"REPAIR EXPENDITURES": NEW EVIDENCE ON REPLACEMENT INVESTMENT

by

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1. Introduction

Since 1946 Statistics Canada has been collecting and publishing data on "repair expenditures" as part of its bi-annual "Private and Public Investment" survey of capital investment spending intentions. [1:Statistics Canada Catalogue 61-205 and 61-206 Annual] Repair expenditures are defined as "non-capitalized outlays made to maintain the operating efficiency of the existing stock of durable physical assets" [2: See Statistical Notes in 61-205] The rationale given for the collection and dissemination of these data is that "by including these outlays, a more complete picture is provided of all demands likely to be made on labour and materials in accomplishing the program" [3: See Introduction to Catalogue 61-205] Repair expenditures are by no means trivial. Total repair expenditures in Canada (private and public including housing) amounted to over $37 billion in 1990. In the manufacturing sector where the share of repair spending is highest, repair expenditures accounted for over 45% of capital investment spending during the 1980s.

These repair expenditure series have not received the attention they deserve in the theory and econometrics of investment. The underlying assumption in the literature has always been that outlays on fixed durable assets are of a capital nature and that <u>replacement investment</u> -that portion of gross fixed capital expenditure required to maintain the existing stock of capital intact- is also of a capital nature. Hence the well known partition of gross fixed capital formation into <u>net</u> or <u>expansion</u> and <u>replacement</u> shares. Since repair expenditures are not capitalized for accounting purposes by firms then they should not be included under investment. Although conceptually appealing, this approach is based on a highly superficial understanding of the replacement process which fails to define the level of aggregation of the asset and hence the relationship between replacement and maintenance. In addition, it fails to account for the relationship between the level of maintenance and repair expenditure and the length of the physical life of the asset.

In this paper, the authors re-examine the nature and purpose of replacement spending and provide a link between repair expenditures and replacement. They find that repair and maintenance expenditures not only maintain the operating efficiency of capital goods intact, but also serve to prolong the physical life of these assets. In so doing, they perform the role of replacement investment in the exact same sense in which it is conceived and defined in the investment literature. The repair expenditure series published by Statistics Canada provide a unique and invaluable source of directly measurable data on replacement. They open the door to the empirically meaningful investigation of the replacement process.

2. **Repair Expenditure as Replacement Investment**

In practice, a durable fixed asset is rarely a singular homogeneous entity. It is a composite of heterogeneous parts and components which are assembled together along with the necessary engineering support structure and designed to perform a predetermined function. Each component is designed and fabricated separately often with interchangeable parts, and has a unique decay pattern and expected physical life. Some components operate at 100% of their designed capacity until they experience a sudden and complete failure (e.g. light bulbs and electronic components) while others wear out gradually, yielding progressively a reduced percentage of their designed capacity (e.g. most mechanical components). Some components are designed to be replaced and/or serviced frequently based on a rigid maintenance schedule while others undergo very little tear and therefore are subject to occasional and discretionary maintenance intervention. Furthermore, some components are mass produced by capital goods manufacturers and designed based on standardized specifications while others are custom built and designed around very exact specifications. A durable fixed capital asset therefore is a composite of different parts and compoments with distinct properties which wear out at different rates. Underlying each piece of capital equipment is a recommended maintenance and repair program which consists of routine scheduled maintenance and periodic replacement and repair of parts. Whether the program reflects a preventive maintenance policy, or corrective maintenance (following equipment failure), firms incur significant maintenance and repair outlays in order to ensure that the operating efficiency of their physical assets remains up to operating standard. The cost of the replaced or rebuilt parts plus the cost of materials and labour is treated as an operating expense.

The moment one recognizes that an asset is not just a singular entity but a composite of individual components that wear out at different rates, one must re-examine the concept of replacement. If the purpose of replacement investment is to maintain the operating efficiency of physical assets intact then it does not matter whether one is replacing the component parts of an asset gradually over time or replacing the whole asset (i.e. all of the composite parts) all at once. The same purpose is served either way. It becomes necessary then to differentiate between the replacement of a whole asset by a new same asset -which is a capital expenditure- and the continuous replacement of parts of an asset with new parts -which is an operating expense. In other words, the replacement program of a firm is accomplished at two levels: the machine or asset level through capital spending and at the sub-machine or sub-asset level through maintenance and repair expenditure.

