an important exception? The most important activity to study in this regard is munitions production. This sector flourished briefly in Canada on account of the war and disappeared quickly after. Given that government planners knew the increase in munitions demand would only last for the duration of the war, did economic factors still matter? If not, what other factors prevailed? What were the government's strategic aims in this area? How can they explain the observed patterns of munitions production? The next essay addresses these questions directly and shows that the dominance of economic considerations extended to that of munitions production proper.

Appendix: Calculating the Burden Requirements

To illustrate the general method of determining the amount of coke, ore and limestone required to produce a ton of pig iron, this appendix details the calculations used to report the figures in the first row of Table 2.7. Adjusting the iron ore composition used below to reflect those of the different types listed in Table 2.6 yields the figures in the remaining rows. Calculating the burden involves the determination of three quantities: 1) the amount of ore required based on the pig iron's desired iron content, 2) the amount of coke required to reduce the ore, and 3) the amount of limestone required to flux the impurities and produce slag. This last step is slightly more involved since both the coke and limestone themselves contain impurities that must be removed from the furnace. Table A2.1 records the composition of the coke, ore and limestone used in the calculations below.

Table A2.1.–Content analysis of coke, ore and limestone

Wabana Ore	Percentage content	Limestone	Percentage content	Coke	Percentage content
Fe (Iron)	53.2%	CaO (Calcium oxide)	51.87%	C (Carbon)	88.85%
SiO_2 (Silica)	13	SiO_2	1.85	S (Sulphur)	2.02
Al_2O_3 (Alumina)	4.3	MgO (Magnesium oxide)	1.93	Ash[a]	8.8
CaO (Lime)	1.8				

Notes: a) The ash content is the amount of silica and alumina occurring in the coke.
Source: Beaton Institute

To begin, the pig iron's desired iron content determines the amount of ore required which, in turn, depends on the ore's iron content. If the pig iron is to contain 92.5 per cent iron, then one ton of ore will contain 0.925*2240 or 2072 lbs (941.8 kgs) of iron. The iron content of

Wabana ore is 53.2 per cent so,

$$\frac{2072}{0.532}x100=3894.37\ pounds\ of\ ore$$

is required to make one ton of pig iron.

There is no exact formula for the second step; experience and practice largely determines the coke requirements. Bashforth (1957, 227) quotes a coke consumption rate in normal furnace practice that varies from 1800 (81.8 kgs) to 2200 (1000 kgs) lbs per ton of ore. Dosco's blast furnace records for August 1944 show burden ratios of 1.87 and 1.94 for Furnace No. 1 and No. 3, respectively. I use the average of these two observations, 1.91, so that each ton of ore requires 2049.9 lbs (931.8 kgs) of coke.

The final step is to determine the required amount of limestone, largely dictated by slag's desired basicity. (The slag's basicity is the sum of its lime and magnesia content divided by its silica content ($CaO+MgO)/SiO_2$) In practice, it depends on the content of the coke, ore and limestone and the company's desired operating practice. Although Dosco's slag analysis records were unavailable for the war years, I located the necessary figures for a 3 month period in 1936 and the average of 1905 given in Table A2.2.

Table A2.2.–Dosco's average slag analysis

	1905 (average)	1936 April 22-27	May 25-30	June 5-9	June 26-30
basicity	1.64	1.7	1.65	1.6	1.75

Source: Beaton Institute.

The figures in Table A2.2 indicate that, in terms of the desired basicity, blast furnace practice

changed very little between 1905 and 1936. Therefore, it seems reasonable to use the average basicity for the three month period in 1936, 1.675.

Limestone provides the lime which fluxes the silica and other impurities entering the furnace and keeps it from entering the molten pig iron. If the ore's silica content is 13 per cent then the silica input from 3894.737 lbs (1770.3 kgs) of ore is:

3894.737*.13=506.32 lbs (230.1 kgs) of silica.

The specification of the pig iron used here calls for a 1 per cent silicon content so the amount of silicon in one ton of pig is 22.4 lbs (10.2 kgs). The source of this silicon is the silica input itself, reduced to elemental silicon within the blast furnace. Pig iron containing 22.4 lbs (10.2 kgs) of silicon per ton requires:

$$\frac{60}{28} * 22.4 = 48 \ \textit{pounds of silica}$$

This amount, 48 lbs (21.8 kgs) must be subtracted from the total silica input of 506.32 lbs (230.1 kgs) leaving 506.32-48, or 458.32 lbs (208.3 kgs) of silica to be fluxed. This figure, multiplied by the desired basicity, gives the required amount of lime: 458.32*1.675=767.68 lbs. (348.9 kgs). This figure must be adjusted for the lime content of the ore. Wabana ore's lime content is 1.8 per cent so its lime input is 0.018*3895.74 or 70 lbs (31.8 kgs). The difference between the total required amount, 767.68 lbs (349 kgs), and the ore's lime input, 70 lbs (31.8 kgs), gives the amount of lime that must be added to the charge. However, the limestone charged to the furnace contains silica that must be fluxed, reducing the amount available to flux the silica from the ore and coke. If the silica content of the limestone is 1.85 per cent, multiplying it by the desired

basicity of 1.675 means that 3.1 per cent of the lime contained in the limestone is required to flux its own silica. This reduces the effective lime content of the limestone by 3.1 per cent to 48.77 per cent. The conversion factor of limestone to lime is given by: 100/48.77=2.05.

The silica, sulphur and other impurities contained in the coke's ash require the addition of extra limestone for fluxing. Based on the coke's content analysis in Table A2.1, 2049.9 lbs (931.8 kgs) of coke contains 180.39 lbs (82 kgs) of ash and 41.41 lbs (18.8 kgs) of sulphur and I assume limestone requirements on a pound for pound basis to flux these two impurities. The following formula gives the total limestone required to produce one ton of pig iron:

(conversion factor * lime requirement for ore) + limestone requirement for coke

=total limestone requirement

or

(2.05*697.57)+ 221.8=1625.1 lbs (738.7 kgs).

Repeating these calculations for the various iron ores listed in Table 2.6, leaving the coke and limestone content constant, provides the remainder of the figures for Table 2.7.

Data Appendix

This data appendix lists the data used in the regressions and figures 2.2 and 2.3. The source is given at the bottom of each table.

Table A2.3.-Data for Dosco's blast furnaces

Year	Month	Furnace	Output (gross tons)	Labour	Repairs	Relining Reserve*	Ore (pounds)	Coke (pounds)	Limestone (pounds)	Quality (lbs of limestone/ ton of ore per ton of iron
1939	April	1	13861	$17326.25	$13861.00	$4158.3	55152919	33654508	17381694	1254
	May	1	13888	16248.96	13888.00	4166.40	55496448	34595008	15262912	1099
	June	1	13599	16046.82	13599.00	4079.70	55687905	33616728	16753968	1232
	July	1	12237	16152.84	12237.00	3671.10	50820261	29784858	14819007	1211
	August	1	12477	15721.02	12477.00	3743.10	52128906	31841304	15134601	1213
	September	1	12846	16057.50	12846.00	3853.80	53246670	32294844	16712646	1301
	October	1	13481	16312.01	13481.00	4044.30	55123809	32206109	16365934	1214
	November	1	13975	17049.50	13975.00	4192.50	55354975	32561750	16476525	1179
	December	1	12589	14729.13	12589.00	3776.70	49877618	32177484	14855020	1180
1940	January	1	12922	15118.74	12922.00	3876.60	52670072	31038644	14420952	1116
	February	1	11939	16117.65	11939.00	3581.70	46072601	29441574	13503009	1131
	March	1	12553	14435.95	12553.00	3765.90	46860349	31683772	14774881	1177
	April	1	10685	13890.50	10685.00	3205.50	44118365	25825645	13847760	1296
	May	1	14399	14830.97	14399.00	4319.70	57696793	31159436	18257932	1268
	June	1	13318	13983.90	13318.00	3995.40	51061212	31230710	16141416	1212
	July	1	13043	14086.44	14347.30	5217.20	54024106	32881403	17008072	1304
	August	1	13215	14536.50	14536.50	13215.00	56494125	33235725	16413030	1242
	September	1	12786	15087.48	14064.60	17900.40	52102950	30072672	15547776	1216

	October	1	13575	15747.00	14932.50	19005.00	56444850	31521150	16833000	1240
	November	1	12894	16246.44	14183.40	18051.60	51305226	29553048	15627528	1212
	December	1	14564	16020.40	16020.40	20389.60	61576592	34472988	18569100	1275
1941	January	1	14396	15979.56	15835.60	20154.40	60549576	34795132	18729196	1301
	February	1	9879	13435.44	10866.90	13830.60	39792612	23512020	12684636	1284
	March	1	10802	14798.74	9181.70	15122.80	45033538	24218084	13308064	1232
	April	1	11658	14922.24	9909.30	16321.20	47494692	27034902	13196856	1132
	May	1	11633	15122.90	9888.05	16286.20	46811192	28768409	14680846	1262
	June	1	10228	14523.76	8693.80	14319.20	42691672	26848500	15955680	1560
	July	1	7102	10581.98	6036.70	9942.80	28862528	17407002	8735460	1230
	August	1								
	September	1	1627	3302.81	1382.95	976.20	9031477	5513903	2752884	1692
	October	1	11083	15627.03	9420.55	6649.80	49297184	27585587	15028548	1356
	November	1	13419	16371.18	11406.15	8051.40	59030181	35989758	18155907	1353
	December	1	14569	18211.25	12383.65	8741.40	61947388	33100768	19828409	1361
1942	January	1	15053	18816.25	12795.05	9031.80	62364579	33176812	20276391	1347
	February	1	12409	17372.60	10547.65	7445.40	52229481	29161150	21728159	1751
	March	1	13375	19795.00	11368.75	8025.00	57352000	31391125	23780750	1778
	April	1	14242	19084.28	12105.70	8545.20	60172450	33340522	23114766	1623
	May	1	14404	19445.40	12243.40	8642.40	60410376	34468772	19762288	1372
	June	1	12751	18106.42	10838.35	7650.60	53235425	31877500	20643869	1619
	July	1	14668	18335.00	12467.80	8800.80	62221656	34836500	21385944	1458
	August	1	14284	17997.84	12141.40	8570.40	61764016	35652864	19711920	1380
	September	1	13380	19267.20	11373.00	8028.00	54978420	35751360	18825660	1407
	October	1	13906	18773.10	11820.10	8343.60	60852656	34890154	19969016	1436
	November	1	13360	18436.80	11356.00	8016.00	56913600	31623120	16967200	1270
	December	1	14297	18729.07	12152.45	8578.20	63392898	32025280	18471724	1292
1943	January	1	9554	12706.82	8120.90	5732.40	44903800	22642980	12821468	1342

	February	1	11555	21376.75	9821.75	6933.00	46254665	27928435	16442765	1423
	March	1	12983	24018.55	11035.55	7789.80	51412680	34859355	23213604	1788
	April	1	12219	21505.44	10386.15	7331.40	49841301	33211242	24780132	2028
	May	1	13312	23296.00	11315.20	7987.20	51504128	32254976	22018048	1654
	June	1	12666	23052.12	10766.10	7599.60	55603740	32640282	17352420	1370
	July	1	13278	20448.12	11286.30	7966.80	58954320	32624046	19000818	1431
	August	1	12708	19443.24	10801.80	7624.80	53538804	32227488	18642636	1467
	September	1	11531	17642.43	10839.14	7610.46	50205974	32494358	17400279	1509
	October	1	11897	21057.69	10112.45	7138.20	53369942	33751789	16905637	1421
	November	1	12468	20572.20	12468.00	7480.80	55470132	33538920	15248364	1223
1939	April	8	5210	9325.90	5210.00	2344.50	23398110	13327180	7299210	1401
	May	8	10679	14523.44	10679.00	4805.55	45022664	24668490	14149675	1325
	June	8	10200	14382.00	10200.00	4590.00	40606200	24418800	12852000	1260
	July	8	10290	15229.20	10290.00	4630.50	40871880	25200210	12317130	1197
	August	8	10816	15142.40	10816.00	4867.20	41944448	25763712	12027392	1112
	September	8	10640	14896.00	10640.00	4788.00	43155840	23769760	12906320	1213
	October	8	10961	15126.18	10961.00	4932.45	42758861	24980119	14260261	1301
	November	8	10654	15128.68	10654.00	4794.30	42200494	22565172	11271932	1058
	December	8	9079	12256.65	9079.00	4085.55	35662312	22343419	9887031	1089
1940	January	8	9902	12476.52	9902.00	4455.90	41449772	23952938	10852592	1096
	February	8	3989	7539.21	3989.00	1795.05	16462603	9932610	4499592	1128
	March	8	9506	12738.04	9506.00	4277.70	38746456	24582516	11074490	1165
	April	8	9516	12370.80	9516.00	4282.20	38901408	24608376	13769652	1447
	May	8	10548	12763.08	10548.00	4746.60	45261468	24460812	16328304	1548
	June	8	8669	11616.46	8669.00	3901.05	39539309	21057001	14017773	1617
	July	8	10114	12844.78	11125.40	6068.40	45816420	24101662	15757612	1558
	August	8	9967	12060.07	10963.70	9967.00	44672094	23422450	14830896	1488

	September	8	9390	12582.60	10329.00	15024.00	44123610	22714410	14479380	1542
	October	8	10300	13596.00	11330.00	16480.00	46947400	22938100	15429400	1498
	November	8	9592	13620.64	10551.20	15347.20	43931360	22569976	14877192	1551
	December	8	10032	13342.56	11035.20	16051.20	45906432	25019808	15549600	1550
1941	January	8	10381	11740.91	11419.10	16609.60	45935925	25672213	15654548	1508
	February	8	9478	12890.08	10425.80	15164.80	42651000	21761488	12425658	1311
	March	8	11314	15047.62	9616.90	18102.40	48910422	25388616	14165128	1252
	April	8	11338	14285.88	9637.30	18140.80	48900794	23685082	13650952	1204
	May	8	12185	14865.70	10357.25	19496.00	51847175	27720875	14329560	1176
	June	8	11251	14513.79	9563.35	18001.60	48424304	23987132	13804977	1227
	July	8	11043	14466.33	9386.55	17668.80	46745019	24195213	13262643	1201
	August	8	11792	16744.64	10023.20	18867.20	50976816	27616864	13997104	1187
	September	8	11644	17116.68	9897.40	10479.60	48986308	27817516	13378956	1149
	October	8	11058	15702.36	9399.30	9952.20	48898476	26295924	16575942	1499
	November	8	10692	15503.40	9088.20	9622.80	47247948	25254504	16005924	1497
	December	8	11960	16146.00	10166.00	10764.00	50782160	26682760	15213120	1272
1942	January	8	11949	16609.11	10156.65	10754.10	49671993	26682117	15019893	1257
	February	8	9686	15110.16	8233.10	8717.40	42008182	22868646	15865668	1638
	March	8	9591	16208.79	8152.35	8631.90	40761750	23085537	15508647	1617
	April	8	10898	16020.06	9263.30	9808.20	45433762	25152584	17088064	1568
	May	8	11152	16058.88	9479.20	10036.80	45187904	25604992	14497600	1300
	June	8	10206	16125.48	8675.10	9185.40	42293664	24259662	16033626	1571
	July	8	11044	15682.48	9387.40	9939.60	46716120	25412244	15881272	1438
	August	8	11106	15215.22	9440.10	9995.40	48022344	26287902	15448446	1391
	September	8	9653	15444.80	8205.05	8687.70	43998374	24991617	16998933	1761
	October	8	9884	15715.56	8401.40	8895.60	42817488	25243736	19886608	2012
	November	8	10424	15948.72	8860.40	9381.60	45104648	24684032	17731224	1701
	December	8	10196	15803.80	8666.60	9176.40	43078100	24562164	15232824	1494

1943	January	8	4659	7174.86	3960.15	4193.10	19073946	10971945	6485328	1392
	February	8	7017	15998.76	5964.45	6315.30	29408247	17149548	11458761	1633
	March	8	10095	20089.05	8580.75	9085.50	41975010	25338450	18968505	1879
	April	8	9465	18456.75	8045.25	8518.50	40955055	23690895	19147695	2023
	May	8	9935	18777.15	8444.75	8941.50	41120965	22482905	15478730	1558
	June	8	10051	19800.47	8543.35	9045.90	41430222	23398728	14604103	1453
	July	8	8084	15763.80	6871.40	7275.60	32934216	19094408	12756552	1578
	August	8	8693	16082.05	7389.05	7823.70	35736923	21732500	17403386	2002
	September	8	8555	15056.80	7357.30	7699.50	35931000	21267730	23817120	2784
	October	8	7481	15635.29	6358.85	6732.90	31278061	19383271	14640317	1957
	November	8	7492	15883.04	7492.00	6742.80	30949452	19404280	14639368	1954

Source: vol. 37, B. ii. (a), MG 14, 26, BI.

* Relining reserve represents one measure of depreciation. The abrasion between the bricks lining the furnace's stack and the coke, ore and limestone as they descended through the furnace eventually wore out the lining. Once they wore down to a minimum thickness, production would stop and the furnace would have its brick lining replaced. At this point, a blast furnace's usefulness as a capital good ceases. Hence, the relining reserve records the amount Dosco awarded to the depreciation caused by the normal wear and tear of furnace operation.

