

# **THE OPPORTUNITY COST OF LAND OCCUPIED BY TRANSPORTATION INFRASTRUCTURE**

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## **1 INTRODUCTION**

Transportation infrastructure investment in Canada has been generating considerable interest during recent years. Large expenditures on airport expansion are an example of this, as well as calls and announcements for more investment in road and public transit infrastructure. Many of these are large capital projects that will last for extended periods of time. While it is no small task to calculate the true capital costs of these projects, the costs associated with land use proves to be at least an equally difficult undertaking. This paper summarizes some of the issues related to the development of land costs associated with transportation infrastructure.

## **2 THE OPPORTUNITY COST**

For most investments, there is an opportunity cost to consider in addition to the cash outlay for the assets themselves. The opportunity cost is usually calculated as the foregone return in the best alternative use, or in the alternative that would have been chosen (regardless of whether or not it was the 'best available'). Since there is a lag between the period in which resources are committed for the investment and the period in which benefits are realized (or the resources are consumed), we must calculate an opportunity cost in order to reflect this lag. Perhaps the most visible and intuitive

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<sup>1</sup> Views expressed in this paper benefited from numerous exchanges between the author and the Transport Canada Full Cost Investigation (FCI) team and the provincial FCI Task Force members. However, these views do not necessarily reflect those of either Transport Canada or the FCI Task Force.

example of these costs are interest costs. While not necessarily a precise representation of the opportunity cost (in particular where other forms of financing – such as equity – are used), interest charges do generally reflect this notion.

This paper does not attempt to discuss in detail suitable measures for the opportunity cost. Whether or not the direct financing cost, a social opportunity cost of capital rate, a rate of time preference or something else is optimal for this purpose is beyond the scope of the paper. Rather, the concept is introduced in order to provide some context for the cost of land use, which results from the opportunity foregone of alternative land use.

### **2.1 The Opportunity Cost of Land – Historical Foundations**

A significant portion of land is used by the transportation infrastructure. However, land in general is somewhat unique in that there was no original cost<sup>2</sup> and does not need to be recreated in the long run (although there can be associated development costs). Furthermore, land does not generally depreciate and instead usually appreciates over time, due to the increase in demand and fixed supply (even in instances where land does depreciate in value, this is for reasons of decreased demand or uses for the land, rather than a loss in efficiency or service life). However, this does not mean that there is no cost associated with the use of the land. An opportunity cost of using the land still exists if there is an alternative use, whether the land is currently occupied by transportation infrastructure or not.

This concept can be cause for some confusion as it is often said that all returns to land are in the form of economic rents, or supernormal profits, as suggested by David Ricardo. However, it is important to note that Ricardo was making the assumption that there was no opportunity cost in the use of the land, in that the agricultural land of which he spoke could not be employed in some other use.

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<sup>2</sup> While there have been cash transactions for the purpose of transferring ownership of the land from one party to another, there was no actual cost of 'building' the land in the first place

For the most part, in the time and society in which we live, this is not the case. There are many alternative uses for land, particularly land in urban areas.

Alternatives to Ricardo's theory, at least in part, as well as the notion of treating land as any other form of capital in general is not by any means new. While he was not the first to depart from Ricardo's thoughts on the subject, and certainly not the most radical departure, Alfred Marshall's work serves as a useful start and focus for this divergence in theory.

While Marshall did consider at least a portion of income derived from land to be a result of "free gifts of nature," as well as a portion from private investment, he considered a third category related to "those parts of incomes which are the indirect result of the general progress of society."<sup>3</sup> Here, Marshall was making specific reference to the value of urban land, rather than the agricultural land that was the focus of Ricardo's efforts. In this case, a significant portion of the value of land was due to its site or 'situation' value,

the situation of a business nearly always plays a great part in determining the extent to which it can avail itself of external economies; and the situation value which a site derives from the growth of a rich and active population close to it, or from the opening up of railways and other good means of communication with existing markets, is the most striking of all the influences which changes in the industrial environment exert on cost of production.<sup>4</sup>

Marshall did not make a judgment concerning who should be deriving the benefits or bearing the costs of the land use; however, it is clear that this value was indeed a cost of production in the forgone opportunity of its use, and that cost has resulted from the efforts of human beings. He went further in order to clarify the distinction by stating that, "in all such cases that yearly income derived from the

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<sup>3</sup> Alfred Marshall (1890), *Principles of Economics*, Book V Chapter XI.1

<sup>4</sup> Marshall, Book V Chapter XI.3

land (or at all events that part of it which is in excess of the agricultural rent) is for many purposes to be regarded as profits rather than rent.”<sup>5</sup> Any land value above that of its best use in agriculture then, would not be considered to have come without a cost, instead being a result of some form of human progress and effort.