This is a well known problem in the accounting profession. Once a complement of plant and equipment has been put in place, the corporate accountant must define the assets for accounting purposes and classify them in different accounts using different depreciation rates. Defining assets is by no means an easy matter and a great deal of judgement and discretion enters these decisions. Answers to this question are based on the application of two criteria: 1) do the assets acquired have different life expectancies? and 2) do they have different perceived identities?

An affirmative answer to either question is usually a sufficient reason to capitalize assets in different accounts. In practice however, application of such criteria yield different answers. For example, although most observers would regard an entire airplane as a single asset, an airline might capitalize the costs of the airframe, engines, and interior fittings in three separate asset categories. The company may do this partly for income tax purposes or because it believes that separate capitalization will produce better financial statement information. How a company defines an asset at the time of acquisition however carries very significant implications on how it will treat its replacement in subsequent periods. For example, if the airframe, engines and interior fittings are treated as separate assets, then their replacements will be capitalized as well. If the airplane is treated as a single (composite) asset, then the subsequent replacement of engines and interior fittings will be treated as repair and maintenance expenses and charged to operating accounts. [4: Where a replacement of a part leads to a significant increase in the asset's service life, raise its productivity or significantly lower its operating cost it is recommended that the cost of the replacement be capitalized for accounting purposes.] To quote from one authoritative textbook:

> "The replacement of specific parts...is a function of the unit or composite selected for depreciation, and the distinction between replacements and maintenance is dependent upon the amount of the aggregation and the selected composite life" [Hendriksen (1982)]

If the composite selected is small enough, then even the replacement of a screw can be treated as a capitalizable replacement, and no room is left for the concept of maintenance. On the other hand, the higher the amount of aggregation selected, the smaller the role of replacement and the larger the role of maintenance and repair becomes. If the level of repair expenditures reported by firms to Statistics Canada is any indication, the level of aggregation -at least in Canada- is quite high. [5: Repair expenditures in the Canadian manufacturing sector in 1990 amounted to $9.2 billion vs.

$20.2 billion in capital expenditures, i.e. 45.5% of capital spending]

If we accept the premise that part of the replacement function occurs at the sub-asset level through the periodic replacement of parts by new or rebuilt ones, one must ask what happens to the notion of service life? The conventional approach used in the investment literature has been to view the average service life of an asset as a technologically determined constant whose value is finite and exogenous to the economic process. This view is overly simplistic and imposes unnecessary and artificial constraints on our understanding of the replacement process. First of all, it misses completely the point that in practice assets are composites of sub-assets. Although the parts and individual components of a machine do appear to have technologically predetermined finite life spans, this does not have to apply at the composite level. Through routine maintenance and periodic replacement and repair of parts, the machine can presumably be made to last for ever! If a machine is maintained properly and all parts which wear and tear are replaced by interchangeable and like parts, there is no reason why this machine should not last forever. It is well known, for example that many firms continue to operate to this day capital equipment and structures that were first built in the 1900s. Antique cars is an other example. The conventional view is valid only in so far as it relates to the replacement of parts of a machine, which we have shown to be classified as maintenance and repair expenditures and are not capitalized for accounting purposes. When the asset is viewed as a composite the conventional view breaks down all-together.

Second, the prevailing view ignores completely the role of maintenance and repair in investment and capital stock theory. The physical life of an asset is certainly a function of the amount of maintenance and repair that has been invested in the asset. It is well known by engineers that equipment which are subject to preventive maintenance usually last much longer than equipment that are only subject to corrective maintenance. It is clearly obvious that the physical life of a composite asset is not an exogenously determined constant, but a variable which is a direct function of the amount of maintenance and repair that has been incurred.

Third, the role of maintenance and repair as it relates to replacement has also been misunderstood. Maintenance and repair does not only serve to maintain the capacity of assets to yield production services to their owners in the current period but also serve to restore the capacity of assets to yield production services in future periods. In effect, a proper maintenance and repair program serves to safeguard and restore the mechanical integrity of a machine and its components and in the process it prolongs its physical life indefinitely. An asset does not reach the end of its physical life because it is no longer technically feasible to repair it, but because we choose not to replace and repair the components that enable it to function. The choice is not based on technical grounds but on economic factors. An asset eventually breaks down or is retired from service not because it has reached the end of its physical life, but because cost, obsolescence or market considerations dictated that it was not economically sound to keep maintaining and repairing the asset. In other words, maintenance and repair expenditures combine elements of both operating as well as capital expense. If these expenditures are not capitalized for accounting purposes it does not imply that they do not exhibit properties of a capital nature.