Table A2.4.–Dosco's production costs and material input prices

Year	Month	Labour ($/ton)	Material Cost ($/ton)	Product Cost ($/ton)	Price of Ore ($/ton)	Price of Coke ($/ton)	Price of Stone ($/ton)
1939	January	$1.42	$12.68	$14.26	$2.65	$6.11	$0.95
	February	1.52	12.70	14.76	2.65	6.28	0.95
	March	1.73	12.22	14.41	2.65	6.13	0.95
	April	1.40	12.71	14.45	2.65	5.82	0.95
	May	1.26	12.43	14.02	2.70	5.65	0.95
	June	1.28	12.46	13.96	2.70	5.66	0.95
	July	1.39	12.17	13.97	2.70	5.43	0.95
	August	1.33	12.03	13.67	2.69	5.33	0.95
	September	1.32	12.25	13.95	2.70	5.57	0.95
	October	1.28	11.89	13.81	2.70	5.46	0.95
	November	1.30	11.91	14.08	2.70	5.69	1.05
	December	1.26	12.69	15.00	2.70	5.69	1.05
1940	January	1.23	12.64	14.78	2.70	5.73	1.05
	February	1.49	12.90	15.51	2.70	6.05	1.05
	March	1.24	12.70	14.70	2.70	5.88	1.05
	April	1.28	12.68	14.86	2.70	5.62	1.05
	May	1.12	12.73	14.84	2.95	5.58	1.20
	June	1.17	12.78	14.91	2.95	5.44	1.20
	July	1.19	13.34	15.70	2.95	5.53	1.20
	August	1.18	13.44	16.32	2.95	5.58	1.30
	September	1.27	13.80	17.50	3.10	5.68	1.30
	October	1.25	13.23	16.86	3.08	5.64	1.32
	November	1.33	13.33	17.02	3.01	5.76	1.41
	December	1.21	13.80	17.18	3.02	5.78	1.44
1941	January	1.24	13.93	17.46	2.97	5.94	1.42
	February	1.37	14.01	18.02	3.21	5.99	1.36
	March	1.36	13.24	16.88	3.04	6.01	1.32
	April	1.28	13.05	16.55	2.95	6.12	1.30
	May	1.31	13.00	16.45	2.90	5.75	1.30
	June	1.39	15.40	19.00	3.99	5.71	1.25
	July	1.40	16.12	19.80	4.33	5.65	1.71
	August	1.46	15.58	19.10	4.01	5.63	1.71
	September	1.55	16.13	18.94	4.13	5.42	1.72
	October	1.45	16.63	19.40	4.25	5.69	1.73
	November	1.42	17.24	19.76	4.58	5.62	1.77

	December	1.34	17.02	19.68	4.84	5.77	1.87
1942	January	1.32	16.08	18.77	4.42	5.98	1.78
	February	1.50	18.61	21.58	5.15	5.99	1.73
	March	1.59	16.98	19.98	4.42	5.90	1.72
	April	1.45	16.40	18.93	4.12	5.97	1.71
	May	1.43	15.30	18.07	4.09	5.62	1.71
	June	1.51	17.30	19.99	4.30	6.09	2.21
	July	1.39	16.27	18.78	3.97	6.15	2.11
	August	1.37	19.22	21.68	5.19	6.11	2.28
	September	1.54	22.02	24.79	6.45	5.76	2.49
	October	1.50	20.74	23.45	5.84	5.87	2.40
	November	1.50	21.24	23.97	6.33	5.91	2.72
	December	1.46	23.11	25.96	7.30	5.77	3.16
1943	January	1.43	35.42	39.01	13.35	6.67	2.50
	February	2.01	26.47	30.14	9.51	6.32	2.24
	March	1.91	30.90	34.00	11.75	6.38	1.83
	April	1.85	22.77	25.75	5.82	6.75	3.50
	May	1.81	17.85	21.26	4.50	6.62	2.80
	June	1.89	16.47	20.03	4.50	6.37	2.80
	July	1.72	21.18	24.34	5.33	6.62	2.60
	August	1.59	20.92	23.94	5.09	6.88	2.60
	September	1.57	21.87	24.69	5.06	6.96	2.60
	October	1.81	21.65	24.12	5.06	6.67	2.75
	November	1.70	21.63	23.92	5.04	7.20	2.75
	December	2.12	21.20	24.71	5.05	7.20	2.75
1944	January	2.33	21.72	25.41	5.07	8.13	2.75
	February	2.38	22.69	26.84	4.98	8.13	2.75
	March	1.64	21.27	24.02	5.06	7.83	2.75
	April	1.58	20.84	23.99	5.04	7.72	3.25
	May	1.63	21.39	24.40	4.94	7.75	3.65
	June	1.72	20.61	23.88	5.37	7.41	2.20
	July	1.69	18.96	22.03	4.44	7.50	2.52
	August	1.78	18.84	21.54	4.68	7.45	2.39
	September	1.80	19.91	22.72	5.07	7.76	2.45
	October	1.56	18.93	20.99	5.11	7.53	2.10
	November	1.67	18.20	20.21	4.70	7.27	2.67
	December	1.74	18.35	20.64	4.57	7.38	2.31
1945	January	1.68	17.85	19.94	4.84	6.92	2.33

February	1.66	18.64	20.74	4.79	7.50	2.33
March	1.68	19.01	20.81	4.78	7.47	2.16
April	1.75	19.10	21.05	5.05	7.18	1.96
May	1.79	18.84	20.81	4.83	7.12	1.93
June	1.84	18.67	21.10	4.89	7.31	1.95
July	1.86	18.21	20.43	4.82	7.21	1.78
August	2.02	18.82	21.31	4.87	7.64	0.19
September	1.90	19.35	21.65	5.24	8.11	1.85
October	1.97	20.03	22.41	5.31	8.15	1.85
November	2.08	20.26	22.66	5.32	7.92	1.95
December	2.00	20.03	22.87	5.41	8.02	1.93

Source: vol. 37, B. ii. (a), MG 14, 26, BI.

Tables

Table 2.1.–Net profits at Dosco, Algoma and Stelco
(thousands of dollars)

	Algoma	Dosco	Stelco
1938	$641.3	$1,239.2	$3,053.7
1939	227.4	1,332.6	4,686.7
1940	780.2	1,157.4	4,264.4
1941	911.8	1,166.1	4,439.7
1942	414.4	1,021.7	4,805.9
1943	846.8	1,022.4	4,176.9
1944	1,057.8	575.3	4,658.7
1945	1,112.1	1,249.2	4,159.3

Source: *Financial Post Survey of Corporate Securities*, various issues.

Table 2.2.–Profit or loss on sales: Sydney Steel Plant
(thousands of dollars)

	1939	1940	1941	1942	1943	1944	1945
Domestic sales	£386.7	£409.3	(£37.8)	(£1,032.3)	(£1,322.4)	(£742.8)	(£634.5)
Sales to agencies	46.1	19.6	(118.3)	(172.8)	(130.9)	(114.8)	(103.1)
Inter-company sales	300.9	(64.1)	(663.7)	(1,445.8)	(1,722.1)	(1,296.7)	(972.9)
Export sales	161.2	1,150.5	489.7	150.3	(72.0)	(347.8)	279.6
Profit or loss on steel sales	894.9	1,515.3	(330.1)	(2,500.6)	(3,247.4)	(2,502.1)	(1,430.9)
Coke sales	20.4	72.1	81.4	90.1	9.2	74.5	205.2
Ore sales	633.4	318.9	138.0	53.4	2.2	21.3	51.5
year end adjustment	-	-	-	47.3	(1,039.3)	568.2	(61.8)
Total operating profit or loss	1,548.7	1,906.3	(110.7)	(2,309.8)	(4,275.3)	(1,838.1)	(1,236.0)

Note: Losses are shown in parentheses.
Source: *General Statistics*, Dominion Steel and Coal Corporation Limited. Sydney Works. file 30, vol. 134, B1. i. (b), BI.

Table 2.3.–Distribution of Dosco's steel sales by type

	Domestic	Agencies	Inter-Company	Export	Total
1934-1938 average	22%	5%	23%	50%	100%
1939	17	5	31	47	100
1940	21	3	29	47	100
1941	25	4	37	33	100
1942	42	3	46	10	100
1943	53	2	42	3	100
1944	37	1	33	29	100
1945	36	1	35	28	100

Note: The actual physical volume of steel sales was not reported by the company.
Source:*General Statistics*, Dominion Steel and Coal Corporation Limited, Sydney Works. file 30, vol. 134, B1. i. (b), BI.

Table 2.4.–Subsidies claimed and granted to Dosco
(thousands of dollars)

	Coal Bonus	Excess Freight	Subsidy	Combined	Cash Received	Total
1939	$246.9	-	-	-	-	$246.9
1940	380.8	-	-	-	-	380.8
1941	370.9	$1,810.0	-	$1,810.0	$1,810.0	2,180.9
1942	419.1	3,543.5	-	3,543.5	2,544.2	2,963.3
1943	322.4	3,873.3	5,805.5	9,678.8	7,250.0	7,572.4
1944	328.9	1,732.1	4,363.7	6,095.8	4,250.0	4,578.9
1945	318.8	1,152.1	1,944.8	3,096.9	8,061.0	8,379.8
totals	$2,387.8	$12,111.0	$12,114.0	$24,225.0	$23,915.2	$29,303.0

Source: *General Statistics*, Dominion Steel and Coal Corporation Limited. Sydney Works. file 30, vol. 134, B1. i. (b). BI.

Table 2.5.–Material input cost increases and comparative production costs

	Dosco[a]	Algoma[b]	Stelco[c]
Iron ore	65%	15%[c]	20.5
Coal	-[d]	26	51
Limestone	80	15	4

Pig iron-average cost per ton				
	1939	1941	1943	1945
Dosco	$14.18	$18.38	$22.90	$21.27
Algoma	17.28	18.5	17.63	22.8

Notes: a) Percentage increase between 1939 and 1941.
b) August 31st 1941 compared with August 31st 1939.
c) Increase between 1939 and 1940
c) Ore used in blast furnaces.
d) Not given.
Source: Dosco and Algoma: T. Rahilly and C. Lang to F. B. Kilbourn, 3 October 1941, file 9, vol. 327, MG 30 A51, NAC; Stelco: R. S. Vickers to L. S. Hart, 7 October 1943, file 11-1-24-3, vol. 452, RG 64, NAC.

Table 2.6.–Content analysis of selected ores

	Wabana[a]	Wabana[b]	Bathurst[c]	Brazillan[d]	Lake Superior[e]
Iron (Fe)	53.2%	50.6%	45.9%	68%	51.5%
Silica (SiO_2)	13	12.1	20.5	0.4	7.7
Alumina (Al_2O_3)	4.3	4.9	2	1.3	2.2

Sources: Wabana[a] ore: Bashforth (1957); Wabana[b] and Lake Superior: F. H. Brown to F. B. Kilbourn, 28 August 1944, file 196-2D-2, vol. 195, RG 28, NAC; Bathurst[c]: Beaton Institute; Brazillan: *The Sydney Operations of the Dominion Steel and Coal Company*, file 12, Box 32, B. i., MG 14, 26, BI.

Table 2.7.–Estimated blast furnace charges by ore[a]

	ore	coke	limestone	total charge	yield[b]	slag
Wabana alone	3895lbs	2050lbs	1652lbs	7597lbs	36%	1632lbs
Wabana+Brazil[c]	3770	1985	1029	6785	41.6	1129
Wabana+Bathurst[c]	4192	2206	1836	8234	33	1821
Lake Superior	4023.3	2118	1080	5103	39	1111
Wabana+Bathurst[d]	4376	2485	1696	8557	-	-
Dosco[e]	4275	1996	1304	5489	36	1630
Algoma[e]	3874	1791	735	4609	43	800

Notes: a)The metric equivalents for these above figures from left to right and top to bottom are: Wabana alone: 1770.5 kgs, 931.8 kgs, 750.9 kgs, 3453.2 kgs, 741.8 kgs; Wabana+Brazil: 1713.6 kgs, 902.3 kgs, 467.7 kgs, 3084.1 kgs, 513.2 kgs; Wabana+ Bathurst: 1905.5 kgs, 1002.7 kgs, 834.5 kgs, 3742.7 kgs, 827.7 kgs; Lake Superior: 1828.8 kgs, 962.7 kgs, 490.9 kgs, 2319.5 kgs, 505 kgs; Wabana+Bathurst: 1989.1 kgs, 1129.5 kgs, 770.9 kgs, 3889.5 kgs; Dosco: 1934.2 kgs, 907.3 kgs, 592.7 kgs, 2495 kgs, 740.9 kgs; Algoma: 1760.9 kgs, 814.1 kgs, 334.1 kgs, 2095 kgs, 363.6 kgs.

b) The yield is calculated as 2000 pounds divided by the total amount of limestone and ore in the charge.

c) I set the proportion of Wabana to Brazilian and Bathurst ore at 75 and 25 per cent respectively.

d) Figures reported by the blast furnace department at Sydney. The report made no mention of the slag amounts and yield. Source: L. M. Fulton to J. H. Fraser, 3 April 1943, file 6, vol. 68, B iv. (f), MG 14, 26, BI.

e)Based on figures given in: F. H. Brown to F. B. Kilbourn, 28 August 1944, file 196-2D-2, vol. 195, RG 28, NAC.

Table 2.8.–Analysis of labour turnover

	employees @ January 1 of each year	total removed during year	% lost to military	other removals	% turnover	% turnover excluding military
1939	3969	419	9.3%	90.7%	10.8%	9.6%
1940	4164	342	12.6	87.4	8.2	7.2
1941	4784	706	33.3	66.7	14.6	10.2
1942	5315	2040	43.2	56.8	38.4	23.3
1943	6025	2555	27.7	72.3	42.4	30.7
1944	5382	2303	14.6	85.4	42.6	36.5
1945	5471	2131	6.3	93.7	39	36.5

Source: *Personnel Statistics 1945-60*, file 1. B. i. (a), MG 14, 26, BI.

Table 2.9.–Frontier estimates[a]

$$y_{it}=\sum_{i=1}^{N}\theta_{i1}D_i+\sum_{i=1}^{N}\theta_{i2}D_i t+\sum_{i=1}^{N}\theta_{i3}D_i t^2+\sum_{i=1}^{N}\gamma_{i1}D_i q_{it}+\sum_{i=1}^{N}\gamma_{i2}D_i\, turnover_t+X'_{it}\beta+v_{it}$$

Furnace 1 fixed effect	θ_{11}	-7.22 (0.725)*	-7.24 (0.638)*	-7.19 (0.44)*	-7.29 (0.405)*
time	θ_{12}		0.001 (0.002)	0.003 (0.001)*	0.0027 (.001)*
time^2	θ_{13}		-0.00006 (0.00003)*	-0.00007 (0.00002)*	-0.00009 (0.0002)*
limestone per ton	γ_{11}			-0.25 (0.034)*	-0.28 (0.035)*
1-turnover rate	γ_{12}				0.24 (0.083)*
Furnace 8 fixed effect	θ_{31}	-7.24 (0.719)*	-7.26 (0.629)*	-6.68 (0.36)*	-7.10 (.272)*
time	θ_{32}		-0.0014 (0.0018)	-0.0006 (0.001)	-0.0013 (0.0011)
time^2	θ_{33}		0.00006 (0.00003)	0.00002 (0.00002)	0.00001 (0.00002)
limestone per ton	γ_{21}			-0.32 (0.03)*	-0.31 (0.0243)*
1-turnover rate	γ_{22}				0.17 (0.074)*
labour	β_1	0.14 (0.045)*	0.24 (0.048)*	0.14 (0.029)*	0.12 (0.028)*
capital	β_2	0.11 (0.023)*	0.05 (0.021)*	0.01 (0.013)	0.02 (0.013)**
materials	β_3	0.84 (0.053)	0.83 (0.047)*	0.95 (0.029)*	0.95 (0.027)*
R^2		0.96	0.97	0.99	0.99
Returns to scale	$\beta_1+\beta_2+\beta_3$	1.09	1.12	1.1	1.09
TxN	110				

a) Diagnostic tests did not detect the presence of autocorrelation or heteroscedasticity. A * and **indicates statistical significance at $\alpha<.05$ and $\alpha=.1$ respectively.

Table 2.10.–F-test results on specification of u_{it} and returns to scale

Hypothesis		Furnace No. 1	Furnace No.8
No inefficiency[a]	H_o: $\theta_{i1} = \theta_{i2} = \theta_{i3} = \gamma_{i1} = \gamma_{i2} = 0$	302.04	314.6
No time-invariant inefficiency[b]	H_o: $\theta_{i2} = \theta_{i3} = 0$	14.85	1.2
No quality or turnover effects	H_o: $\gamma_{i1} = \gamma_{i2} = 0$	32.51	88.3
Returns to scale[d] (full model)	H_0: $\beta_1+\beta_2+\beta_3=1$	93.5	

Table 2.11.–Estimated and actual plate production costs

($ per ton)

	April-May 1920	pre-war estimate	1941 estimate	1942	1943	1944	1945
net material*	$47.55	$31.57	$35.05	$34.92	$35.02	$34.45	$33.52
labour	5.24	6.44	6.44	5.26	5.35	5.63	6.94
total cost	61.93	48.03	52.51	59.92	61.26	60.94	59.89

*)accounting for scrap and scale loss during rolling

Source: 1920 figures: file 1, B. ii. (b), MG 14, 26, BI; Wartime figures: vol. 37, B. ii. (a), MG 14, 26, BI.;

Table 2.12.–Steel ingot production costs

(per ton)

	No. 1 Department			No. 2 Department		
	Ingot costs	labour costs	heating costs	Ingot costs	labour costs	heating costs
1939	$23.74	$1.84	$1.63	$22.97	$1.36	$1.19
1940	27.78	1.69	1.63	26.68	1.38	1.07
1941	32.4	1.92	1.81	30.57	1.56	1.23
1942	38.14	2.66	2.15	35.53	2.07	1.5
1943	38.73	2.93	2.61	36.33	2.57	1.85
1944	39.17	3.28	3.1	36.2	2.78	2.2
1945	39.05	3.28	3.33	35.75	2.51	2.29

Source: vol. 37, B. ii. (a), MG 14, 26, BI.

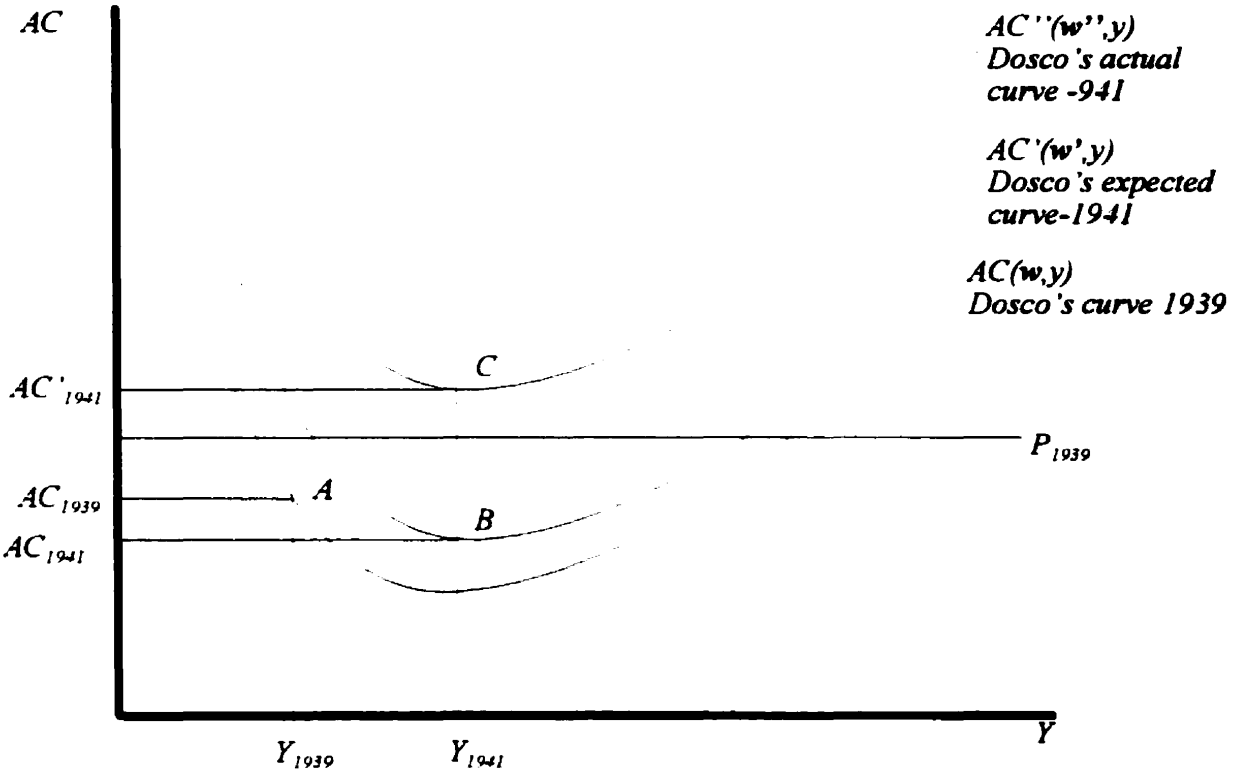

Figure 2.1. Dosco's average cost curves.