A review of the economic literature on replacement [6: For a comprehensive and critical review of the literature see Matziorinis (1988)] reveals that the concept of replacement investment has nowhere been precisely defined nor do any directly observable data on replacement expenditures actually exist. In spite of its presumed importance (it is generally perceived to be one half of gross capital investment) it has received very little attention in the literature. Surely, if an empirical foundation to the concept actually existed statistical agencies would have long ago started to collect separate data on capital expenditures for replacement. The reason that the concept of replacement investment has proved to be so intractable to economic investigators appears to be that the level of aggregation of the asset was never been properly specified.

If one were to attempt to define replacement, all the investigators would agree on the following elements: i) it is "like-for-like" replacement; ii) it arises from the physical deterioration of capital assets due to wear and tear in production; iii) it results in the simultaneous retirement of the incumbent asset; iv) the objective of replacement is to maintain the production capacity of capital stock intact and v) it implies the continuance of the same line of activity or the same service function. The only time that all of these conditions are met is when firms replace worn and torn parts of machines by new ones. But as we have shown, the cost of the new or rebuilt parts including the cost of materials and labour that are incurred in the restoration process are not treated as capital expenditures but are expensed against current income. Clearly, repair and maintenance expenditures which are incurred in practice correspond to the notion of "replacement investment" as conceived in theory. The only difference is that replacement takes place at the <u>sub-asset</u> level and is expensed for accounting purposes instead of the composite or <u>asset</u> level, where it would be capitalized for accounting purposes. In other words, machines are rarely replaced by "like" machines whereas the parts and components of these machines are continually being replaced by "like" parts. Since the continuous replacement of parts helps restore the operating efficiency of assets and in the process help extend the physical life of the asset, repair and maintenance expenditures do in fact constitute "replacement" in practice.

When the definition of repair expenditure used by Statistics Canada in its investment survey is compared to definitions of replacement found in the literature the above conclusion seems hardly surprising at all. For example, Jorgenson (1974) states "at each point of time durable goods decline in efficiency, giving rise to needs for <u>replacement</u> in order to maintain productive capacity". Elsewhere, Nickell (1978) states "potential replacement investment is defined to be that quantity of investment currently required to maintain capital stock".

3. Repair Expenditures in the Canadian Manufacturing Sector: Some Empirical Evidence

Turning to the actual data collected by Statistics Canada we observe striking evidence which supports our theoretical expectation that repair expenditures in fact constitute replacement investment. Capital and repair expenditures in the Canadian manufacturing sector have been deflated using separate price indexes for non-residential construction and machinery and equipment.[7: These are GDP implicit price indexes produced by Statistics Canada, National Income and Expenditure Accounts, 13-001. The same price indexes were used to deflate both capital and repair expenditures. It would have been desirable to use separate price indexes for each time series, however, Statistics Canada does not currently produce a separate price index for repair spending] Figure 1 shows repair and capital expenditures incurred by Canadian manufacturing firms during the 1956-91 period. Capital and repair expenditures have been added together to produce a total picture of investment activity in this sector. Repair expenditure is far less volatile than capital spending, in line with what replacement theory would predict. Figures 2 and 3 show that repair expenditure, expressed as a share of capital spending has remained stable over the 1956-91 period accounting for nearly one half of capital spending (and one third of total investment spending) in the manufacturing sector. Machinery and equipment repair outlays account for about 85% of total repair expenditures and they have been exhibiting a secular upward trend during the period (rising from 80% in the late 50s to 85% in the late 80s. Figure 4 shows the percent annual change in repair expenditures vs. capital expenditures. As replacement theory would suggest, repair spending is significantly less volatile than capital spending. Yet, it also shows that contrary to the mechanistic conceptions of replacement, repair outlays do exhibit a significant variability which supports our theoretical expectation that repair spending is an economic variable. In fact, the tentative evidence presented here indicates that repair (replacement) spending is positively associated with both the rate of change in capital spending as well as manufacturing output. Figure 5 reveals a high degree of positive association between the rates of change of repair spending and manufacturing output. Taken together, the above evidence supports an economic theory of replacement. Clearly, to the extent that replacement is undertaken at the sub-asset level and replacement expenditures are not capitalized, then this body of repair expenditure data constitute the first directly observable empirical evidence on replacement!

4. Re-examination of Issues and Discussion of Findings

Replacement investment has long been conceived to be the outcome of some mechanistically determined process, whereby firms -driven by pure technical necessity to maintain the productive capacity of their capital goods intact- engage in a continual flow of replacement spending. In early work, Einarsen (1938) found evidence from the Norwegian shipping industry that replacements were concentrated in 19-year intervals. He reasoned that if assets have a finite technologically-determined life span then bunching of investment expenditures in one period would result in the bunching of their replacements in subsequent periods, the so called "echo effect". Implicit in Einarsen's formulation has been the assumption that assets experience zero output decay an assumption known as the "one-hoss-shay". An other significant finding of Einarsen's study was that only 50% of the owners replaced their assets and when they did, the replaced assets were not retired from service, but were continued in service under a different set of owners. He found that replacement does not necessarily imply retirement and that retirement does not automatically result in replacement. In more recent years Jorgenson (1965;1974) employing the assumption that capital goods wear out at a constant geometric rate (the so-called exponential decay assumption) formulated the proposition that replacement spending is some constant proportion of capital stock, whatever the initial age distribution of capital stock,and equal to the rate of depreciation. This result, known as the "proportional replacement hypothesis" (PRH) was shown to hold under conditions of constant, growing or declining capital stock provided that either i) the rate of gross investment is constant over time (i.e. capital stock grows at a constant exponential rate) or ii) capital goods decline in efficiency at a constant exponential rate.

Many serious objections have been raised over this mechanistic treatment of replacement. [8: For a review of these criticisms see Rowley and Trivedi (1975), Helliwell (1976) and Nickell (1978)] We subscribe to the view that replacement - irrespective of whether it takes place at the asset or sub-asset level- is an economic decision which is conditioned by economic forces. This view is aptly captured by Bain (1939) when he states that: "the economic life of equipment is analytically a variable... If little or nothing is spent in maintaining a machine, the period during which it will render service may be extremely short. If a sufficient amount is spent on maintenance and repair, it can conceivably be made to serve forever. The reason that equipment is replaced at some particular time cannot rationally be that it has ended its "physical life", but that it is no longer as economical to the firm as a replacement would be." Following this line of approach Eisner (1972), Feldstein and Foot (1971), Feldstein (1974) and Foot (1970) have produced empirical evidence which suggest the rejection of Jorgenson's PRH and confirm the role of economic factors. Feldstein and Rothschild (1974) have attempted to develop an economic model of replacement as a feasible alternative while other economists have resisted the temptation of treating net and replacement investment as separate behavioural functions on the grounds that there is no valid empirical foundation for this partition. Instead, they have treated them both as determined by the same set of economic factors.

A number of variables have been proposed as potential determinants of replacement expenditure. Amongst these are i) internally generated funds (or liquidity);

ii) the rate of interest; iii) the level of sales or output; iv) the level of expansion investment; v) the level of capacity utilization; vi) the level of capital utilization; vii) business expectations and confidence; viii) the rate of change in capital goods prices; ix) the average age of capital goods; x) tax factors and xi) technological change. Both Eisner (1972) and Feldstein and Foot (1971) have supplied empirical results which indicate a significant positive correlation between cash flow and replacement on the one hand and replacement and expansion investment on the other. In addition to the positive correlation between expansion and replacement Feldstein and Foot also found some evidence of negative partial correlation between the two which they attribute to the desire of firms to conserve scarce resources by alternating expansion and replacement spending over the phases of the business cycle. Eisner employing a slightly different framework was unable to replicate the same negative partial coefficient. Rather he found strong positive correlation between expansion and replacement, with replacement exhibiting one quarter of the variability of the former. He found this positive correlation to be highly significant at all three levels of aggregation. It is interesting that these results fully match the repair expenditure patterns presented above from the Canadian manufacturing sector in all three respects: 1) the variability of repair expenditure is significantly smaller than that of capital spending; 2) there appears to be a significant positive correlation between capital and repair spending and 3) there also appears to be at this initial stage of investigation a positive correlation between cash flow and repair spending (assuming that the rate of change in output can be used as a proxy for internally generated funds).