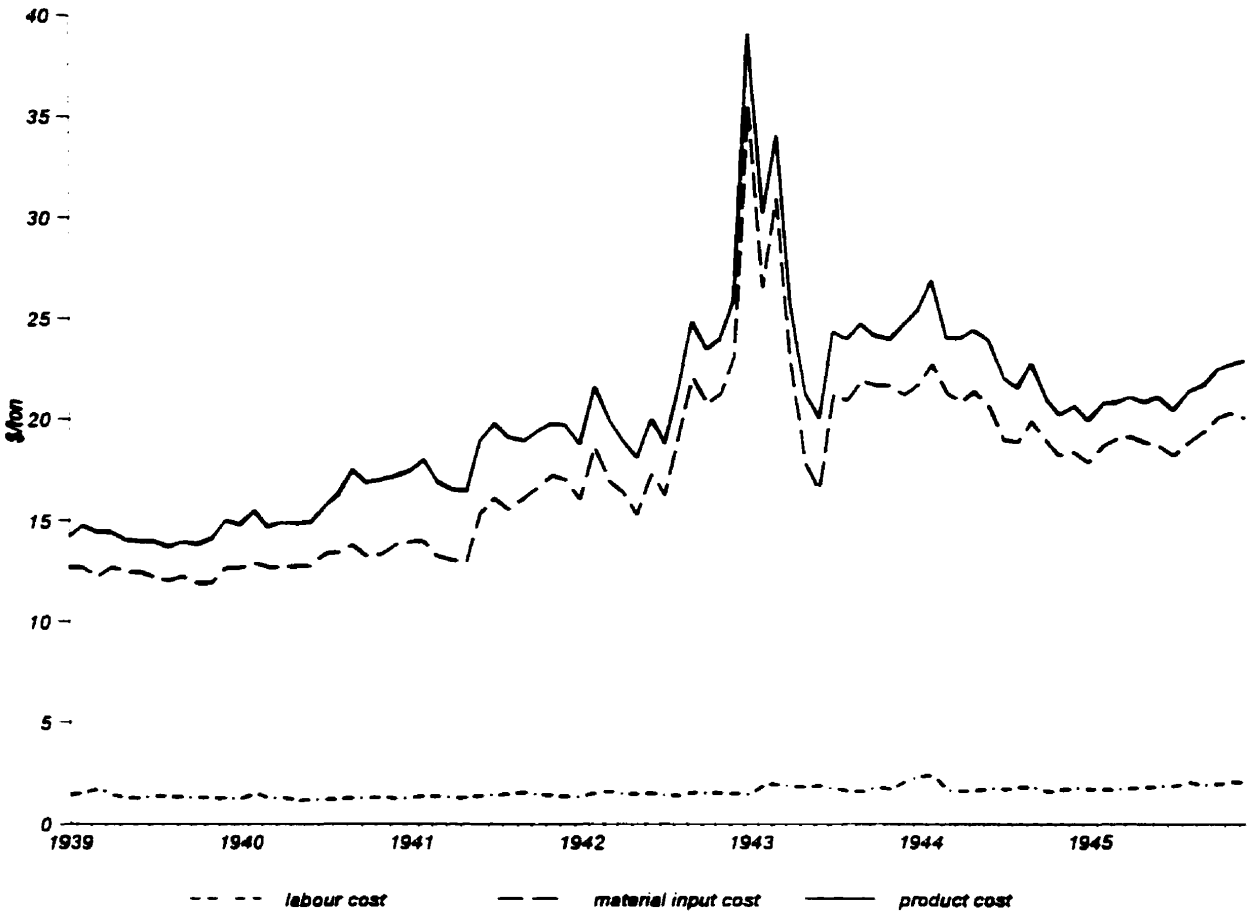

Figure 2.2. Dosco's pig iron production costs, January 1939-December 1945.
Source: vol. 37, B. ii. (a), MG 14, 26, BI.

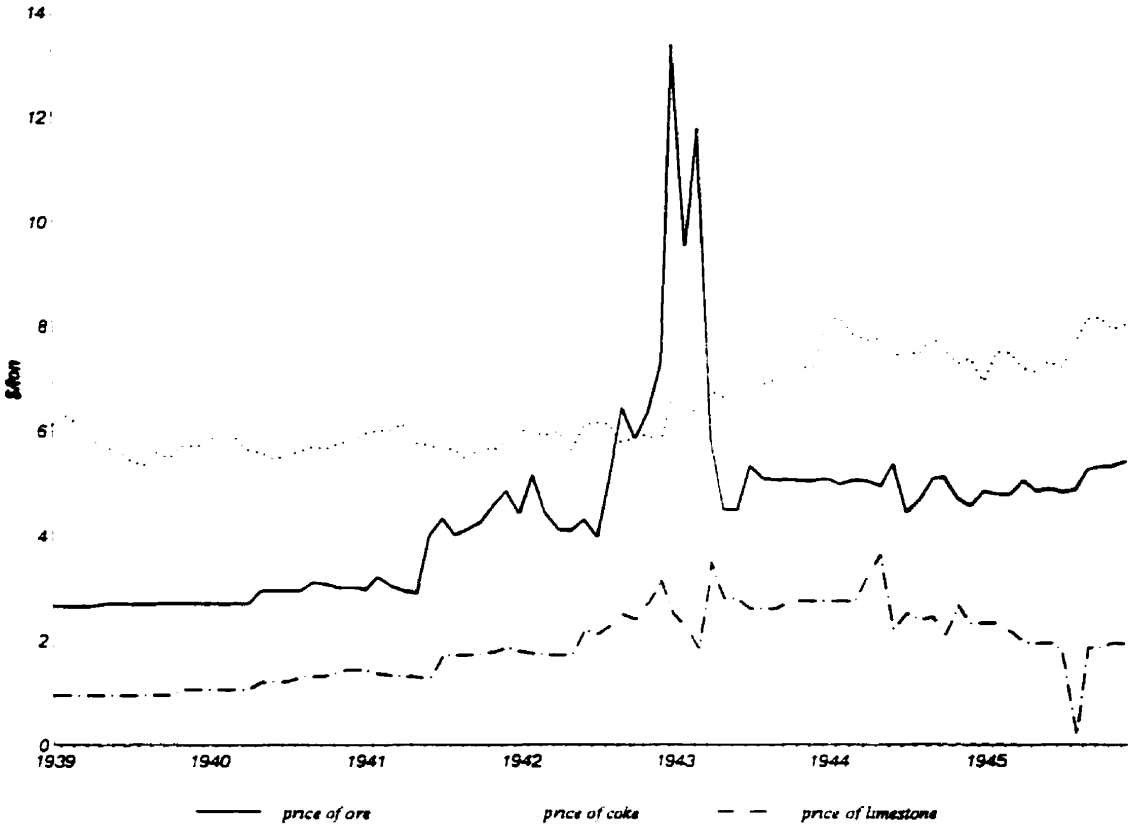

Figure 2.3. Dosco's raw material prices, January 1939-December 1945.
Source: vol. 37, B. ii. (a), MG 14, 26, BI.

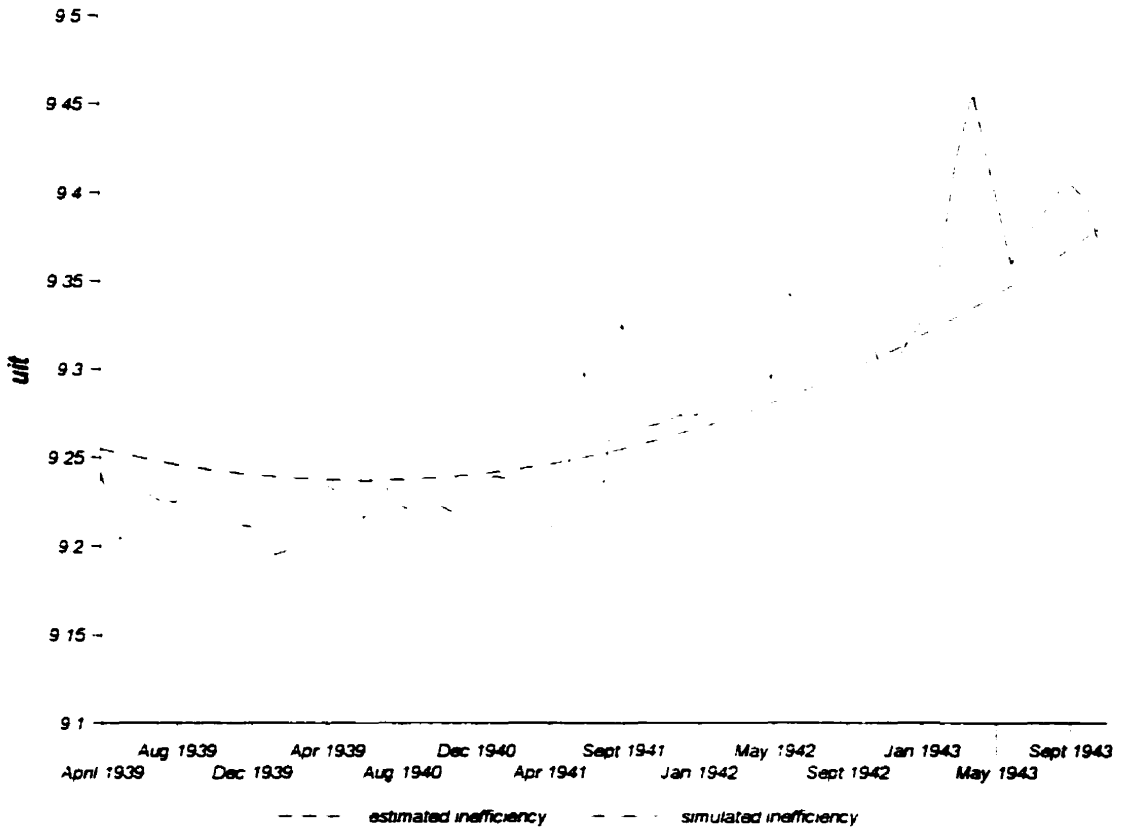

Figure 2.4. Inefficiency for furnace No. 1 fixing labour turnover and *lnstone*. ($u_{it}=\theta_{i1}+\theta_{i2}t+\theta_{i3}t^2+\gamma_{i1}lnstone_{it}+\gamma_{i2}turnover_t$)

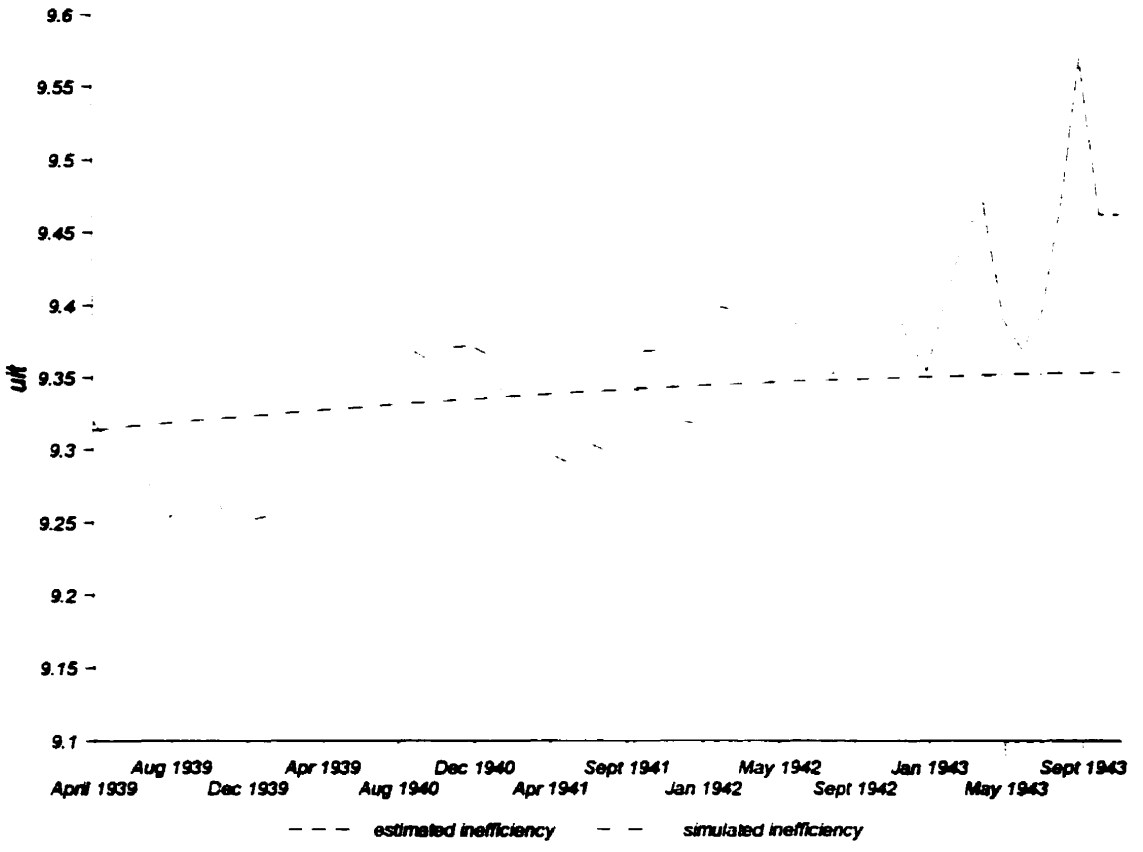

Figure 2.5. Inefficiency for furnace No. 8 fixing labour turnover and *lnstone*. ($u_{it}=\theta_{i1}+\theta_{i2}t+\theta_{i3}t^2+\gamma_{i1}\text{lnstone}_{it}+\gamma_{i2}\text{turnover}_t$)

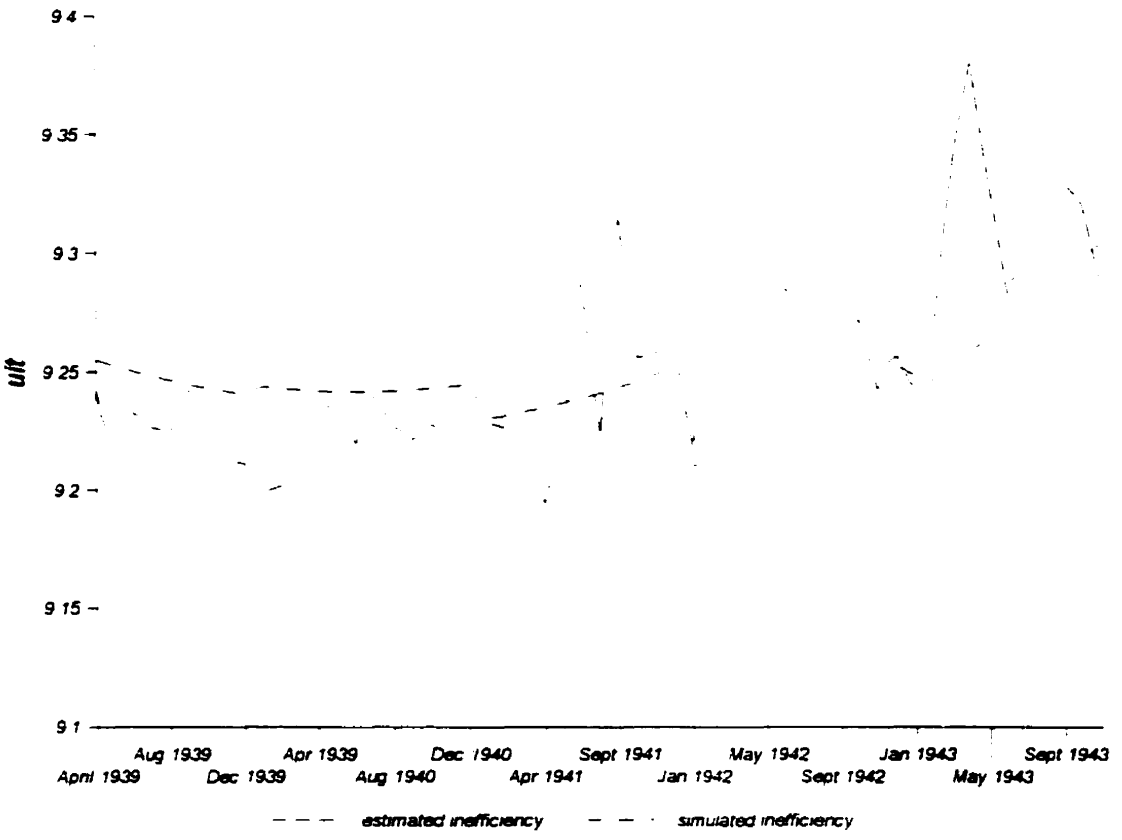

Figure 2.6. Inefficiency for furnace No. 1 fixing lnstone only.
($u_{it}=\theta_{i1}+\theta_{i2}t+\theta_{i3}t^2+\gamma_{i1}lnstone_{it}+\gamma_{i2}turnover_t$)

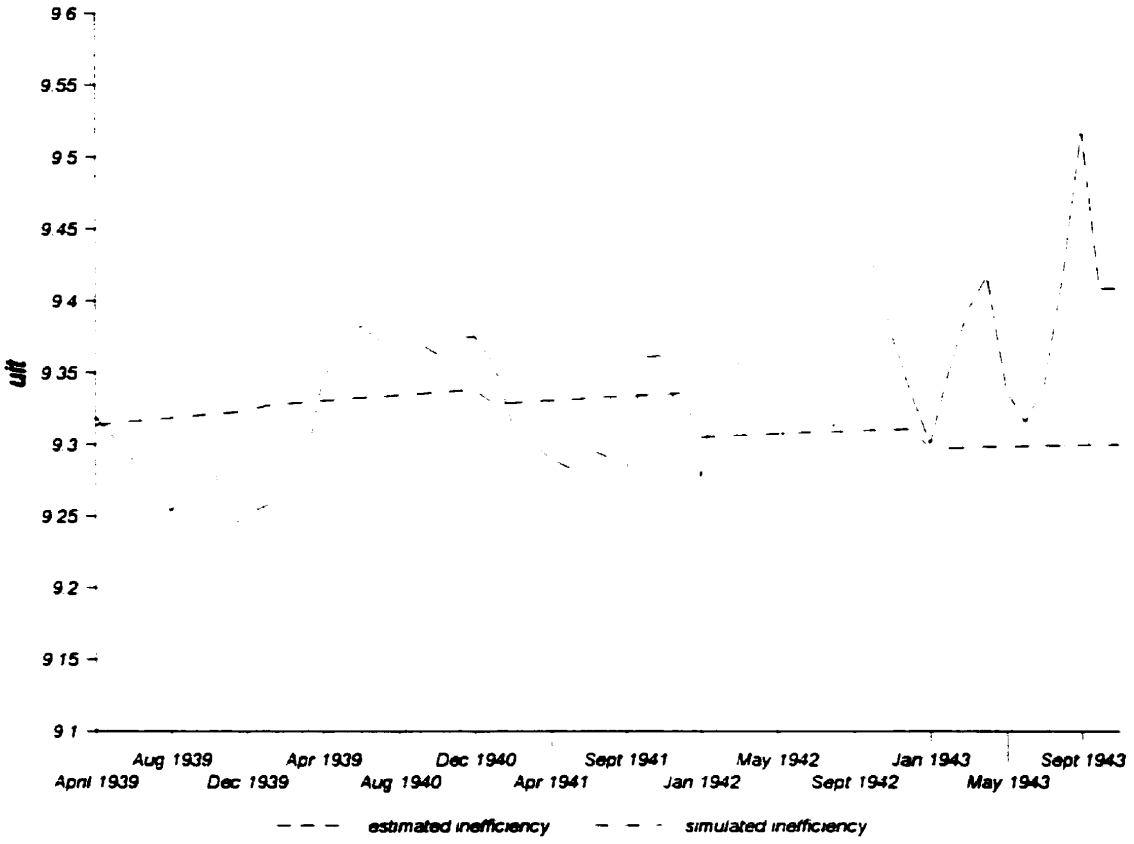

Figure 2.7. Inefficiency for furnace No. 8 fixing *lnstone* only.
($u_{it}=\theta_{i1}+\theta_{i2}t+\theta_{i3}t^2+\gamma_{i1}lntone_{it}+\gamma_{i2}turnover_t$)

40. The responsibility of Steel Control fell under the Dominion government's overseer of the Canadian war effort, the Department of Munitions and Supply.

41. Many of the chapters in De N. Kennedy's history of the Department and its control agencies were simple rewrites of the preliminary accounts prepared by the agencies themselves in 1943, updated to the end of the war. Often, draft chapters were sent to the former heads of the Department's various agencies for comments and proof-reading. I have seen at least two occasion were details on production problems or mistakes were manually deleted and did not appear in print. Hence the inability to accept the official history as any sort of objective account.

42. T. F. Rahilly to F. B. Kilbourn, 5 September 1944, file 196-2D-2, vol. 195, RG 28, National Archives of Canada (NAC).

43. T. F. Rahilly to F. B. Kilbourn, 5 September 1944, file 196-2D-2, vol. 195, RG 28, NAC.

44. T. F. Rahilly to F. B. Kilbourn, 5 September 1944, file 196-2D-2, vol. 195, RG 28, NAC.

45. F. H. Brown to C. D. Howe, 28 August 1944, file 196-2D-2, vol. 195, RG 28, NAC. Anson, Sydney's general manager, held a degree in metallurgy from McGill University and was an experienced steel worker with previous employment in Australia, Canadian, and American steel plants.