Both Eisner (1972) and Feldstein and Foot (1971) test the role of capacity utilization although they assign to it different behavioural roles. Here their findings are inconclusive. The former finds a slightly negative but insignificant coefficient while the latter finds a small but statistically significant positive correlation between replacement and the rate of capacity utilization. It is important to note that the replacement data utilized by both investigators are neither repair and maintenance data nor directly observable data on capital expenditures on replacement. Rather they derived their data from responses in the McGraw-Hill capital expenditure survey. Here respondents are asked to report the shares of their investment anticipations devoted to "expansion" and "replacement and modernization". By multiplying the share of total investment planned for "replacement and modernization" by the amount of capital investment outlays they derived their replacement series. Thus the empirical evidence they report is not for pure replacement i.e. in the "like-for-like" sense discussed in this paper nor the sense conceived by Jorgenson and his collaborators. It is for a composite of capitalized expenditures which are perceived by respondents to be "replacement and modernization". Our Canadian data on repair and maintenance are not capitalized expenditures are therefore are not directly comparable to theirs.

Although the interpretation of their empirical findings should be treated with caution their theoretical framework for developing an economic model of replacement is still valid and pertinent in our attempt to reconcile our repair data with replacement and establish a framework for the empirical investigation of replacement. In fact, one plausible way to reconcile the mechanistic proportional models of replacement with economic models is to view Jorgenson's or some other variant conception of proportional replacement as determining the <u>long-run</u> value of replacement with economic factors determining the <u>short-run</u> level of replacement. Although Jorgenson's particular specification of the proportionality relationship is clearly unsatisfactory, no one can deny that replacement is not some function of capital stock. On the other hand, the replacement decision remains an economic one and nor can any one deny a role for economic factors in the determination of the short-run level or timing of replacement expenditure. We concur with Feldstein and Foot (1971) that the evidence furnished by Jorgenson in support of his PRH neither proves that replacement is a constant proportion of capital stock nor does it imply the rejection of the alternative hypothesis that "replacement investment varies around some <u>average</u> non-zero level in a way which is systematically related to other short-run factors. This alternative hypothesis is also not contradicted by the renewal theory result which refers only to the long-run limiting behavior of the process under the empirically uninteresting conditions of constant growth."

A cursory look at our repair data from the Canadian manufacturing sector (Figure 1) clearly seem to support the above alternative formulation. They are a remarkably stable component of investment spending rising gradually over the 1956-91 period as Jorgenson's PRH would suggest. Moreover, aside from normal cyclical fluctuations in the share of repair relative to capital investment which are due to investment booms in capital spending, the ratio of repair to capital spending has also remained remarkably constant over the surveyed period. If we accept the premise that replacement occurs at the sub-machine level of aggregation through the replacement of worn parts by new and rebuilt ones and that contrary to our theoretical expectation replacements are not capitalized but expensed for accounting purposes, then Jorgenson is at least in part justified in treating replacement as a matter of technical necessity and therefore a recurrent event. He is also justified in expecting a continual flow of replacement spending over time -in order to maintain productive capacity. The treatment of replacement in his model is entirely consistent with the conception of replacement in the "like-for-like" sense which implies continuance of the same line of activity by the firm and therefore the need to maintain productive capacity intact. Where Jorgenson is wrong is in imposing the implicit assumption that replacement occurs at the asset level of aggregation and therefore must be capitalized. Either we abolish the notion of replacement altogether and substitute the concept of repair and maintenance as the only empirically founded and meaningful variable in capital theory or we retain the concept of replacement with the understanding that it occurs at the sub-machine level of aggregation and even though it is not capitalized for accounting purposes it still constitutes investment. The approach taken here by the authors is to treat non-capitalized repair and maintenance as replacement and to add it to capital investment in order to arrive at gross or total investment.

Although we reject Jorgenson's specific formulation of proportional replacement as being overly and unnecessarily rigid, we accept the notion that replacement -as defined here at the sub-asset level of aggregation- must exhibit some <u>flexible</u> proportional relationship with capital stock in the long-run. In the short run, we accept the role of economic factors. A look at the repair expenditure patterns of our data (Figures 4 and 5) provides support for our eclectic view that economic factors play a role in the determination of the short-run level of replacement outlays. Clearly, the timing and level of preventive maintenance and repair (as opposed to corrective maintenance) spending is highly discretionary. It would be reasonable to expect a significant positive correlation between repair expenditures and internally generated funds on the one hand and repair expenditures and capital spending on the other. Lack of sufficient funds in the short-run is likely to lead to the postponement of preventive maintenance while availability of funds is likely to lead to a catch-up in preventive maintenance. The positive correlation between repair and capital spending can be explained by the fact that in a cyclical expansion where firms acquire the need to add additional capacity, they have an even greater need to maintain there existing capacity to supply current demand. When demand is high and capacity utilization is above normal the cost of unexpected break-downs in machinery and equipment is likely to be excessively high which compels firms to step-up their preventive repair program. Fortunately, when demand is high so are profits and cash flow which accommodate the repair program. We disagree with Feldstein and Foot (1971) who view that in the short-run replacement and expansion investment are substitutes and concur with Eisner (1972) who views them as complements.