46. F. H. Brown to C. D. Howe, 28 August 1944, file 196-2D-2, vol. 195, RG 28, NAC.

47. The EPT, enacted by the June 1940 budget, applied when a company's wartime profit exceeded a base level determined by pre-war levels. Allowable profit under the excess profits tax was considered as 116.67 per cent of standard profit. Excess profits were initially taxed at a rate of 75 per cent and the firm was still subject to a corporation income tax of 18 per cent of total profits. The excess profits tax was raised to 100 per cent with a 20 per cent rebate available after the War in the June 1942 budget (Slater 1995, ch. 4, 5, 6).

48. Accelerated depreciation during the War was an added expense. Dosco, as well as any other firm, could claim special depreciation on plant investment required for war production if it was shown that this would result in capacity beyond normal peacetime requirements, usually based on pre-war output levels in 1938-39. Such projects could be written off in as little as three years. The table below gives the value of such depreciations by project at Sydney.

Special depreciation awarded to Sydney plant
(000's of $)

1940	1941	1942	1943	1944	1945	1946	amount expended by Dosco	total value of special depreciation
$111.9	$223.3	$929.2	$847.6	$916.7	$268.8	$149	$8421.8	$3446.5

Source: *General Statistics*, Dominion Steel and Coal Corporation. Limited. Sydney Works. Volume 134 B1. i. (b) file 30. BI.

49. Since German steel firms were Dosco's largest customer, profits from the sale of iron ore virtually disappeared with the start of the war. Profits at Dosco's other subsidiaries were insufficient to offset the losses experienced at the Sydney plant. In fact, Dosco's coal mining division, Dominion Coal also reported continual operating losses throughout the war. Its secondary manufacturing plants were only marginally profitable through the war.

50. The bonus amounted to a payment of $1 for every ton of coal converted to coke for use at the Sydney plant.

51. Granatstein (1975, 174-186) provides an account of how economy-wide price controls came into effect in December 1941. He also remarks on the operation of squeeze but provides few specific examples of where they occurred.

52. The Dominion government's price control over the industry began in September 1939 with a request by R. C. Vaughan, chair of the Defence Purchasing Board (predecessor to the Department of Munitions and Supply), that the major Canadian steel producers maintain prices at existing levels. Compliance was voluntary and full. On 4 July 1940, with a radically altered production programme following Dunkirk, C. D. Howe and Steel Control extracted a renewed obligation from Stelco, Dosco and Algoma to continue the freeze on prices. Any price adjustments would now require Steel Control's approval. Although compliance was voluntary, it could be enforced by law. The Dominion government's Wartime Prices and Trade Board, established 1 December 1941, replaced this scheme with a formal system of strict price controls on all iron and steel products, maintained throughout war.

53. F. H. Brown to M. Hoey, 30 August 1944, file 196-2D-2, vol. 195, RG 28, NAC.

54. F. H. Brown to M. Hoey, 30 August 1944, file 196-2D-2, vol. 195, RG 28, NAC.

54. F. H. Brown to M. Hoey, 30 August 1940, file 196-2D-2, vol. 195, RG 28, NAC.

56. F. H. Brown to L. E. Dewar, 2 September 1944, file 196-2D-2, vol 195, RG 28, NAC.

57. F. H. Brown to L. E. Dewar, 2 September 1944, file 196-2D-2, vol 195, RG 28, NAC.

58. This profit figure ignores capital costs other than depreciation charged against the mill.

59. C. L. Dewar to H. J. Carmichael, 28 February 1945, file 196-2D-2, vol 195, RG 28, NAC.

60. C. L. Dewar to H. J. Carmichael, 28 February 1945, file 196-2D-2, vol 195, RG 28, NAC.

61. Memo to C. D. Howe from F. H. Brown, 22 September 1944, file 196-2D-2, vol 195. RG 28, NAC.

62. T. F. Rahilly to F. B. Kilbourn, 5 September 1944, file 196-2D-2, vol. 195, RG 28, NAC.

63. F. H. Brown to M. Hoey, 29 June 1944, file 196-2D-2, vol. 195, RG 28, NAC.

64. F. H. Brown to M. Hoey, 30 August 1944, file 196-2D-2, vol 195. RG 28, NAC.

65. However, Steel Control's financial advisor maintained that Howe still considered the situation sufficiently bad to attempt to force the department's closure. Undated memorandum to Godsoe, 6 September 1944, file196-2D-2, vol 195, RG28, NAC.

66. Steel Control's official account reports that Dosco used an average mix of 70 per cent pig iron and 30 per cent scrap steel in a typical charge of its open hearth furnaces. This is in sharp contrast to Stelco who, with a more ready supply of scrap steel, could charge twice this amount and operate on a charge consisting of about 40 per cent pig iron (Steel Control, 88).

67. C. M Anson to H. J. Kelley, 12 May 1944, file 3, vol. 143, BI.

68. In 1939, ore was unloaded at the rate of 860 tons per hour which fell to 530 tons per hour due to the smaller carriers. This and other unloading cost increases raised the cost of ore by $0.23 per ton, 10 per cent of the ore's prewar cost. C. M. Anson to H. J. Kelley, 12 May 1944, file 3, vol. 143, MG14, 26, BI.

69. The Canada Iron Corporation briefly worked the Bathurst ore deposit in the early 1910s, shipping its output to Philadelphia. Operations ceased in 1913, reportedly due to market conditions in the US (New Brunswick, 9).

70. Transportation costs had only increased by 10 per cent on the Great Lakes. T. Rahilly and C. Lang to F. B. Kilbourn, 3 October 1941, file 9, vol. 327, MG 30 A51, NAC.

71. Rising raw material costs at Algoma resulted from imposition of the 10 per cent War Exchange Tax, levied by the Dominion government on all imports, and an "adverse" exchange rate of 11 per cent (Steel Control, 73). Wartime payments of the cost of living bonus and unemployment insurance raised the labour costs at all Canadian plants.

72. The limestone and coke also contain compounds found in the ore's gangue and contribute to slag production.

73. Elliot and Bond provide detailed description of production difficulties that siliceous ores and their high slag volume entail (Elliot and Bond 1959, 241-242). Siliceous ores prevent a smooth, continuous descent of the stock through the furnace to the tuyeres where the combustion of the coke occurs. They cause the hanging or slipping of the coke, ore and limestone in the furnace which can also seriously disrupt production. A chilled hearth can also result from slipping. Furthermore, the use of siliceous ores require an operating practice known as checking where the furnace operator regularly reduces the air blast to permit the descent of the stock (Haley 1969, 587). The stock cannot descend smoothly on its own accord without this periodic disruption in

the air blast. Consequently, the production rate of pig iron must fall temporarily, reducing the furnace's daily output.

74. Technical efficiency, is perhaps best defined as, "the ability to avoid waste by using as little input as production allows." Allocative inefficiency arises from a sub-optimal combination of factor inputs (Lovell 1993, 9-10).

75. The most common distribution assumed is the half-normal, although the exponential, truncated normal, and gamma distribution have also been used in previous empirical work.

76. To study the regional shift in the location of steel production to the western US states, Hekman created a two-equation supply and demand model for the 1921-1972 period.

77. The translog or transcendental logarithmic function is a second order approximation of some arbitrary function (that is twice differentiable) in prices. The Cobb-Douglas is merely a special case of the translog–a first order linear approximation of some arbitrary function in input prices.

78. Inwood (1986, 267) also faces the same problem with the lack of capital data for pig iron production at the Nova Scotia Steel and Coal Company. He considers the lack less serious than might otherwise be supposed since he reports that capital inputs accounted for 10 percent of the total cost of iron and steel production. Hence, they play a relatively minor role compared to the other inputs.

79. Actually, furnace No. 1 stopped producing for the month of August 1941. This month is deleted from the data to avoid an unbalanced panel, or the formation of two smaller balanced panels.

80. The primary concern of Bertin, Bresnahan and Raff is to explain procyclical productivity movements. Part of their investigation involves the identification of short-run increasing returns to labour reflecting presence of scale economies in blast furnace operation over the short-run and the inefficiency this occasioned.

81. This fact comes from the Dominion government's own unpublished history of its Merchant Marine. *Canadian Government Merchant Marine Limited*, file 5-12-2-10, vol. 3988, RG 19 NAC.

82. McCracken (1932, 154) reports that this exemption from the duties on imported capital goods was worth approximately $750 thousand.

83. There was also the option to increase the order to a total of 375 thousand tons, delivered at a rate of 75 thousand tons per year.

84. Frank (1977) reports that a small amount of plate was sold to Britain but this cannot be confirmed.

85. The engineering study into the plate mill's conversion into a slab mill revealed it was driven by a non-reversing motor and so was unsuited for use as a slab mill. Source: Lord Invernairn to Sir N. Moore, 19 June 1923, file #3 vol. 142 B1. i. f) BI.

86. A. Theuerkauf to L. Johnson, 7 November 1923, file #3, vol. 142, B1. i. f) BI.

87. F. Ross to Hon. A. Macdonald, 24 October 1940, file 1157-1, vol. 1523 MG 2, Public Archives of Nova Scotia (PANS).

88. F. Ross to Hon. A. Macdonald, 24 October 1940, file 1157-1, vol. 1523 MG 2, PANS.

89. A universal plate mill included a set of rollers to shape the edges of the plate along its width producing a more finished piece of steel. The production of sheared plate in the first proposal did not include the extra set of rollers so that the steel plate would require further rolling elsewhere to produce a finished product. This, of course, would limit the appeal of plate produced by Sydney to any potential customers.

90. Starting in 1941 and for the remainder of the war, Steel Control began preparing steel budgets to forecast and plan production and identify any deficiencies domestic capacity. The McKee company's report formed the basis for Steel Control's 1941 forecasts (Preliminary Report on the Canadian Steel Shortage, file S-9-1 vol. 3988, RG 19, NAC.).

91. Preliminary Report on the Canadian Steel Shortage, file S-9-1 vol. 3988, RG 19, NAC.

92. The imbalance between melting and blooming mill capacity was almost as severe at Algoma with an imbalance of 123 thousand tons (gross) (125 thousand tonnes). Among the big three steel firms, only Stelco had modest surplus capability of 45 thousand tons (gross) (46 thousand tonnes). Source: Preliminary Report on the Canadian Steel Shortage, file S-9-1 vol. 3988, RG 19, NAC

91. The typical yield achieved in rolling steel plate from ingot was approximately 70 per cent.

94. Report on the activities of Steel Control from its establishment...June 24th to October 1943, 1 November 1943, file 176-2-15, vol. 205, RG 28, NAC.

95. The author of this letter is unknown but it was probably written by A. Cross, president of Dosco since President appears at the bottom. Letter to C. D. Howe, 12 March 1941, F 1157 #5 Angus L Macdonald papers, PANS.

96. Although Steel Control suppressed rail production at the Canadian firms for most of the war, Dosco adapted its rail mill to produce steel billets for manufacturing shells. Hence, the rail mill continued to be used throughout the war.

97. The frigate component is of special significance to the demand for ships plate since it was physically larger than a corvette and required more steel to construct.

98. Armour plate required more care and a slower rolling rate in its production.

99. The contract details are from *General Statistics*, file 30, vol. 134 B1. i. b), Steel papers, BI.

100. F. H. Brown to L. E. Dewar, 2 September 1944, file 196-2D-2, vol. 195, RG 28, NAC.

101. R. F. Rahilly to F. B. Kilbourn, 5 September 1944, file 196-2D-2, vol. 195, RG 28, NAC.

102. The agreement to transfer ownership was verbal in nature. Dosco's records give no explicit date for the transfer. The absence of depreciation charges from the mill's operating costs in 1945 and the cessation of repayments to the government indicate the transfer was complete by January 1945. *General Statistics*, file #30, vol 134, B1. i. b. and vol. 37, B. ii. (a), MG 14, 26, BI.

Chapter 3: Shell Game: The Department of Munitions and Supply and the Trenton Steel Works Limited during the Second World War

3.1 Introduction

The outbreak of the Second World War saw Canadian industry ill-prepared to undertake a wholesale conversion to munitions manufacture. Unlike Australia's pursuit of self-sufficiency in munitions production during the international rearmament period of the late 1930s, Canadian domestic politics and a lack of funds arrested the development of a military-industrial complex that could facilitate a changeover from peacetime to wartime production. The limited demands placed upon Canadian industry during the "phoney war" only forestalled the inevitable problems of adjustment that came with the lack of industrial preparedness. The reversal of Allied fortunes in continental Europe in the spring of 1940 also required the Dominion government to take a more proactive approach to munitions production. In response, the government replaced its War Supply Board (WSB), which functioned as a centralized government purchasing agency, with the Department in April 1940. The Department provided the Dominion government, at least in theory, with almost total control and direction over the domestic economy. Such powers were to prove necessary to equip the Canadian economy with the capacity to produce munitions while simultaneously supplying at least the basic needs of the civilian sector.

The Munitions and Supply Act charged the Department with the responsibility to mobilize the Canadian economy, allocate raw materials and direct production in both the civilian and war sectors of the economy. How did it do at its task of coordinating munitions production? Bothwell (1981) and Bliss (1987) consider the Department's efforts at converting the Canadian economy to a war footing largely successful as witnessed by aggregate production figures.

However, aggregate production overlooks the concentration of war production in Central Canada. Bothwell considers this to have been the result of time constraints; the need for munitions was immediate and available plant for conversion was already in existence. In a dissonant note, Forbes (1986) argues the regional concentration of munitions production was also the direct product of C. D. Howe's preferences for developing Central Canadian industry over its counterparts in other regions and not just the steel industry. Consequently, political considerations largely dictated the pattern wartime investment and production. Schultz (1986) reviews several of the Department's decisions regarding the location of munitions plants to provide further evidence in support of this hypothesis. Bothwell, Drummond and English (1987, 355) cite the fact that Howe secured the cabinet's consent to ignore all ordinary political factors in awarding contracts for war work.

As argued in the introduction of this thesis, the issue of success in the government's conduct of its war effort revolves around how well it achieved its own strategic aims. The previous essay studied this issue with respect to the iron and steel industry by examining the Department's interaction with Dosco over its steel plant. Subventions paid to Dosco and the development of the Bathurst ore supply maintained and helped maximize the nation's steel production. Once the peak of wartime demand passed, the government then endeavored to curtail the plant's operations to economize on its financial obligations to keep the steel plant in operation. To comply with its own aim of avoiding the development of post-war excess capacity through wartime plant expansion, the rehabilitation of Dosco's plate mill proceeded only after the government exhausted all other possible sources of supply. After the war, the government shut down the mill and sold it to a US firm. The plate mill, in particular, demonstrates the interaction

between the Dominion government's strategic aims, embodied in the preferences of the Department's minister and its controllers, and wartime economic demands. Within allowable constraints, the government always acted to minimize the costs of war effort and this involved choices that appeared to discriminate against Dosco.

Does this strategic aim, to minimize the war effort's economic costs, also apply to firms involved in the production of war materiel proper? Or did some other strategic aim exist in the allocation of war production and investment, one that involved discriminating against firms in the country's outlying regions as Forbes and Schultz imply? Were economic factors even part of the strategic synthesis in the Canadian war effort when it came to munitions production? To even begin to answer these questions, we must first identify the guiding principles behind the Department's investment and production decisions. Within the archival holdings of the Department's files, the lack of correspondence, production and cost records of Canadian manufacturers involved in munitions production makes it difficult to identify the planning principles the government used to achieve its strategic aims, let alone judge its success in achieving them.

One potential source of information is the archival records of firms formerly engaged in war production. Fortunately, the surviving papers of the Trenton Steel Works Limited located in Trenton, Nova Scotia and a subsidiary of Dosco[1], provide an opportunity to investigate these issues. A secondary steel firm, it experienced a delay in procuring its first munitions contract despite its extensive experience producing shells during the First World War. Its first contract in the spring of 1940 came only after the acceleration of the war effort in Canada. The company's

papers allow us to investigate its attempts to secure its first contract, the eventual procurement of the four inch naval shell contract and the discourse between Trenton, the Department and other firms involved in equipping its shell factory. They also allow us to examine the efforts by the Department to allocate munitions contracts among producers on a least cost basis, as the company's efforts to produce a shell ill-suited for its equipment led to the loss of a contract.

To better situate the issues, Section 3.2 provides a literature review. It develops the two contrasting positions about the Department's procedures in allocating munitions production noted above and the issues surrounding Canadian munitions production. Section 3.3 examines the lack of domestic munitions manufacture and capacity during the 1930s which was the economic consequence of a political decision. The policy of equipment standardization among Britain and its Dominions, combined with limited Canadian demands, discouraged domestic munitions manufacture by either government arsenals or private firms due to high unit costs. Section 3.3 presents the Bren Gun's estimated manufacture costs which suffice to show the problems posed to domestic munitions manufacture by this combination of factors.

With the backdrop established, Section 3.4 examines Trenton's attempts to capture its first war contract. I argue that until the spring of 1940, excess potential munitions capacity in Canada created a competitive process for securing war contracts. Despite Trenton's efforts, its attempts at procuring government orders during the first ten months of the war were unsuccessful. As the European situation worsened and both Canadian and British orders began to flow, a modified competitive process emerged for developing domestic productive capacity and this gave Trenton its first contract. Using the example of West Coast Industries, a Crown Corporation established

by the Department to facilitate the arrangement of munitions production in Western Canada, and applying it to Trenton's case, I recover an economic criterion the Department used to evaluate various projects and plant configurations to show it made investment and allocation decisions concerning munitions production on a rational basis. The existence of such rational criteria were not just specific to Steel Control and the primary iron and steel industry.

Section 3.5 examines the efforts by the company and Department to quickly establish a shell plant. The sudden scarcity of machine tools in July 1940 and their absolute necessity to the mass production of shells required the Department's establishment of a control agency, Citadel Merchandising, to oversee the procurement and allocation of new and existing equipment among domestic manufacturers. Working closely with Trenton, the agency helped to reduce the capital costs associated with equipping the shell plant. However, its lack of knowledge about firm-specific constraints, namely Trenton's electricity supply, and the general inexperience with munitions manufacture led to confusion and delay over the choice of a suitable press to manufacture the shell casings. The company, recognizing its energy constraint, made the appropriate equipment choice early in the process of selection.

To further demonstrate the rational basis on which the Department made its production decisions, consistent with its strategic aims, Section 3.6 examines Trenton's production of the 5.5 inch shell. Dominion Engineering's press proved ill-suited for forging the shell leading to production costs well in excess of the company's original estimates. The cost plus version of the 5.5 inch shell contract, the target price contract, could not mask Trenton's inefficiency due to the existence of a competitor. Ontario Forgings was a factory constructed by Stelco in Hamilton,

Ontario solely for the purpose of manufacturing shells and other gun ammunition. With both companies producing the 5.5 inch shell, the Department could determine the more efficient producer even with the use of cost plus contract. After the Department recognized Trenton's relative position as the high cost producer, it transferred the balance of its production to Ontario Forgings, allocating production amongst producers in a least cost fashion. Hence, the cost plus contract did not totally obliterate economic incentives. This decision was also part of a learning process, by both the Department and the company, about how to produce what in an economic fashion. It shows the Department acting as a rational planning agency in its allocation of war production and making investment decisions without political considerations as part of the process. This example is not unlike the situation discussed in the previous essay confronting the Department and Steel Control about Dosco's production of steel plate. Once sufficient capacity existed at other domestic steel firms, Steel Control and the Department adjusted prices to reallocate production among firms in a least cost fashion. By using the correspondence between Trenton and the Department and firm-level data on the costs of munitions production one can delve into the Department's decision processes to a degree never possible before.

The findings of this essay establish the importance of economic factors in the strategic synthesis involved in the government's conduct of its strategic plan. It shows the Dominion government's strategic aim to minimize the costs associated with the war effort extended to include munitions production. The Department made a conscious effort and choices to minimize the costs of production and its investment expenditure. It chose among various plant configurations according to which would minimize the average fixed costs of production. The Department also attempted to duplicate market mechanisms by allocating munitions production

among Canadian firms in a least cost fashion once discrepancies in the costs of production became known to it; just like it did with Dosco's plate mill. The Department's crown corporation, Citadel Merchandising, also acted to minimize the costs associated with the construction of war plant. Working with the company, it successfully helped to reduce the costs of equipping Trenton's shell plant. Within the context of this aim and with respect to Trenton, the Department performed very well.

The government was less successful in establishing munitions production as quickly as possible. Delays arose in the construction of Trenton's shell plant from a dispute of the choice of an appropriate forging press. Trenton's choice embodied the use of a largely experimental technique, contrary to the desires of the Department. The existence of a binding constraint on Trenton's energy supply dictated the use of Trenton's choice. Only more adequate information on the constraints facing Trenton and greater experience with munitions production could have avoided the delay. The economic barriers to the latter, explored in Section 3.3, rendered this unavoidable. So, in large part, the government's efforts to quickly establish munitions production were a qualified success.

The Dominion government's effort, as part of a larger allied effort, to outproduce the Axis powers was also a success. The Department's reallocation of the 5.5 inch shell contracts was not only consistent with distributing production amongst firms in a least cost fashion, but was also consistent with efforts to maximize production. Trenton's production rate of the 5.5 inch shell never reached the rates specified in its contract with the Department. Although we do not know the exact production rate of Ontario Forgings, it was higher than Trenton's. Furthermore, the

reduced costs to the government arising from the reallocation of production freed up resources for other uses. By Milward's definition of success, the government consistently made choices that, while not always as successful as they might have hoped for, were at least in the proper direction for the fulfilment of this goal.

Section 3.2 Literature Review

Aggregate production figures in Table 3.1 for select munitions provide one crude method to judge the success of the Canadian war effort and show the basis for the conclusions by De N. Kennedy about its overall success. Canadian industry undertook a rapid conversion of existing product lines to manufacture of thousands of ships and planes, hundreds of thousands of vehicles and small arms, gun ammunition production that numbered in the millions and millions of pounds of explosives.[2] Bliss (1987) acknowledges, albeit grudgingly, the success of the Department with respect to its production programme although he rightfully concludes that "most of the government's control programs were temporary, patchwork arrangements held together only by the glues of patriotism and the War Measures Act" (Bliss, 450). Bothwell (1981) also considers the DMS successful in directing the conversion of the Canadian economy to a war footing. Production problems due to labour shortages were largely beyond the control of the Department and the successful conclusion of the Hyde Park Agreement with the US avoided financial problems stemming from the scarcity of US dollars due to the disruption of Canada's triangle arrangement with Britain and the US.[3]

Bothwell also observes that the pattern of munitions production and investment in industry reinforced the existing regional distribution of manufacturing activity rather than expand the base

outside Quebec and Ontario. In his view, the shortage of time in which to convert and construct factories for munitions and not politics were the crucial determinants in explaining the location of investment and production; there was simply no time for the doubtful experiments that locating plants outside Central Canada involved. Bothwell, Drummond and English repeat the observation that 'speed and efficiency' were the main criteria behind awarding contracts and constructing new plant, not 'regional balance' (Bothwell, Drummond and English, 355). They also cite the fact that Howe secured the cabinet's consent to ignore all ordinary political factors which normally included regional considerations.

Ignoring the simple fact that the Dominion government did not intend for the Department to function as a regional development agency, Forbes espouses the more sinister belief that the Department's production and control policies had the goal of achieving the closer integration of Central Canadian industry with the US. To fulfil this goal, Forbes claims the Department deliberately chose to overlook Maritime industry as a source of supply for war materiel until munitions production satiated the industrial capacity of Central Canada. A systemic bias existed on the Department's part to against investing in Maritime industry and developing supply sources reflecting the minister's preferences for developing Central Canadian industry ahead of that in the outlying regions. Forbes suggests this preference reflected the political gains to the Liberal Party from developing Central Canadian industry, the need to appease the Montreal metropolis which owned/controlled these firms, whose political influence he regards as considerable, and even Howe's friendship with Sir James Dunn, Algoma's owner. In short, political factors and interests largely dominated the government's munitions production programme and the decisions contained therein. Economic considerations did not factor into the Department's investment and production

decisions until a scarcity of appropriate industrial capacity in Central Canada appeared. Only then did the Department turn to industry in the Maritimes.

The aggregate production figures cited earlier mask the regional concentration of munitions production and investment evident even by early 1941 and the evidence we have seems to accord well with the Forbes' conclusions. Based on the dollar value of purchases under awarded contracts, Table 3.2 shows that Ontario and Quebec received 85 per cent of the total contracts awarded in Canada. The three Maritime provinces received slightly over 4 per cent, a similar figure to that of the Prairie provinces while British Columbia was the third largest recipient of contracts. A similar pattern emerges concerning investment in manufacturing facilities. Almost half of all new investment in manufacturing facilities occurred in Ontario, with Quebec in second place receiving one-third of the total, and with comparatively minor amounts invested in the remaining regions. Per capita purchases were markedly higher in Central Canada than elsewhere but the three Maritime provinces were not the sole victim of this alleged bias. The three Prairie provinces also featured per capita purchase on par or below that of the three Maritime provinces. Only British Columbia's participation in the government's shipbuilding programme kept it from a similar fate. However, these patterns only reflected an uneven distribution of activity existing before the war.

Schultz's (1986) study of munitions production in the first three years of the war also emphasizes the role of political factors in governing the allocation of new plants and investment. He provides some examples, such as a bomb plant in Cap de Madeline, Quebec, where political considerations determined the location of production and investment. The Department's own

crown corporations became a vehicle through political factors exerted themselves on munitions production. As one example of this, Schultz cites the case of the Allied War Supplies Corporation, the Department's crown corporation established to supervise the construction and operation of explosives and ammunition filling plants. The Corporation recommended the construction of a TNT plant in Moncton, New Brunswick to meet a shortage of TNT. Against the weight of its recommendation, the minister apparently decided against proceeding with the plant's construction. Based on the pattern of the corporation's investment figures, Schultz concludes that 'despite what business sense might dictate, patronage and party interests ruled' and drew the vast majority of the government's resources into industry in Central Canada (Schultz, 47).[4] On this point, however, Schultz's observations on the awarding of shell contracts contradict this conclusion since the government apparently awarded these contracts largely on the basis of political considerations even though it entailed 'delay, uneconomic production and unwarranted costs' (Schultz, 47). In this case, political considerations appear to work in the opposite direction, leading to war work for regions outside of Central Canada. Moreover, his observations leads one to conclude that in the strategic synthesis, political factors dominated economic ones. Coupled with Forbes' study, they lead one to further conclude that economic factors were absent altogether from the Dominion's strategic synthesis.

The reason for this is obvious. The attention paid by the above researchers largely focus on the outcome of the Department's decisions—aggregate production and investment and its regional distribution. But it is not enough to examine the simple outcome, to understand why the Department made the production and investment decisions it did, one must examine how the Department made its decisions. The rather murky criteria suggested to date of speed and

efficiency, patronage and politics does not suffice to fully explain the Department's decisions. After all, the example of Trenton and its munitions contracts run counter to the conclusions by Forbes. They suggest the Department preferred awarding contracts and investing where existing plant and equipment facilitated a quick changeover to munitions production. The following study derives specific criteria the Department used to select its producers and plant configurations once demand consumed existing capacity.

The following sections study Trenton's production of ammunition shells. By doing so, economic factors emerge to play a clear role in the Department's investment and production decisions. As an economic event, the acceleration of the war effort was an increase in the demand for munitions of all types and gave Trenton its first munitions contract to produce four inch naval shells. The Department exercised its powers to construct a shell plant that minimized the costs of construction and, once constructed, allocate production among Canadian producers in a least cost fashion. The decision to move production of the 5.5 inch shell to an Ontario company reflected economic and not political considerations. The investment decisions and choice of equipment made by both the company and the Department also reflected economic considerations and the existence of a binding constraint. Even during the interwar period, economic factors provided a serious discouragement to domestic munitions production by either the government arsenals or private firms.

This essay also places a judgement on the success of the Department from a different perspective of that used by the above authors. Schultz and Forbes judge the success of the Department, implicitly or otherwise, based on the resulting distribution of war work, which, in the

case of Forbes at least, they consider less than equitable. It is difficult, if not impossible to define what an equitable distribution of munitions production would have been except to say that it was something different than what occurred. Supposedly, this would have entailed less production in Central and more in the outlying regions. Nevertheless, the simple fact remains that the government did not charge the Department with the responsibilities of a regional development agency.

The government's success must be judged in terms of how well it achieved its strategic aims. In this respect, it performed very well. The study below shows how the Department, through its decisions, attempted to minimize the costs associated with the war effort and allocate production among producer so as to maximize production. In short, it strove for the efficient allocation of production and, within constraints, it was largely successful. These actions were in keeping with what Milward terms the government's true strategic aim, to out-produce the enemy. In the Canadian context, this consisted of the Dominion government's participation in a larger allied effort.

3.3 Canadian Munitions Production: 1920-1939

3.3.1 Production and Defence Budgets: 1920-1936

After the First World War, munitions manufacture by the private sector in Canada simply disappeared. The Dominion government quickly sold the handful of national factories established late in the war and disposed of other plant and equipment. With the disappearance of British orders and a sharply reduced Canadian defence budget in the immediate postwar period, demand evaporated. The reduction in Canadian defence spending meant insufficient funds to keep both

government arsenals in operation and so the government mothballed the Lindsay Arsenal in Lindsay, Ontario shortly after the war's end while it sharply curtailed production at the other government-owned arsenal, Dominion Arsenals near Quebec. Throughout the early 1920s, the procurement of some foreign orders, mostly American, allowed Dominion Arsenals to continue operating on a full time basis. By the late 1920s, however, the complete disappearance of foreign orders and the modest needs of the Canadian militia meant a shift towards part-time operation. As Bothwell, Drummond and English note (Bothwell, Drummond and English, 312) the meagre defence budgets over the 1930-35 period allowed the armed forces to do little more than buy postage stamps; existing stocks of field artillery ammunition, for example, were sufficient for only ninety minutes of battle after which there would simply be no more. The Dominion defence budgets reflected back in Dominion Arsenals reduced operations throughout this period and, on occasion, its complete shutdown. Only in 1936 did production return to a full time basis.

3.3.2 The Consequences of Neglect

One purpose of a government arsenal is the preservation and advancement of a country's technical capacity to produce munitions. Reduced demands for such items during peacetime limit the opportunity for private firms to undertake their production, let alone specialise in them and their development. By the mid-1930s, the capacity of Canada's industrial sector, public and private, to produce munitions deteriorated to such an extent that Canadian General Staff (CGS) observed, "At the present no facilities whatsoever exist for the production of rifles, machine guns and artillery weapons in Canada."[5] Despite its operation, Dominion Arsenals' capacity was in a virtual stasis since the end of the First World War. Even by the late 1930s, the range of munitions it could produce was restricted to small arms ammunition, artillery and gun shells up to 4.5 inch

calibre.[6] Although recent additions to its plant allowed it to manufacture shells for gun sizes up to 6 inch, its annual production capacity remained "unduly limited."[7]

By 1939, an industrial survey by the Navy, Army and Air Supply Committee (NAASC) confirmed the deleterious effects of neglect on the Dominion's defence industrial preparedness. Begun in 1936, the NAASC's survey of almost 1600 domestic manufacturing firms revealed they were not properly tooled to produce the British designed munitions used by the Canadian milita. Not only did Canadian manufacturers suffer from a lack of production experience but to even begin producing munitions required a tooling up process involving the construction of new plant and equipment. This was the purpose behind the British and Canadian "educational" orders during the later 1930s. Designed to create the necessary plant and equipment and provide domestic manufacturers with production experience, the British and Canadian governments employed these orders only on a limited basis, restricting them to shell production. High fixed costs of production for the necessary equipment, the small scale of production and the manufacturer's limited experience entailed high unit production costs for such orders. Under the supervision of the Dominion Arsenals in 1937, the Montreal Construction Supply and Equipment Company produced 18-pounder and 4.5 inch Howitzer shells for the DND at a unit cost of $7.01 and $14.81 each, respectively.[8] By comparison, Trenton produced both types during the First World War, in far greater quantities, achieving lower unit costs of $2.84 for the 18-pounder and $3.25 for the 4.5 inch Howitzer shell (based on 1918 cost figures).[9]

3.3.3 Political Constraints on Production and their Economic Consequences

The high cost of these educational orders and political constraints on domestic munitions

manufacture proved an effective deterrent to their proliferation during the international rearmament period. On the political side, Mackenzie King wanted to distance himself and his government from the "merchants of death" spectre that had haunted munitions manufacture during the First World War. King was also reluctant to promote Canadian firms as potential suppliers to Britain because of his desire for neutrality (Eayrs 1969, 135-155 and Haycock 1988). Economic factors, however, also weighed heavily in the discouragement of the development of any domestic munitions capacity.

Domestic munitions production for the Canadian armed forces proved prohibitively expensive due to a particular conjunction of factors peculiar to the British Dominions. At the Imperial Defence Conference of 1909, the United Kingdom and its Dominions agreed upon the principle of standardization in weapons, ammunition, and military equipment. By default, Canadian forces were always to be equipped with munitions conforming to British specifications. With the exception of aviation, the Dominion government and the Department of National Defence remained committed to this agreement, in both theory and practice, for the next three decades (Stacey 1970, 488). Although this policy appeared useful in preventing the proliferation of different weapons types during an armed conflict involving Britain and its Dominions, it gave British arms manufacturers a virtual monopoly over arms production. This was problematic because munitions manufacture of the1930s required highly specialised machine tools, hydraulic presses and other equipment, the designs of which were the intellectual property of British firms. These British firms would grant their Canadian and other Dominion counterparts access to the necessary blueprints and machinery if production only supplied the home country's armed forces. Any licensing agreement would prohibit their export to other countries, especially Commonwealth

countries where their sales could compete with those of the British producer of the item (Department of National Defence (DND)1958, 11). Given the high fixed costs of munitions manufacture for plant and equipment, coupled with the relatively small scale of the Canadian armed forces requirements, this translated into high unit costs and a further discouragement to launching a wholesale Canadian rearmament effort.[10]

3.3.4 The Bren Gun

The example of the Bren Gun clearly illustrates this problem. To have a domestic manufacturer undertake its production, DND authorities estimated the Bren's unit costs in 1936 at $535.48, based on a Canadian army requirement of 7000 guns.[11] The Dominion cabinet concluded that Canadian production of the gun at this level of production was too expensive. Eventually, the Dominion government secured a British order for an additional 5000 guns, reducing the gun's estimated unit costs to $411.91.[12] After approval of the order, the Dominion government selected Toronto's John T. Inglis Company, a machine tools manufacturer, to produce the gun instead of building a government-owned plant or expanding production at an existing arsenal. The stated advantage to its manufacture by a private firm was that the plant and equipment were not entirely worthless once production of the gun was finished. Production by a private firm mitigated the disposal problem for plant and equipment posed by a government-owned plant.[13]

3.3.5 Summary of the 1920-1939 Period

The restricted nature of Canadian munitions production during the interwar period had an

important consequence for domestic manufacturers looking for government contracts. They faced the difficult task of establishing production without a large in-country repository of knowledge and production technique in either the private sector or Dominion Arsenals. With respect to Trenton, the firm at the centre of the current study, there was the additional factor that it did not participate in any educational orders before the war. This gave Trenton the difficult task of having to prove itself and search out contracts initially, until demand conditions rendered a search unnecessary later in the war. Although the experience from shell manufacture during the First World War would prove helpful, it was ultimately limited given changes in shell production technology during the 1930s.

3.4 Munitions Production: The Second World War

3.4.1 A Limited War: September 1939-June 1940

The outbreak of the Second World War found only one private firm and Dominion Arsenals engaged in munitions work. The British War Office had contracted National Steel Car Company in Hamilton, Ontario to produce 25 pounder and 4.5 inch Howitzer shells.[14] The industrial sector still suffered from the deficiencies uncovered by the earlier NAASC survey which meant that Canadian industry did not lend itself to rapid conversion towards munitions manufacture (DND, 13). But the expected flood of government contracts for war work initially produced only a trickle so that any deficiencies did not show themselves until the following summer. The war's limited nature until the spring of 1940 placed few demands on Canadian industry whose capacity the British considered residual to their own. British authorities, who recognized the deficiencies of Canadian industry, were also reluctant to let any contracts out in Canada because of the long lead time required to establish production. This view continued to

prevail in the spring of 1940 as the European situation worsened. The need for munitions was immediate and not "six or eight months ahead when Britain was expected to catch up with demand." Coupled with the ruling hypothesis of a three years war, Britain would gain little by encouraging the manufacture of a variety of munitions beyond the little that Canada was capable of producing in the short term (DND, 13). Of course, Britain's own manufacturers and armament firms would have objected strongly to supply lines developing elsewhere that would only emerge as potential competitors in a postwar world. Thus, the initial demands placed upon Canadian industry by Britain's purchasers were largely limited to the provision of foodstuffs and raw materials. Limiting their demands to these items also helped the British government to circumvent a second problem, the conservation of its foreign exchange reserves. To emphasize the limited amount of war work, Table 3.3 lists the first ten British orders placed in Canada. The quantities and production rates show the limited nature of the war and the resulting demands.

This situation led to a competitive market for war work in Canada, if only for a short duration. Since orders were few and substantial excess capacity for such work still existed among engineering and secondary iron and steel firms, the Dominion government could afford to tender contracts on a competitive bid process. This is evident in the nature of the government's earlier procurement agencies, the Defence Purchasing Board and the WSB, and in the outcome of Trenton's attempts to procure its first contracts. As early as September 1939, Trenton's officials prepared cost estimates for the production of 9.2 inch, 8 inch and 6 inch shells on instructions from Dosco's head office in Montreal. Despite Trenton's experience with the production of the 9.2 inch and 6 inch shell during the previous war, which formed the basis for their preparation, the contracts went to Canada Car and Foundry and the Sherbrooke Pneumatic Tool Company, both

located in Montreal, Quebec. Presumably cost was the major factor involved in such a decision. Unlike later bids made by Trenton, these ones did not include the costs of establishing a shell forging and finishing plant; they merely referred to the cost of producing the shell.

The remainder of the fall and the following winter saw little activity on Trenton's part to secure any government contracts. This was a function of the parent company's organization and geographical location of its plant. All of Dosco's head offices, including its sales office, were found in Montreal while the Trenton plant itself was in Nova Scotia.[15] Dosco's subsidiaries were neither expected nor supposed to take any active involvement in the search for work resulting from the war as this was considered the exclusive domain of the Montreal office.[16] The head office, however, was supposedly in close touch with Ottawa since the declaration of war and on the lookout for any work.[17] This "close touch" did not appear to produce any material results until June 1940 and only after a visit to Ottawa by some of Dosco's management and technical staff did Trenton secure its first contract. This followed on the heels of a request not from Dosco's head office, but Senator Thomas Cantley[18] (a Senator representing Nova Scotia) that officials from Trenton and Sydney "come here at once and demand a share of the contracts now being given out" since several firms comparable to Trenton's capabilities were already receiving contracts.[19] The trip to Ottawa also provided Trenton with the ability to inform the Department quickly if their facilities were adequate for the Department's needs or if munitions production would require additional investment.

3.4.2 Acceleration of the War Effort: June 1940

Senator Cantley's request suggests that politics played a significant role in Trenton's

efforts to obtain war work. However, this ignores the increased demand for munitions after the winter of 1940 that included the item yielding Trenton its first munitions contract. As the European situation grew increasingly acute in the spring, the WSB in Ottawa received several requests from Britain to investigate the production of: 1) the 25 pounder shell, 2) the 4.5 inch howitzer shell, 3) the 4 inch naval shell and 4) to increase production of the 6 inch howitzer shell. Following the events in France during June 1940, further production increases for existing orders arrived in Ottawa along with orders for several new munition types on July 5. The magnitude of these new orders and the increases in existing orders, detailed in Table 3.4, marks a clear turning point in Canadian munitions production. British authorities abandoned their earlier restraint applied to orders and utilisation of Canadian industry at the same time the allied army abandoned their equipment on Dunkirk's beaches. British and Canadian authorities dispensed with educational orders and the competitive process could no longer exist. More importantly, the absence of the acceleration would have only lengthened Trenton's wait for war work. Politics could not obtain for Trenton what did not exist.