We also disagree with the role that they assign to capacity utilization. They theorize that as capacity utilization rises firms bring into operation older, less efficient machinery which raise marginal production costs. To contain these cost pressures firms are induced to replace their equipment. Rather than replace the "whole" of a machine firms replace instead the "parts" that are defective or worn out. Why should a firm replace a machine in "whole" by a "like" machine, when the cost of repair is invariably lower? The only conceivable reason for replacing the "whole" of a machine is that the newer machine is technologically superior and of a newer vintage. But the moment we allow the replacement of a machine by a machine of a different vintage, we violate the "like-for-like" replacement rule. Who is to say then that this investment was not made to serve some other purpose rather than that of simple replacement?

5. Conclusion and Implication of Findings

The conventional approach in the theory and econometrics of investment has been that expenditures on fixed durable assets are of a capital nature and that <u>replacement investment</u> -that portion of gross fixed capital expenditures that is required to maintain the existing stock of capital intact- must also be of a capital nature. There has never been any empirical foundation to support this view. It has always been and remains an assumption. Our findings on the role of repair expenditures clearly reject this assumption.

The reason that this assumption managed to survive is that conventional theory failed to provide an adequate definition of replacement and failed to define the effective level of aggregation of capital assets. We have shown that replacement actually takes place at the sub-asset level, through the replacement and/or repair of parts and that the expenditures incurred to replace the parts together with the associated costs of materials and labour are charged to operating accounts.

Our findings -to the extent that they are true- hold very significant implications for the theory and econometrics of investment as well as for public and business policy. First, they suggest that the nature of replacement investment has been completely mi-specified. To the extent that replacement occurs at the sub-asset level and not capitalized for accounting purposes then there is absolutely no basis for the partition of gross fixed capital formation into expansion (net) and replacement parts! Moreover, it suggests that the level of "total" investment (capital and non-capital repair spending) is much higher than what is commonly assumed, at least as far as the Canadian manufacturing sector is concerned!

Second, our findings cast serious doubt as to the reliability of capital stock measures. To the extent that plant and equipment have economic lives which is most cases supersede the physical lives of the underlying assets and to the extent that repair expenditure helps restore the integrity of assets to yield capital services to their owners and in effect help prolong their physical lives, the assumptions used to derive capital stock estimates, including the "perpetual inventory method" cannot be relied upon. Moreover, to the extent that capital stock figures serve as inputs in the calculation of capacity output and therefore capacity utilization rates, it further casts doubt as to the accuracy of these figures. It suggests that the "trend-through-peak" method of estimating capacity utilization is superior to the one used presently by Statistics Canada which relies on gross capital stock estimates. The same criticism applies to total factor productivity measures that rely on capital stock estimates.

The third set of implications has to do with policy, public and business policy. In the post-war period governments all over the world have relied extensively on tax policy to stimulate capital investment expenditures. To the extent that replacement occurs at the sub-asset level and not capitalized for accounting or tax purposes, the tax system has inadvertently been providing a very powerful stimulus in favour of like-for-like replacement at the sub-machine level rather than replacement at the asset level which involves the purchase of a new machine which must therefore be capitalized. To this extent, tax policy has encouraged like-for-like replacement at the expense of more "dynamic" replacement, which is associated with capital spending on superior vintage (i.e. more advanced technologically machinery and equipment). Moreover, tax-incentives such as accelerated depreciation and investment tax credits may have been more useful than previously thought. To the extent that these measures helped narrow the tax advantage in favour of non-capitalized repair expenditures, in addition to the liquidity and rental price of capital effects they also had a substitution effect in favour of capitalized replacements (replacements at the asset level) and away from non-capitalized repairs (replacements at the sub-asset level).

The fourth and perhaps the most significant implication of these findings has to do with the following question: if replacement occurs primarily at the sub-asset, non-capital level, and expansion accounts for only a portion of capital spending, then what is the other half of capital investment!? We can advance the following hypothesis. To the extent that replacement at the asset level occurs for economic reasons and is not mechanistically driven, and to the extent that replacements at the asset level are mainly obsolescence-type investments whereby an asset is replaced by an "un-like" asset of superior vintage, then such capitalized investments hardly classify as replacements in the normal sense conceived in economic theory. Such capital investment expenditures whose purpose is neither expansion nor replacement can be classified under a new label called structural investment, where structural investment can be defined as spending to up-grade, modernize, revamp, or overhaul existing facilities to render them economically more profitable for the firm.