3.4.3 The Four Inch Naval Shell

Britain's request for the Department's staff to investigate the production of the 4 inch shell gave Trenton its first contract. After several meetings with Department officials during the Dosco delegation's Ottawa tour, Trenton's management received a request on June 25, 1940 for a capital expenditure estimate to establish a shell forging plant capable of producing up to ten thousand forgings per week. The Department also requested the submission of capital expenditure proposals for a finishing shop capable of producing finished 4 inch naval shells[20] at the rate of 4000, 7500 and 10 000 shells per week. The proposals were also to include estimated

prices for the forgings and finished shells.

3.4.4 Plant Configurations, West Coast Industries: Recovering the Investment Criterion

Assignment of this contract to Trenton raises the question of how the Department chose between various plant configurations and production rates when no other competitor existed. Investigating this question reveals that the Department used an economic rationale in its investment and production decisions concerning munitions plants and that it was not limited in its application to Trenton. This is important since previous research on this matter provides few answers. The minister's instructions to his officials following June 1940, "take such steps as we feel proper in the interest of getting on with the war effort,"[21] obscures any economic criteria governing the Department's investment choices (Bothwell, 62). The belief that Howe, backed by the Dominion war cabinet, had effectively removed the dollar sign from the Canadian war programme following Dunkirk also helps to create the misperception that there was no budget constraint governing wartime capital assistance expenditures. Evidence to the contrary includes the iron and steel industry where there was always the consideration, (applied with particular vigor) that investment in new capacity should take advantage of existing plant where possible. This originated from the need to produce munitions and equipment as quickly as possible[22] and the obvious way was to initiate production where manufacturers could utilize existing plant. Secondary iron and steel firms were prime candidates for such projects as shell manufacture.

The case of West Coast Industries establishes a firm criterion for the evaluation of such projects. West Coast Industries was another of Howe's crown corporations established in the summer of 1940 to facilitate the development of munitions production in Western Canada and, in

particular, British Columbia.[23] In the fall of 1940, the Department requested that West Coast Industries develop a proposal for the forging and finishing of 3.7 inch anti-aircraft shells in conjunction with manufacturers in BC and Alberta.[24] The initial plan proposed to develop a forging plant in BC and to split the finishing work between two plants in BC and Alberta. Like similar projects elsewhere, these plants would develop as extensions to existing engineering and secondary iron and steel firms.[25] The Department rejected West Coast's initial proposal because of the required capital expenditure per shell. The proposed setup was too expensive relative to the costs obtained for similar projects in Ontario and Winnipeg. West Coast's proposal estimated the unit capital costs at $1.57 per shell compared to $1.06 per shell for the Winnipeg plant and $0.50-$0.62 per shell in Ontario.[26] Although West Coast eventually developed a lower cost proposal costing $1.06 per shell (based on a lower monthly finishing rate in the BC plant), the full project eventually became a casualty of the fluid nature of the war programme during this period.[27]

If we characterize the capital costs of a munitions plant as the fixed costs of production, then the Department chose among competing plant proposals or configurations based on which incurred the lowest average fixed cost. Table 3.5 constructs Trenton's unit capital costs (based on an initial contract for 200 000 shells) for the forging and finishing plants based on the weekly production rates for the three requested configurations. The plant configuration capable of producing ten thousand shells per week entailed the lowest average fixed cost per shell was the deciding factor in choice of the shell plant's layout. This configuration also corresponds to the lowest unit price estimate. This correspondence reflects the spreading out of overhead and other fixed costs of production excluding the amortization of plant and equipment.

With the decision on a plant configuration made, there was still the problem of its construction. While Trenton's existing buildings would suffice to hold the shell plant, little of its existing machinery would prove useful for shell manufacture. The main problem was securing the desired equipment appropriate for Trenton's environment in a period of high demand for scarce machine tools. As we shall see in the next section, the problem of an appropriate manufacturing technique emerged due to the lack of pre-war production experience by both the government and Trenton. Ultimately, constraints on available factor supplies, namely electricity, determined the choice.

3.5 Construction of a Shell Plant

3.5.1 The Machine Tool Problem and Citadel Merchandising

The acceleration of the war effort during 1940 revealed the deleterious effects of the Great Depression on the Canada's stock of machine tools and a fundamental weakness the nation's defence industrial preparedness. The Department's national inventory of machine tools adaptable for munitions work taken during the spring revealed that only one-third of Canada's estimated 30 000 machine tools were less than 10 years old while the remainder ranged in age from 10 to 50 years. Department officials concluded that only one-third of this total stock was readily available for munitions work. The Department estimated (or guessed) that the hastily revised munitions production programme in the summer of 1940 would require some 40 to 50 thousand machine tools over the next two or three years. This created an immediate shortfall, or excess demand, of some 30 to 40 thousand machines. Obviously, their procurement required some measure of centralized coordination. Two problems in particular presented themselves: the (re)allocation of existing machine tools and the procurement of new machines to expand production. To handle

the procurement problem, on 3 May 1940 the Department incorporated Citadel Merchandising (a crown corporation), to act as a purchasing agent for new equipment and a clearing house for existing machines. Formal control over the Canadian industry and market for machine tools started on 22 August 1940 with the creation of Machine Tools Control.[28] Together, these two agencies gave the Department the means to direct the allocation of machine tools within the Canadian war economy.

3.5.2 The Procurement Problem: How effective was Government Control?

The procurement and allocation process required Trenton's technical staff to prepare and submit to Citadel's head office in Montreal a list of the necessary machinery to establish a forging plant and finishing shop. There, Citadel's staff compared it to a list of machines available elsewhere in Canada. They also checked the technical description and price quotations obtained by Trenton's staff on their chosen equipment against that of alternative suppliers in Canada and the US.[29] Citadel Merchandising, backed by Machine Tools Control, had the power to dictate to Trenton, or any other manufacturer, the machinery it would ultimately purchase.

With respect to the machinery list proposed by Trenton for the finishing plant, Citadel took exception to machines in eight of the twenty-three operations involved in shell finishing. Noting that "machines for this class of work cannot be selected entirely from considerations of price and rated output."[30] Citadel's staff suggested substitutions when they could identify a machine that was less expensive and/or capable of a higher output. In the interaction between the two companies that followed, Trenton's officials eventually accepted three of Citadel's substitutions where machines of lesser cost were involved. For the other recommendations,

Trenton's officials located cheaper machines by themselves. These machinery and equipment substitutions by Trenton and the Department reduced the estimated cost of outfitting the finishing plant from $226 000 to $212 000.[31]

While Citadel's performance here was worthy, equipping the shell forging shop produced several delays over the selection of an appropriate forging press. This decision, however, also involved a choice of an appropriate production technique. Before the 1930s, a hydraulic press could forge a small caliber shell blank but to produce a smooth cavity required several extra finishing steps in a series of operations that were both labour intensive and time consuming. An alternative means involved the piercing and drawing method where a press first pierced a steel billet which was then drawn to size through rings or rollers. A major innovation in shell manufacture occurred during the 1930s, when a German munitions firm developed a "one shot" forging process that produced a finished cavity by forging press alone, thus eliminating the finishing operations at the forging stage. The production rates made possible by such a production method gave Germany a substantial technological lead. With the onset of rearmament in Britain, a deliberate catch up process started in 1936 with Stewart and Lloyds (an engineering firm) developing its own version of the press that it completed by 1939 (Postan 1952, 403 and Hornby 1958, 304-306). By the summer of 1940, Dominion Engineering of Montreal developed its own version of the press, apparently without outside technical assistance.[32]

Trenton initially selected the Dominion Engineering press for its forging plant. The press and its production method had two advantages. First, with the elimination of the finishing steps, the one-shot process required less labour to produce a smooth cavity. In the labour scarce

environment of a war economy, this process would prove invaluable. It also saved on capital since the process also required fewer machines. Finally, the one-shot method was less energy intensive since it eliminated the drawing process. This was not only time consuming but required extra labour and capital in the form of the drawing benches to complement the forging process. Despite the obvious advantages, Citadel informed Dosco's sales manager in mid-August that it considered the Dominion Engineering press unsuitable for the production of 4 inch shell forgings and advised Trenton officials to find an alternative.[33] The reason for this decision was twofold. Shortly after getting the 4 inch contract Trenton secured another one to produce the 6 inch howitzer shell urgently required by the British. In anticipation of further unexpected demands, it was the Department's stated wish that any forging equipment installed at Trenton could produce forgings up to this size.[34] As we shall see, the Dominion press was not always well suited for the manufacture of shells below this size. There was also the desire on the Department's part to standardize production methods across plants as a method of economizing on the sharing of technical advice. They suggested that Trenton officials contact their counterparts at Page Hershey Tubes Limited, which was already producing this shell type and Stelco, whose management was in the process of purchasing equipment for their own shell plant, about what constituted a suitable press.[35]

The lack of experience with the one-shot method of production in Canada before the war explains the reluctance by Department officials to sanction its use. Shell production at National Steel Car relied on the two-stage piercing and drawing method. Department officials expressed their concern about whether the Dominion press could produce a smooth bore finish in a single forging operation, "whereas they do know that the old type of press combined with a draw bench

is satisfactory for this type of work."[36] Their preference for established methods was embodied in their eventual selection of an alternative forging unit, the Southwark Press and Draw Benches, a unit identical to that already in operation at the National Steel Car plant, obviating the problem of sharing technical information.[37]

The selection of an alternative press by either Trenton's officials or Citadel's staff was still incomplete by the end of August. However, Citadel's staff and the Department officials appeared to soften their stance against the Dominion Engineering press. The Department informed Trenton to postpone the selection of an alternative until it could evaluate the performance of a Dominion press under installation at the Manitoba Bridge Company.[38] But less than a week a later, the Department informed Trenton to select an alternative press as they did not expect the installation of the Dominion press at Manitoba Bridge for another four to six weeks.[39]

At this point in the planning process the smooth coordination between Citadel, the Department, and Trenton breaks down. Not only was the installation of the Dominion press at Manitoba Bridge, which the Department claimed would not be finished until at least the end of September, complete by mid-September, it was also ready for production. Trenton's General Superintendent went to Winnipeg to observe its operation and evaluate its performance. Meanwhile, Citadel officials informed Trenton that they had ordered four Southwark press and draw bench combinations with at least one destined for Trenton. This marks a serious error of judgement on Citadel's part as there were several problems with the unit for Trenton's plant. The rated production capacity of a Southwark unit was one-half that of a Dominion press necessitating the installation of two units to achieve the required production rate of 10 000 forgings per week.

A single Southwark unit was almost twice as expensive as the Dominion press at $141 000 per unit versus $78 000[40] and its production by an American company necessitated the use of scarce US dollar reserves for its purchase. Imports from the US were also subject to a temporary wartime tax (to help conserve on US dollar reserves) regardless of end use, thus further increasing its cost. The Department accepted the additional expense of the Southwark unit as the cost of establishing the country's capacity to produce munitions from scratch. One final source of resistance against the Southwark unit was view held by Trenton's management and technical staff that the Southwark unit represented an experimental method of manufacture, contrary to that held by Department and Citadel officials. The company did not express this view to either the Department or Citadel Merchandising.

In the end, Trenton's management prevailed in their choice. However, this did not result from the company usurping the powers of the Department and Citadel Merchandising. Instead, it was the consequence of a binding constraint on the company's available electrical supply that the use of the Southwark unit would create. To achieve the target production rate of 100 shells per hour, the Dominion press required 300 horsepower compared to the Southwark's unit requirements of 1600 horsepower.[41] The demands of the Southwark unit exceeded the capacity of Trenton's electrical supply forcing the selection of the Dominion press. The installation of additional generating capacity at Trenton could alleviate this constraint but there was simply no time to consider this option. Construction of an additional generating unit would have taken a year or more and given the additional constraints imposed by time and the urgency of demand, installation of the Southwark unit was not feasible. This was another advantage to the single shot method: not only did the Dominion press combine the three steps of piercing, drawing and

machining into a single forging operation but it required less labour and fewer machines, offering substantial energy savings over the two-stage method of piercing and drawing. Once Trenton's management informed Department officials of the constraint, there was no choice but to approve the purchase of the Dominion Press despite their reservations. This left the Department with four Southwark units that it attempted to foist upon Dominion Bridge and Stelco for installation in their own shell plants under construction.[42]

3.6 The Allocation of Munitions production

3.6.1 The 5.5 Inch Shell Contracts

Examining Trenton's production of the 5.5 inch shell forging demonstrates clearly how the Department acted to allocate production among existing firms when the capacity to do so existed. In the spring of 1941, Britain canceled all orders for the 6 inch howitzer shell. Trenton planned to forge this shell with the same single shot method used for the four inch naval shell in a second Dominion Engineering press under construction. Shortly after the cancellation, Trenton received three separate contracts to produce a total of 230 000 5.5 inch shells. Although Trenton's management predicted that the dimensions of the 5.5 inch shell were not amenable to forging by the Dominion press [43], the Department instructed the company to use it anyway. This prediction proved well founded. Trenton and Dosco's staff tried without success to overcome the difficulties by experimenting with the size of the steel billet. In October 1941, four months after the start of production, the press was still undergoing modifications and Trenton could not report when they would reach maximum production. Average weekly production over the first seven months rarely exceeded 2500 per week and the Department informed Trenton staff in December that the minimum acceptable rate was 3750 with provisions for increasing to 5000 forgings per

week if necessary.[44] (The daily production of the original setup was estimated at 1000 per day.) Further production troubles involving the grinding, sand blasting and inspection steps later followed the troubles posed by the forging.

Trenton's surviving business records include detailed monthly production cost statements for each type of shell it produced. The Department required all its munitions producers to prepare records of this type for use in subsequent audits. Under the Department's target price contract, described in greater detail below, these records ensured that the firm's rate of profit did not exceed 5 per cent of costs as defined by the Department. Figures 3.1 to 3.4 allow us to examine the behavior of the shell's unit production costs and compare it with that of two other shells successfully produced by Trenton, the four inch and the 4.5 inch. Figure 3.1 shows that, unlike Trenton's experience with the four and 4.5 inch shell, the 5.5 inch shell's unit production costs continued to increase six months into the shell's production. The unit costs of the four and 4.5 inch shell quickly declined in the first month of production and remained level for the first year of their production. The spike in the 5.5 inch shell unit costs in the fourth month of its production reflects Trenton's considerable experimentation with the press in October 1941 and its attempts to ensure the efficient manufacture of the shell forging. Unit production costs continued their upward trend following this spike, attesting to the company's inability to overcome the press's operating difficulties. While unit forging costs for the four inch and 4.5 inch shell were 58 and 80 per cent of the first month's level in the twelfth month, respectively, the unit cost of the 5.5 inch shell remained unchanged.

Figure 3.2 shows that rising unit labour costs contributed to the overall rise in unit

production costs over the initial six months of the shell's production. This is in sharp contrast to the production of the other two shells which featured initially declining unit labour costs, leveling out shortly after they entered production. Not only does the scope for learning by doing and its effect on labour costs appear limited but its benefits were exhausted within two or three months of each shell entering production. Trenton's experimentation in the fourth month of the 5.5.inch shell's production had a considerable impact on unit labour costs and also failed to stem a continuing rise in unit labour costs for the next two months.

The unit tool costs in Figure 3.3 measure the Dominion press's consumption of the dies and punch tips used to manufacture the forgings. Compared with the production of the other two shells, the 5.5 inch shell's unit tool costs were consistently higher in the later months of production, well after those for the production of the four and 4.5 inch shell had declined. This divergence helped contribute to the shell's continuing high unit cost compared to that produced by Ontario Forgings. Again, the effects of Trenton's experimentation in the fourth month of the 5.5 inch shell's production is reflected in a spike in unit tool costs. This cost item remained consistently higher than what Trenton experienced with the other two shells, testifying to the inappropriateness of the Dominion press for producing a larger shell.

From Figure 3.4, high unit repair costs appear common to the initial month of each shell's production. In the case of the four inch shell, unit repair costs fell dramatically between the first and second month and thereafter remained relatively constant over the first twelve months of its production history. Unit repair costs also fell for the 5.5 inch shell but remained higher than for the four inch. Unlike the four inch shell, unit repair costs for the 5.5 inch rose in the last four

months depicted in the figure. The economic consequences of Trenton's attempt to use the Dominion press for the production of the 5.5 inch shell are obvious from the consistently higher and irregular unit repair costs its use entailed. Combined with the behavior of the press's unit tool costs for the 5.5 inch shell, these figures clearly demonstrate the insurmountable problems posed by the technical capacity of the press. An inefficient plant layout perhaps had less to do with the 5.5 inch shell's excessive cost than technical constraints placed upon Trenton's production capabilities by the capital equipment within its shell shop. Given the Department's unfamiliarity with not only the latest methods of shell production but their manufacture in general, the technical capacity of the Dominion press would only become apparent with the passage of time and gaining of experience.

3.6.2 The Structure of Munitions Contracts

The production difficulties outlined above led to higher than expected unit costs under Trenton's target price contract with the Department. One of several types of contract the Department used, a target price contract required the company's submission of estimated unit production costs to the Department with a markup of 5 per cent over costs as profit. After production of an initial set quantity, the Department required the firm to submit a detailed cost accounting statement for comparison with the target version. If actual costs exceeded the target cost, the Department deducted 25 per cent of the difference from the profit allowance until reaching a minimum preset figure. Where actual costs were less than the target cost, the firm received a bonus equal to 25 per cent of the difference. Under this arrangement, the price received by firms for munitions work would always cover actual production costs, although the actual profit rate would vary.[45] Occasionally, the initial target quantity was split into smaller lots

to account for "expenses of an exceptional, non-recurring nature" involved in start-up.

3.6.3 Target and Actual Shell Production Costs

With respect to the 5.5 inch shell, the Department's staff expected costs on the target quantity of 10 000 (after the initial 15 000) to represent normal practice and form a fair target basis for estimating unit costs on the remaining shells.[46] Trenton's staff estimated a unit production cost of $7.76 per shell and with a profit of 5 per cent, that brought the price for forged blanks to $8.15 per shell.[47] The Department countered with an offer of $8 per shell stating that it considered $8 high. Trenton accepted this offer.[48]

As production continued through the spring and summer of 1942, the 5.5 inch shell's forging costs remained high relative to that obtained by Ontario Forgings. In July 1942, the *price* of a 5.5 inch shell blank produced by Ontario Forgings was $6.80 per shell versus a unit production *cost* of $7.30 per shell at Trenton.[49] The Department complained to Trenton in the following month about the shell's high cost of production and threatened to pull all contracts for its manufacture if the company could not improve its performance. Within the company, Trenton's management conceded that given their use of the Dominion press, further reductions in the shell's unit cost were unlikely. Rather than reveal this fact to the Department, Trenton's management argued to the Department that its shell plant could not compete with the streamlined operation of Ontario Forgings. Its construction as an entirely new plant for the express purpose of shell manufacture allowed for the optimum arrangement of machinery and equipment whereas Trenton's shell plant, constructed around their existing plant and equipment, yielded a less efficient layout. This, the company implied, lead to higher unit costs through delays in the

production process and increased materials handling. After the Department guaranteed Trenton's management that cancellation would not harm the company's reputation in future bids on munitions contracts, they conceded all outstanding 5.5 inch shell contracts to Ontario Forgings.[50] The Department's guarantee was good as Trenton soon received a contract to produce 4.5 inch shell forgings. Its dimensions were amenable to forging by the Dominion press and its production did not entail any of the problem posed by the 5.5 inch shell. Production of this shell by the company continued until the end of the war in Europe.

3.7 Conclusion

The lack of well-defined, publicized criteria guiding the Department's wartime investment and production decisions is responsible for the dominance of political factors in explaining their observed patterns. The nebulous criteria described to date, such as that by Bothwell, Drummond and English, where considerations of speed and efficiency were essential to the Department's decisions compounds the problem. Therefore, the Department's guiding principles, if any, are naturally open to speculation. Moreover, it is not even clear whether economic factors were present in the government's own strategic plan and its conduct of the war effort. Fortunately, the information available from Trenton's wartime records helps clarify the Department's planning principles and yields the following three findings about its decisions: 1) where possible, the Department allocated production among Canadian munitions plants in a least cost fashion to minimize the economic costs of munitions production; 2) the Department chose among plant configurations for different production rates according to which one minimized the average fixed costs of construction; and 3) the Department, through its control agencies, attempted to minimize the equipment costs associated with the construction of new plant. Economic factors clearly

mattered to the government in its investment and production decisions and in its role as a central planning agency, the Department performed, or at least attempted to, as well as the market it replaced. It did not entirely suppress market incentives with its own system of priorities and physical controls but merely modified them. Costs of production and profit were still factors in the wartime economy and were part of the government's strategic synthesis discussed in the introduction of this thesis.

The shear fact that economic costs mattered to the government must reduce, or at the very least qualify, the importance given by Forbes, Schultz and others to political factors in explaining the observed pattern of production and investment. Trenton's loss of the 5.5 inch shell contracts demonstrates this fact. If costs did not matter to the government, Trenton would have kept producing the shell. Furthermore, the initial delay in Trenton procuring its first contract resulted from the limited munitions demands characteristic of the phoney war. Before the spring of 1940, there was simply not enough demand and war work to satisfy every Canadian manufacturer. Although politics may have played a small role in securing Trenton's first contract, even the investment decisions regarding the type of plant were subject to economic criteria. Future research on the Department's activities and Canadian munitions production must take account of these facts and determine how far it extends to other firms.

The Department's success in achieving its strategic aims involved in the production programme met with mixed results. Delays occurred in establishing shell production at Trenton due to the confusion over what constituted a suitable forging press. The choice, ultimately dictated by a binding constraint, resulted from the government's lack of knowledge about the

constraints facing Trenton. Once known, the government still proceeded in a manner to initiate production as quickly as possible by authorizing the purchase of the Dominion press. In this case, Trenton's concealment of its constraint hindered the government's efforts to quickly establish operations and so it can hardly be faulted for the delays in start-up. Here, the Department maintained the pursuit of its goal to establish factory and plant and initiate production as quickly as possible, with mixed degree of success.

Still on the matter of success, Trenton's use of the Dominion press embodied an experimental method of production that proved ill-suited for the manufacture of some shell types. Its attempts to produce the 5.5 inch shell with the Dominion press when it was clearly not suited for the task resulted from a lack of production experience on the part of the government and the firm with munitions before the war. This lack of foresight and experience could not be remedied but its effects, once apparent, were. In reallocating the production of the 5.5 inch shell away from Trenton and towards Ontario Forgings, the Department chose not only to minimize costs but to maximize production. Trenton's production rate of the 5.5 inch shell never reached the called for targets. This reallocation accords well with Milward's concept of the true strategic plan, the attempt to outproduce the enemy. Production of the 5.5 inch shell by Ontario Forgings was one step closer to this plan's successful implementation. Regional balance in the distribution of war work was simply not a strategic aim or priority of the Dominion government in the conduct of its war effort.

Once the war in Europe was over, the shell plant ceased operations. It resumed production after receiving orders from the Department of Defence Production, testifying to the

specialized nature of the plant's equipment. It finally ceased operations after the end of the Korean War.

Tables

Table 3.1.–Production volume for select munitions 1939-1945

	1939-40[a]	1941	1942	1943	1944	1945
Ships[b]	16	124	232	907	2,407	762
Aircraft[c]	913	1,699	3,782	4,133	4,178	1,713
Mechanical Transport[d]	-	189,178	199,542	176,885	157,270	92,854
Armoured Fighting Vehicles[e]	-	3,027	12,987	15,559	13,746	5,344
Small Arms[f]	1,391	25,739	385,576	609,276	531,219	214,191
Heavy Ammunition[g] (thousands of rounds)	0	100	13,718	15,044	10,403	1,730
Small Arms Ammunition[h] (thousands of rounds)	0	383,407	1,175,557	1,491,709	1,182,175	405,561
Explosives[i] (thousands of lbs)	0	139,902	284,164	240,625	174,723	161,476

a) Figures for 1939 separately are not available.
b) Total production of naval and cargo vessels.
c) Total consists bombers, fighters and trainer production.
d) Total includes production of 4x2, 4x4, 6x6 and other vehicles.
e) Total consists of tanks, Bren Gun carrier and other tracked vehicles.
f) Total includes production of rifles, pistols, machine guns and other types. It does not include magazines, spare barrels and tripods.
g) Total production of filled fixed ammunition only. It does not include the production of cartridge cases, projectiles, grenades, mortar bombs and other types.
h) Total production of .303 inch and other types of ammunition.
i) Total for explosives production only. It does not include chemicals. Their metric equivalents are from left to right: 63,592 kgs, 129,165.5 kgs, 109,375 kgs, 79,419.5 kgs, 73,398.2 kgs.
Source: Department of Reconstruction and Supply. *Canada's Industrial War Effort.* Table 8. Vol. 8, RG 28, NAC.

Table 3.2.–Provincial distribution of contracts and investment–14 July 1939 to 31 January 1941

	purchases (000,000's)	distribution	manufacturing investment (000,000's)	distribution	purchases per capita
PEI	$1.0	0.15%	$2.6	0.07%	$10.98
Nova Scotia	15.3	2.28	91.4	2.62	27.7
New Brunswick	9	1.35	82	2.35	20.09
Quebec	269.6	40.08	1146	32.88	83.93
Ontario	307.5	45.7	1677	48.11	81.94
Manitoba	16.5	2.45	114.4	3.28	22.63
Saskatchewan	7.9	1.17	38.4	1.10	8.33
Alberta	11.3	1.68	69.2	1.99	14.31
British Columbia	34.6	5.14	264.6	7.59	44.71

Source: H. G. Calwell, Chief Statistician, Economics and Statistics Branch, Statistics Division, Department of Munitions and Supply, 17 March 1941, Vol. 184, RG 28, NAC.

Table 3.3.–Initial requisitions by the British Purchasing Mission

	article	quantity and production rate
BPM Requisition 1	3.7 inch cartridge case empty[a]	80,000 @ 7,000/week
BPM Requisition 2	6 inch shell empty[b]	15,000 @ 2,000/week
BPM Requisition 3	9.2 inch shell empty[c]	5,000 @ 1,000/week
BPM Requisition 4	40 mm shell complete round[d]	100,000 @ 10,000/week
BPM Requisition 5	40 mm Bofors barrel	350 @ 10/week
BPM Requisition 6	3.7 inch loose barrels	100 @ 6/week
BPM Requisition 7	2 pounder anti-tank carriage	200 @ 4/week
BPM Requisition 8	Valentine tank Mk. I	25 @ 2/week
BPM Requisition 9	25 pounder shell	350,000 @ 7,000/week
BPM Requisition 10	4.5 inch Howitzer shell	150,000 @ 3,000/week

notes: a) order also includes fuses and primers.
b)order includes fuses, tubes and transit plugs.
c)order included fuses, tubes and transit plugs
d)comprised of shell, cartridge case, fuse, primer, and transit plug
Source: Manuscript, *History of the Ammunition Production Branch*, vol. 16, RG 28, NAC.

Table 3.4.–Standing and new shell orders-July 5th, 1940

Shell Type	Previous level	New level
40 mm	42,500/month	350,000/month
3.7 inch A. A.	30,000	150,000
6 inch Howitzer	8,000	60,000
9.2 inch Howitzer	4,000	30,000
4.5 inch Shell	new order	100,000
2 Pounder A. P. Shot	new order	380,000

Source: Manuscript, "History of the Ammunition Production Branch", Vol. 16, RG 28, NAC.

Table 3.5.–Average fixed costs spread over 200 000 shells.

production rate	item	average cost per shell
4000 per week	forging	$36.88
	finishing	41
	total	77.88
7500 per week	forging	$19.67
	finishing	36.67
	total	56.33
10000 per week	forging	$14.75
	finishing	34.8
	total	49.55

Source: Calculated from figures in O. P. Stensrud to Lt. Col. G Ogilvie, 18 July 1940, G-18, MS 4-106, Dalhousie University Archives. (Hereafter referred to as Trenton Papers.)

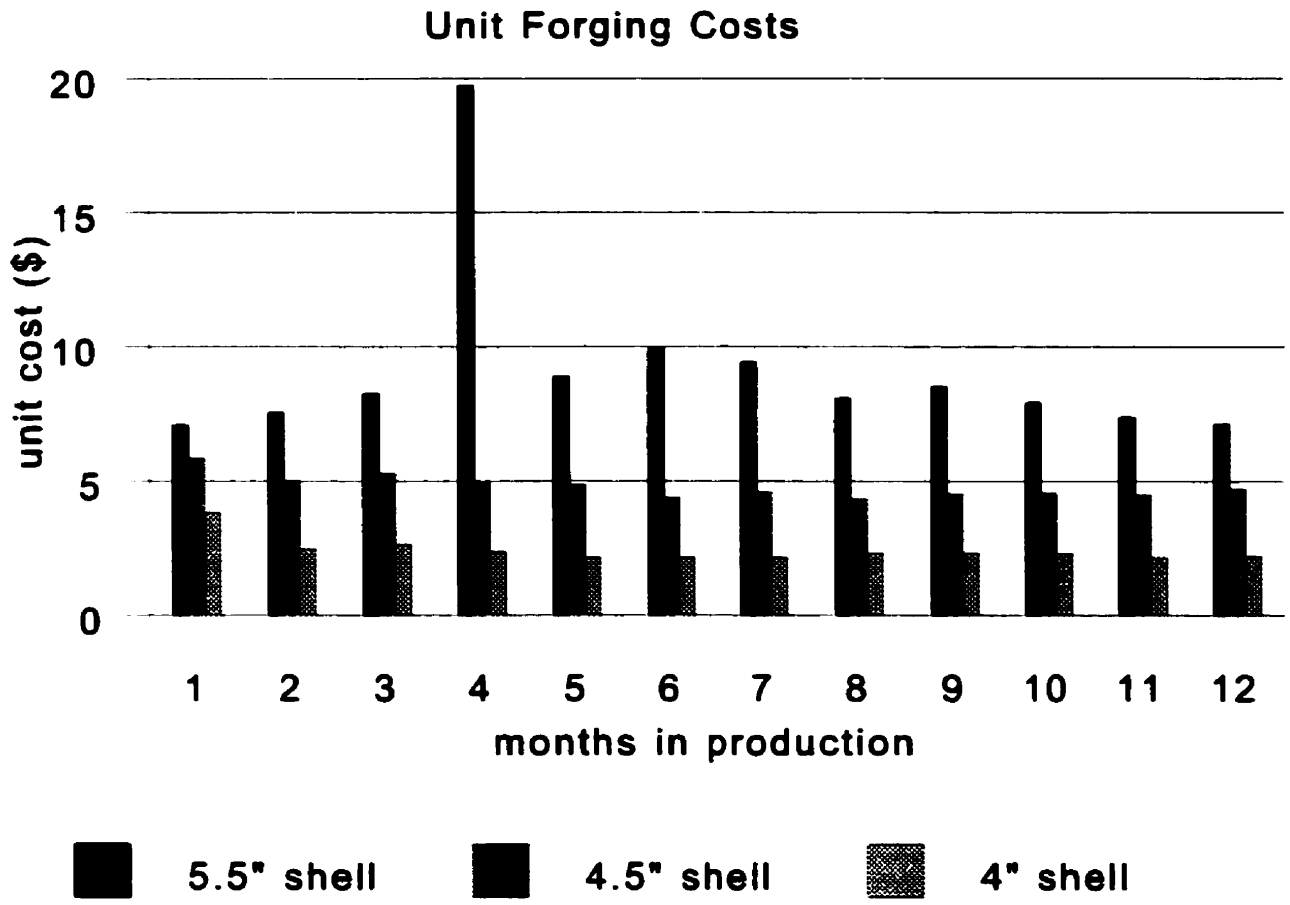

Figure 3.1. Unit forging costs for the 5.5 inch, 4.5 inch and 4 inch shell.

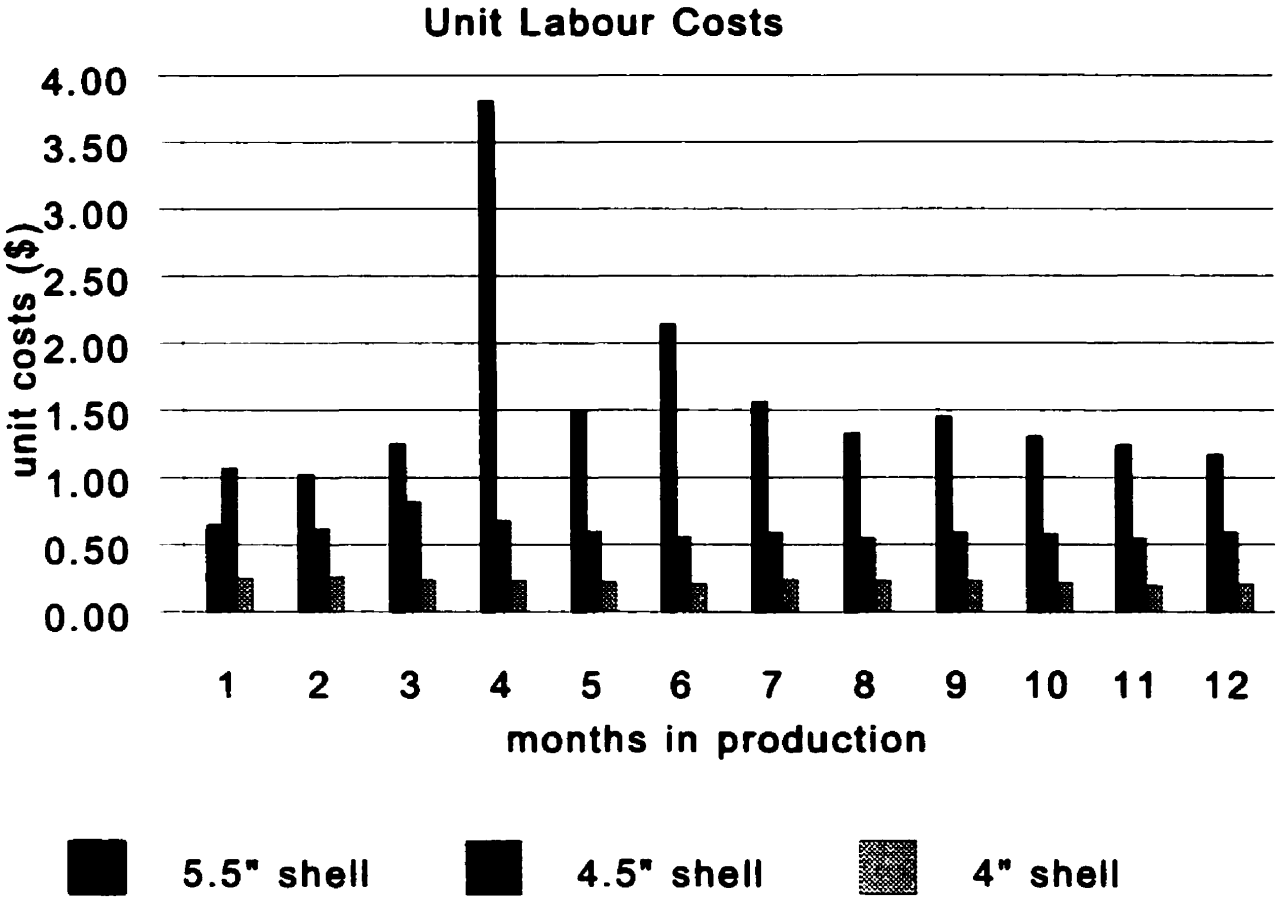

Figure 3.2. Unit labour costs for 5.5 inch, 4.5 inch, and 4 inch shell.

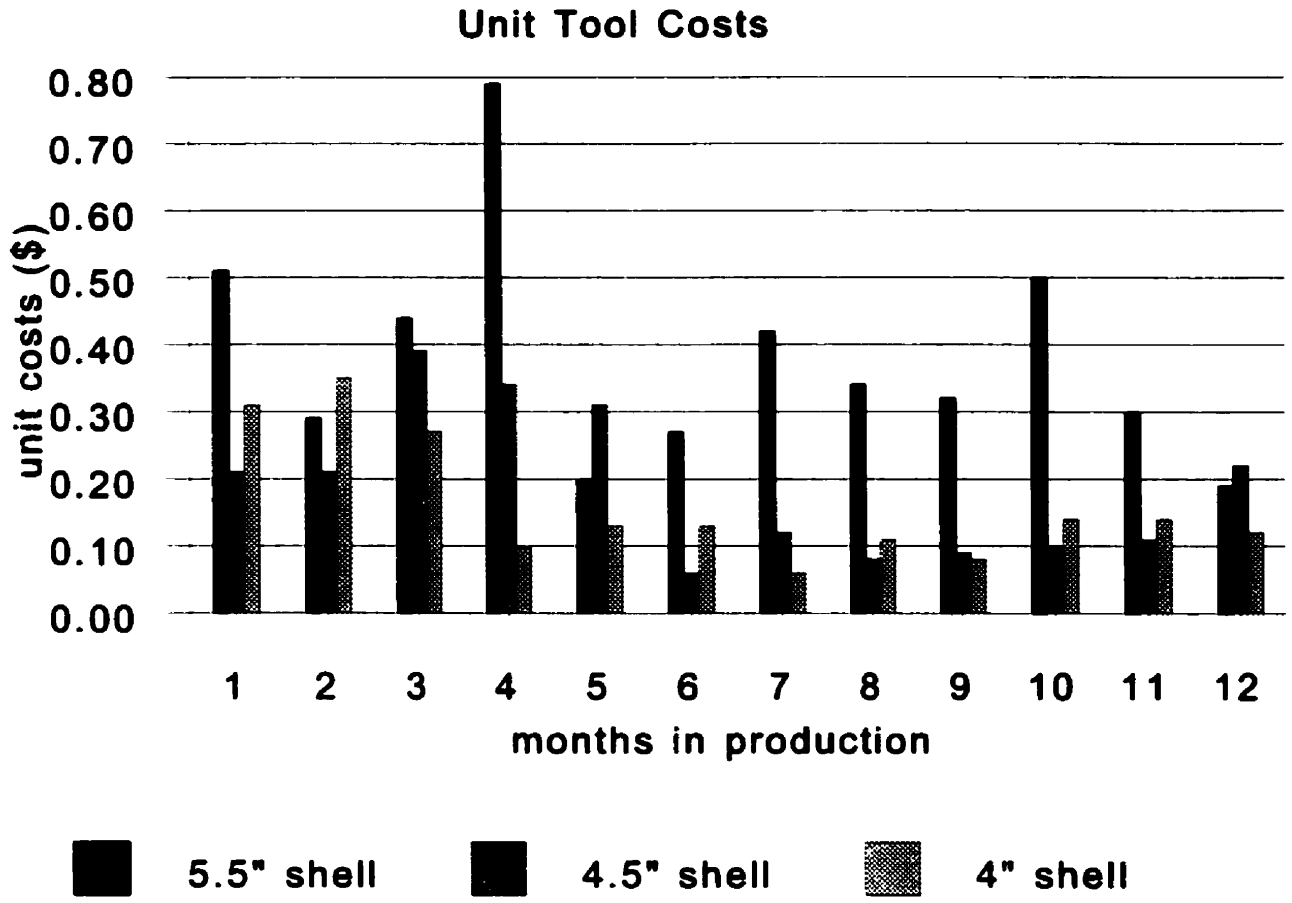

Figure 3.3. Unit tool costs for the 5.5 inch, 4.5 inch, and 4 inch shell.