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Comments, feedback and discussion on this paper are welcomed and would be much appreciated by the authors.

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Figure 1
Capital and Repair Investment Expenditures in Canadian Manufacturing Sector: 1956-1991

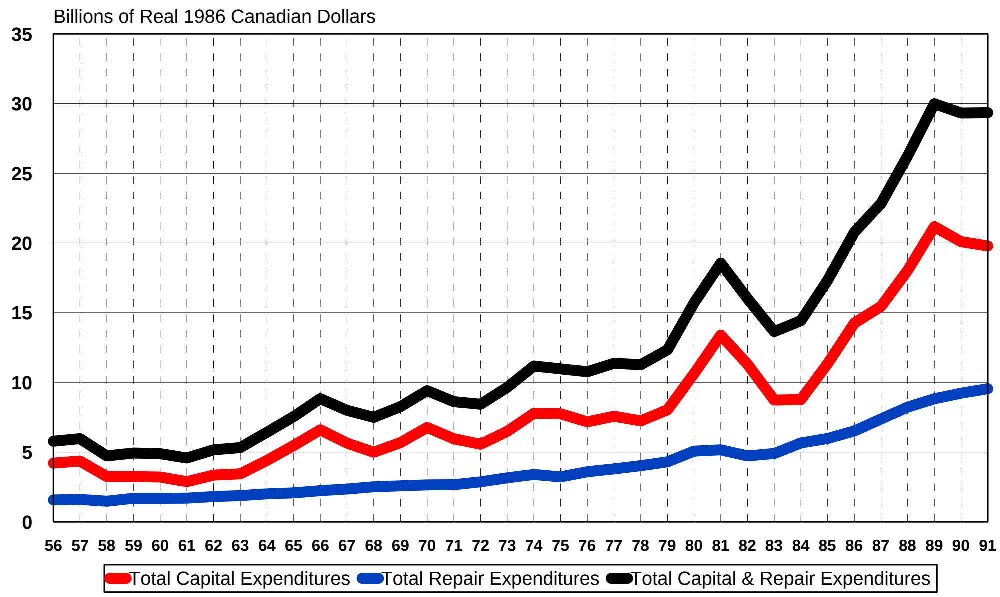

Figure 2
Repair Expenditures as a Share of Capital and Total Investment Expenditures in Canadian Manufacturing: 1956-1991

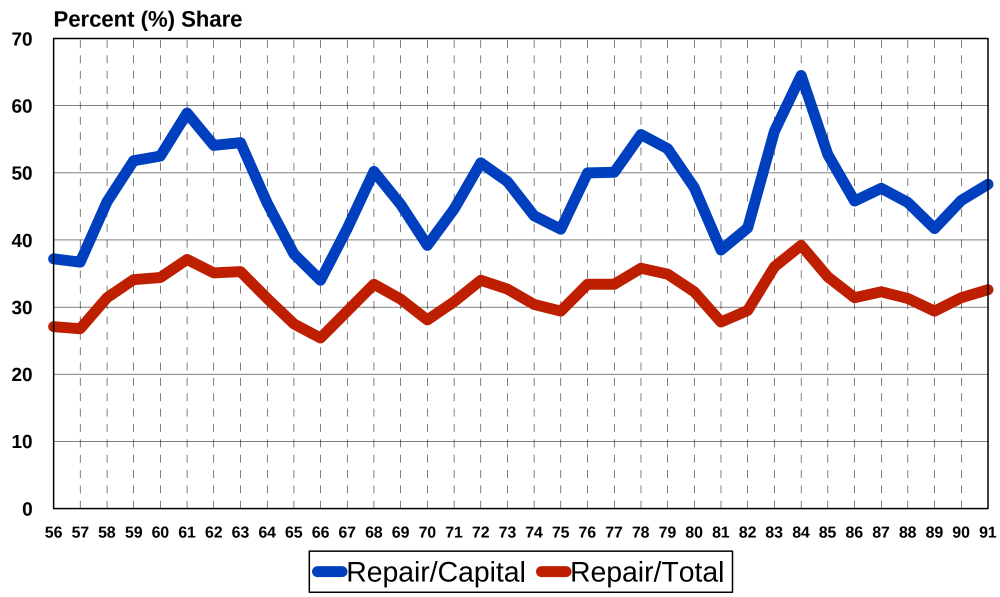

Figure 3
Machinery & Equipment Repair Expenditures as a Share of Total Repair Expenditures, Canadian Manufacturing: 1956-1991