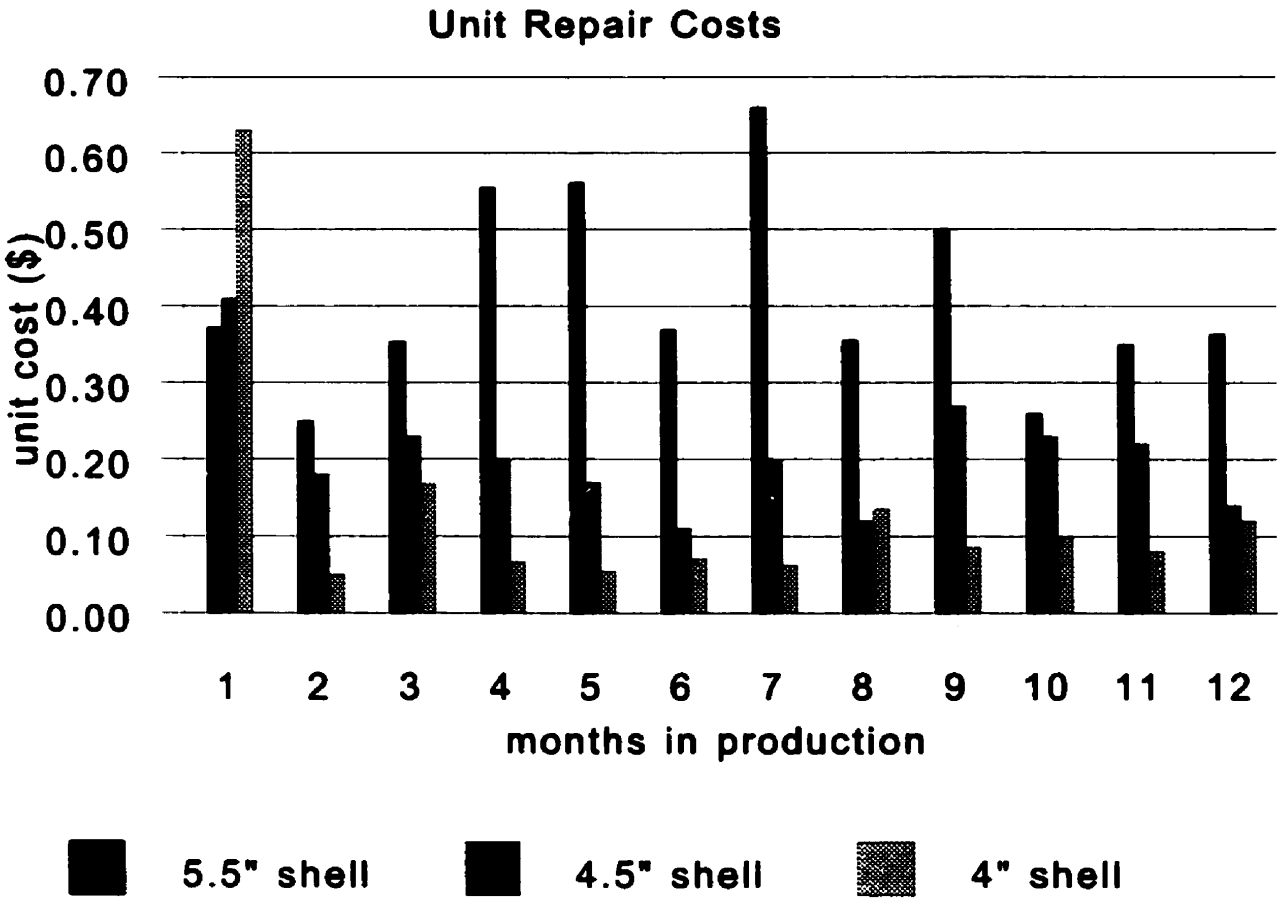

Figure 3.4. Unit repair costs for the 5.5 inch, 4.5 inch, and 4 inch shell.

Data Appendix

This data appendix lists the data used for Figure 3.1 to Figures 3.4 and gives the reference for each shell.

Table A3.1.–Unit forging costs and select components.

($ per shell)

	Unit forging costs			Unit labour costs			Unit tool costs			Unit repair costs		
	5.5 inch shell	4.5 inch	4 inch	5.5 inch	4.5 inch	4 inch	5.5 inch	4.5 inch	4 inch	5.5 inch	4.5 inch	4 inch
1	$7.06	$5.84	$3.82	$0.65	$1.07	$0.25	$0.51	$0.21	$0.31	$0.51	$0.21	$0.31
2	7.53	4.96	2.45	1.02	0.62	0.26	0.29	0.21	0.35	0.29	0.21	0.35
3	8.24	5.27	2.62	1.25	0.82	0.24	0.44	0.39	0.27	0.44	0.39	0.27
4	19.73	4.94	2.36	3.81	0.68	0.23	0.79	0.34	0.10	0.79	0.34	0.1
5	8.88	4.87	2.15	1.50	0.60	0.22	0.20	0.31	0.13	0.20	0.31	0.13
6	9.95	4.38	2.16	2.14	0.56	0.21	0.27	0.06	0.13	0.27	0.06	0.13
7	9.43	4.58	2.15	1.56	0.59	0.24	0.42	0.12	0.06	0.42	0.12	0.06
8	8.09	4.32	2.31	1.33	0.55	0.23	0.34	0.08	0.11	0.34	0.08	0.11
9	8.52	4.52	2.32	1.45	0.59	0.23	0.32	0.09	0.08	0.32	0.09	0.08
10	7.92	4.54	2.29	1.30	0.58	0.22	0.50	0.1	0.14	0.50	0.10	0.14
11	7.38	4.48	2.15	1.24	0.55	0.20	0.30	0.11	0.14	0.30	0.11	0.14
12	7.11	4.70	2.20	1.17	0.59	0.21	0.19	0.22	0.12	0.19	0.22	0.12

Source: 5.5 inch shell: file G-107 "Cost of Forging 5.5 Inch Shell", Trenton Papers.
4.5 inch shell: file G-64 "Cost of Forging 4.5 Inch Shell", Trenton Papers.
4 inch shell: file G-32 "Cost of Forging 4 Inch Naval Shell, Trenton Papers.

Endnotes

1. The Trenton Steel Works was actually a wholly owned subsidiary of the Nova Scotia Steel and Coal Company. In turn, Nova Scotia Steel and Coal was a wholly owned subsidiary of Dosco.

2. These figures by no means provide a comprehensive account of total Canadian munitions production. One more notable item that is missing from the table due to the heterogeneity within the group is guns and their related equipment. Field gun, naval gun and anti-aircraft gun production each numbered in the tens of thousands, exceeded annually in production by the manufacture of tens of thousands of replacement barrels.

3. Before the war Canada ran a current account surplus on its trade with Britain and a deficit trading with the US. To finance this deficit, Canada normally exchanged its accumulated Sterling balances for US dollars. The war disrupted Canada's this pattern of trade, increasing its current account surplus with Britain who could no longer afford to pay for its imports. Canada soon faced a shortage of US dollars. With the Hyde Park Agreement, the US government guaranteed to place a certain proportion of its purchases in Canada thus providing the government with a source of US dollars to finance its imports from the US. Granatstein (1975, 135-145) provides an account of the difficulties that eventually led to the Hyde Park Agreement.

4. In support, Schultz provides us with the Corporation's own investment figures (Schultz, 56). Allied War Supplies invested a total of $155.5 million in new plant and equipment. The Corporation built a total of nine plants and spent $129.7 million in Ontario and Quebec. The remainder went to three plants constructed in Alberta, British Columbia and Manitoba.

5. CGS memorandum, 11 November 1935, The Requirements of Canadian Defence", MG 27 IV 13-5, NAC. (Hereafter referred to as the Mackenzie Papers.)

6. CGS memorandum to the Minister, 27 January 1936, Bren Gun: CGS memoranda, Mackenzie Papers.

7. E. C. Ashton to MGO, 7 November 1936, CGS Staff Branch memoranda, Mackenzie Papers.

8. H. Cantley to M. Dywer, 11 July 1940, file G-18, MS 4-106, Dalhousie University Archives. (Hereafter referred to as the Trenton Papers.)

9. H. Cantley to M. Dywer, 11 July 1940, file G-18, Trenton Papers.

10. A similar set of circumstances faced Australia but did not deter it from a drive towards self-sufficiency in munitions production during the late 1930s. Merrett and Schedvin (1981, 124-125) describe the interplay between British imperial factors and Australia's economic characteristics as a small open economy and how they discouraged the establishment of private armament firms,

> Australian defense and equipment policy was dominated by adherence to a unitary conception of empire with strategic concern centred on Western Europe and

> commercial arrangements directed toward the preservation of the imperial market against foreign competition. The dominions were regarded as reservoirs of men and materials. Given Australia's acceptance of its role and the difficulties of industrialization in a small, high cost country, there was little scope for the emergence of private armaments manufacturers built on a stable flow of orders from the state.

Government factories remained the repository for production techniques and technology for munitions.

11. File 42-52, vol. 22, Mackenzie Papers.

12. Even with the addition of this British component, unit production costs were still higher in Canada. Hall (1955, 7) quotes a per gun production cost in Canada of £108 versus £90 from the Birmingham Small Arms Company in Britain. It is unclear as to what the source of this differential is, possibly licensing costs or a difference in the scale of production.

13. The issues surrounding the Bren gun scandal are not relevant to the subject of this paper. It is mentioned here to show the role of economic factors in discouraging domestic munitions manufacture.

14. By the summer of 1939, munitions work at National Steel Car proved sufficiently regular that it was in the process of constructing a specialised plant solely for the purpose of producing shells.

15. Montreal, as the contemporary financial capital of Canada, was home to the head offices of most major Canadian firms. Stelco and Algoma both maintained offices there as well. It is considered a Maritime firm since most of its plant and employment was located in Nova Scotia.

16. M. Dwyer to Senator Col. T. Cantley, 13 June 1940, Trenton Papers.

17. M. Dywer to H. J. Kelley, 11 June 1940, Trenton Papers.

18. Thomas Cantley was not just any senator representing the province of Nova Scotia. He was the former President of NSSC, the iron and steel firm from which the Trenton eventually emerged as wholly owned subsidiary. During the Depression, NSSC entered receivership and in the reorganization that followed in 1938, Trenton emerged as a separate entity.

19. T. Cantley to M. Dewar, 11 June 1940, Trenton Papers.

20. The 4 inch naval gun was the standard used on corvettes, destroyers and other naval vessels by the British and Canadian navies.

21. Howe's comment is based on an interview with Henry Borden by the article's author, Robert Bothwell.

22. C. D. Howe to I. Mackenzie, 22 February 1941, file 42-52, vol. 22, Mackenzie Papers.

23. Curiously, no mention is made of West Coast Industries in the official history of the Department.

24. The British order was for a total of 750 thousand shells to be produced at a monthly rate of 107 thousand. J. L. Ralston to I. Mackenzie, 25 January 1941, file 42-52, vol. 22, Mackenzie Papers.

25. The firms involved in the initial proposal were: Vancouver Engineering Works, Hamilton Bridge Western Limited, Heaps Engineering Works and BC Marine Engineering Works.

26. J. L. Ralston to I. Mackenzie, 25 January 1941, file 42-52, vol. 22, Mackenzie Papers.

27. British authorities continually scaled back the original requirements until arriving at a monthly production rate 17 thousand shells requiring only a single plant.

28. The first set of regulations implemented with the creation of Machine Tools Control forbade the procurement of machine tools by firms not engaged in production designated "essential", established a permit system for the sale of new and used machine tools, and regulated the introduction of new models at firms that required a tooling up process De N. Kennedy (1950, 92-93).

29. Given the risk of loss from transporting machine tools across the Atlantic, British firms were never considered as a primary source of supply by the Department.

30. W. H. Hutchison to M. Dwyer, 2 August 1940, G-18, Trenton Papers.

31. These figures are computed from two equipment lists dated July 24th and August 12th 1940. file G-18, Trenton Papers.

32. An unpublished manuscript of the company's history provides only a brief description of the press and its development in response to orders placed by the "authorities". Dominion Engineering Works Limited, MG 28 III 100, vol. 41, file 15, NAC.

33. O. P. Stensrud to A. Cross, 14 August 1940, G-18, Trenton Papers.

34. O. P. Stensrud to A. Cross, 14 August 1940, G-18, Trenton Papers.

35. O. P. Stensrud to A. Cross, 14 August 1940, G-18, Trenton Papers.

36. O. P Stensrud to M. Dwyer, 6 September 1940, G-18, Trenton Papers.

37. J. W. Buckland to M. Dywer, 9 September 1940, G-18, Trenton Papers.

38. O. P. Stensrud to A. Cross, 30 August 1940, G-18, Trenton Papers.

39. O. P. Stensrud to M Dwyer, 6 September 1940, G-18, Trenton Papers.

40. M. Dwyer to C. B. Lang, 14 September 1940, G-102, Trenton Papers.

41. M. Dwyer to C. B. Lang, 14 September 1940, G-102, Trenton Papers.

42. H. Cantley to M. Dwyer, 30 September 1940, G-102, Trenton Papers.

43. The 5.5 inch shell was a longer forging than the 6 inch shell it was replacing. Production problems soon revealed that the Dominion press and the one shot method were best suited for shells of a shorter length.

44. C. M. Anson to H. Cantley, 31 December 1941, file G-87, Trenton Papers.

45. This profit rate can not be interpreted as a return to capital since capital costs were not counted as production costs.

46. W. S. Lecky to O. P Stensrud, 27 May 1941, file G-85, Trenton Papers.

47. H. Cantley to O. P. Stensrud, 14 April 1941, file G-85, Trenton Papers.

48. W. S. Lecky to O. P. Stensrud, 27 May 1941, file G-85 and O. P. Stensrud to R. C. McDonald, 28 May 1941, file G-85, Trenton Papers.

49. O. P. Stensrud to C. M. Anson, 20 August 1942, file G-90, Trenton Papers.

50. O. P. Stensrud to C. M. Anson, 20 August 1942, file G-90, Trenton Papers.

Conclusion

The first part of this thesis confirms the traditional view of the importance of the Second World War in providing a quick end to the Depression in Canada. By 1939, the peacetime recovery had closed less than half the estimated output gap. In only two years, the Dominion government's war-related fiscal policy closed the remainder. A series of policy experiments involving the calculation of fiscal and monetary multipliers for the Canadian economy confirms the importance of war-related fiscal policy to this quick closure. However, the experiments also suggested that fiscal policy played a significant role in the peacetime recovery between 1933 and 1939, a most surprising result due to the absence of counter-cyclical fiscal policy. By making a distinction between the Dominion government's internal and external fiscal policy, it is possible to identify a positive role for the government's fiscal policy in promoting the recovery. The Dominion government's use of the tariff as a bargaining device to extract reciprocal reductions from Canada's two largest trading partners, Britain and the US, helped indirectly to stimulate exports, the most important source of growth following the trough in output, to these two destinations. Simulation results from export demand equations predict that if the Dominion government had not participated in the bi-lateral trade negotiations with either country, exports would have lagged, hindering the overall recovery. This result suggests that the account of the Canadian recovery should be amended to include a role, albeit perhaps a small one, for Dominion fiscal policy in the peacetime recovery.

The second part of this thesis addressed the problematic issue of the Dominion government's success at directing the war effort. Success, it is argued, depends on how well the Dominion government achieved the strategic aims that comprised its strategic plan dictating the

conduct of the Canadian war effort. This plan is a synthesis of not only military factors that define the goals and objectives a nation's government hopes to achieve in war but economic, political, military, social and psychological ones that also dictate what strategy it may pursue. The correct strategic plan is one that makes only those demands necessary to achieve the intended strategic purpose. Although Canada could not outproduce the Axis powers by itself, it could participate in a much larger effort, helping the Allied countries to outproduce the Axis powers. This did not mean, however, that munitions production proceeded apace without regard to economic considerations.

Economic factors loomed large in the strategic synthesis and plan the Dominion government formulated following June 1940 and implemented through the Department of Munitions of Supply and its various control agencies. They are reflected in at least two strategic aims identified in the second and third essay. First, based on a least cost principle the Department employed in its production and investment decisions, it is possible to discern the government's strategic aim to minimize the costs of the war effort through cost minimization of munitions production. The success of these efforts, however, was contingent upon its knowledge of a firm's costs of production. Hence, when sufficient slack existed, we observe the Department allocating steel plate and shell production among Canadian producers as it became aware of production cost differentials. This awareness, gained through a series of investigations in 1944, provided the Department with the relative costs of production at Algoma, Stelco, and Dosco. With respect to steel plate production, this knowledge produced a clear hierarchy based on relative costs of production that determined how Steel Control allocated production among Canadian steel firms. Only when demand for steel plate peaked did Steel Control and the Department authorize the

purchase of steel from Dosco.

The Department's investment decisions regarding the iron and steel industry reflected a second strategic aim. The government wished to avoid investment in plant expansion projects that would only create post-war excess capacity. Although sharp, unexpected increases in demand often made this a difficult aim to achieve, it strove to do so as witnessed by its treatment of Dosco over the rehabilitation of its plate mill. Despite repeated attempts by the company to place the mill back into production, the Dominion government proceeded with the project only when sufficient domestic demand existed for its product, demand that imports could not satisfy. Once the war was over, the government disposed of the mill, ridding the domestic market of any excess capacity its existence posed. The government's ownership of the mill merely facilitated its disposal.

The Department's investment decisions also provide further evidence that the Department sought to minimize the costs of munitions production. When investing in the construction of new plant and equipment, it chose among various plant configurations and locations based on which yielded the lowest average fixed cost of production. Although this criterion does appear to include considerations of variable costs, it clearly indicates the Department wished to construct plant to help munitions producers minimize average fixed costs of production.

Based on an analysis of its production and investment decisions, the government achieved these results rather well. It allocated production on a least cost basis and made investment decisions to help minimize production costs. It invested in plant expansion only when necessary.

However, resource constraints placed limits on the government's ability to do better. A capacity constraint on Trenton's electrical supply required the use of a largely untried method of shell production in Canada. The use of the more traditional method might have avoided some of the problems Trenton experienced in its attempt to produce the 5.5 inch shell and it might have been able to establish shell production more quickly than it did.

A more significant problem arose in the iron and steel industry. The source for two of Dosco's material inputs meant increased production costs arising from the presence of German U-boats along the shipping lanes. A substitute ore from New Brunswick, while ensuring continued production, also proved costly to use. Rising pig iron production costs combined with the government's wartime price controls to produce large operating losses on Dosco's steel plant, losses that the Dominion government had to cover. Also, due to the metallurgical properties of the substitute ore, the company experienced a temporary decline in material input quality leading to falling productivity in the production of pig iron. However, since the source of the problem was largely beyond the government's control, it can hardly be faulted for its subsidization of Dosco's operations. These subsidies, while undesirable, helped maintain Canadian steel production which served as a critical input into munitions production.

These economic factors existed alongside others in the Canadian strategic synthesis. Previous accounts of the wartime economy often stressed how political factors influenced the Department's investment and production decisions and dominated this synthesis. The findings presented in the second and third essay clearly show that economic factors played a large role and dominated political ones. The Department allocated production and made its investment

decisions on the basis of economic costs with political factors such as a producer's location taking a back seat, at least in the case of Dosco and Trenton.

The findings here point a clear direction that future research into the history of the Second World War in Canada should follow. Within the framework developed by Milward, other firms and industries must be studied in order to determine: 1) how widespread the strategic aims identified above were in the Canadian war economy and 2) whether or not economic factors dictated the Department's production and investment decisions implemented to achieve these strategic aims. Doing so will provide a clearer picture of the Canadian strategic synthesis in place during the was and the strategic plan that governed the government's conduct of the war effort. Only then can we make a better informed judgement about the success of the government's efforts at planning and control.

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