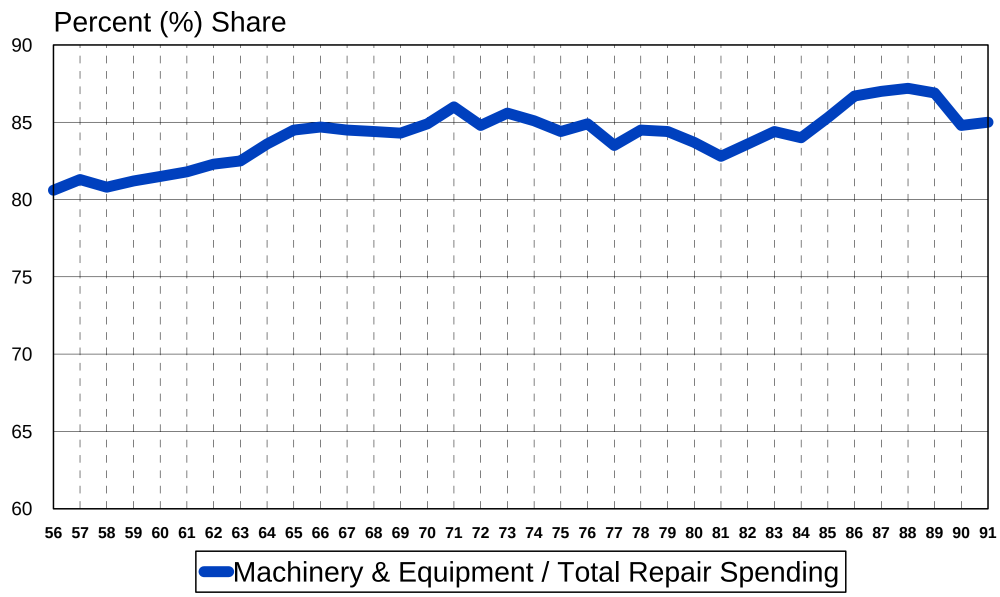

Figure 4
Annual Percent Change in Capital and Repair Expenditures in Canadian Manufacturing: 1956-1991

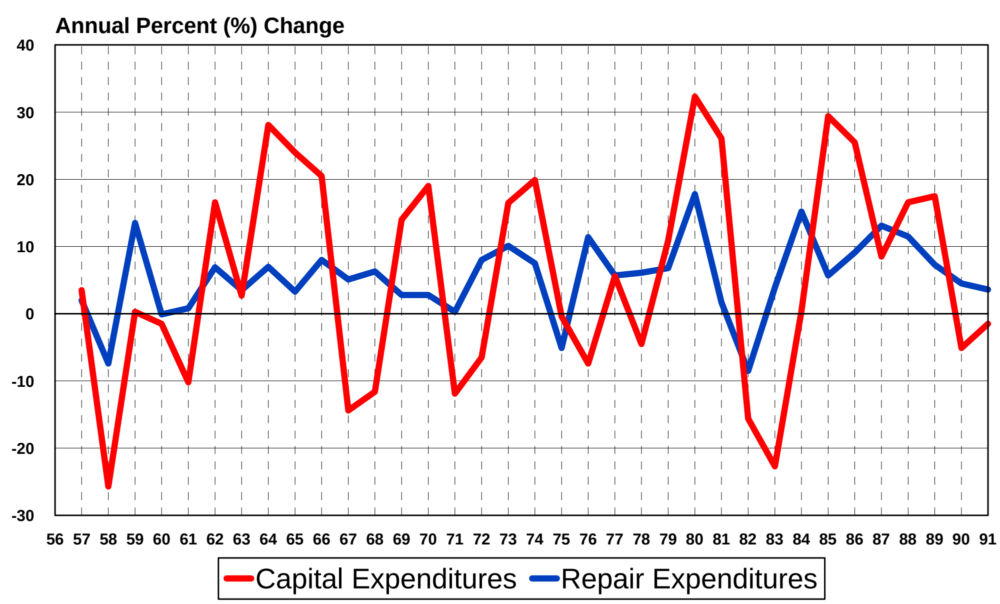

Figure 5
Annual Percent Change in Capital and Repair Expenditures in Canadian Manufacturing: 1956-1991