While this particular distinction did not make any assessment with respect to who should bear the rewards of the increased land value, Marshall made reference to at least some circumstances in which the private owner would be entitled to the benefits,

Cases somewhat analogous to these arise when the owner of a score or more of acres in the neighbourhood of a growing town "develops" them for building. He probably lays out the roads, decides where houses are to be continuous, and where detached; and prescribes the general style of architecture, and perhaps the minimum expenditure on each house; for the beauty of each adds to the general value of all ... Thus that improvement of the environment, which adds to the value of land and of other free gifts of nature, is in a good many cases partly due to the deliberate investment of capital by the owners of the land for the purpose of raising its value; and therefore a portion of the consequent increase of income may be regarded as profits.<sup>6</sup>

Other examples of differing treatments of land also exist, as Marshall was certainly not alone in his thinking. Marshall's contemporary, Francis Edgeworth held similar views on land though he viewed land as a form of capital when considering the individual, but not to society as a whole.<sup>7</sup> James Mill "maintained that the attempt to distinguish land from other forms of property was futile."<sup>8</sup> Later on, many from the "Austrian School", from whence the theory

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<sup>5</sup> Marshall, Book V Chapter XI.7

<sup>6</sup> Marshall, Book V Chapter XI.10

<sup>7</sup> Francis Edgeworth (1925), collected Papers Relating to the Political Economy.

<sup>8</sup> American Journal of Economics and Sociology (Dec. 2002), *Land as a factor of production*, p. 2.

of opportunity cost was established, refuted the classification of land as a distinct factor from other forms of capital. Pareto made similar remarks in that “‘land capital’ had no precedence over other capital.”<sup>9</sup>

John Bates Clark, along with some other prominent economists from the United States, echoed similar sentiments. With reference to arguments that land is different “based on the notion that land cannot be increased and that other things can be,” Clark was specifically adamant in eliminating the distinction between land and other capital in a static study, “for the static assumption itself precludes all increase of capital.”<sup>10</sup> He also made reference to the efficiency loss arising when not including the opportunity cost of land, as land is versatile with respect to the various uses in which it can be employed and “when you apportion either your land or your other capital badly, you get a smaller income.”<sup>11</sup>

With direct reference to the claim that earnings from land only consist of surpluses, Clark maintained that “the positive power of each bit of land to create wealth fixes the rent of it, just as the positive power of each unit of capital to create wealth fixes the interest on it.”<sup>12</sup> The profits of the two then, should be considered alike. Frank Fetter made arguments somewhat parallel to those of Clark, as he supported the notion that “land rent is necessary to maintain the supply of the land’s productive qualities as well as to induce their expansion.”<sup>13</sup> Later texts continued the concept of disregarding a distinction between land and other capital, such as those by Tibor Scitovsky, who wrote, “there is no logical reason for treating land as a separate factor because, from the economist’s point

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<sup>9</sup> Ibid, p. 2.

<sup>10</sup> John Bates Clark (1899), *The Distribution of Wealth: A Theory of Wages, Interest and Profits*, Chapter XXII.11

<sup>11</sup> Clark, Chapter XXII.14

<sup>12</sup> Clark, Chapter XXII.19

<sup>13</sup> AJES, p. 5.

of view, it is similar in all essentials to produced factors. This is why we propose to regard land as a capital good.”<sup>14</sup>

The references above demonstrate evidence supporting the inclusion of an opportunity cost of land among capital costs in general, though this is at least somewhat distinct from the issue of who ought to capture the returns to the land. For example, those who argue in favour of land taxes based upon the work of Henry George believe in charging users for the use of land but disagree only with the returns accruing to a private owner. If this cost is ignored, it is possible that an efficiency loss would occur, as the land would not be employed in its most productive use. This concept applies in the transportation-specific cases as well, as ignoring the cost would discriminate against the modes that use land (or more valuable land) less intensively or would discourage more efficient land use in general. Transportation ‘competes’ for the use of land not only amongst the modes, but against non-transportation uses as well. This opportunity cost would be prevalent regardless of the outcome or judgment on who ought to capture the returns resulting from the employment of land, whether it be the land-owner, the consumer of the resulting products or society in general.

## **2.2 The Opportunity Cost and Transportation-Specific Land Use**

Even amongst those for whom the case for applying an opportunity cost of land use is well-established, there are often reservations about applying the same concept to land used by transportation infrastructure. There are a number of objections that are frequently applied to this specific case. A few of these specific objections are discussed here.

### **A. Transportation is a Necessity**

It is sometimes argued that transportation is a necessity and as a result, a cost of land should not be considered. Transportation

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<sup>14</sup> Tibor Scitovsky (1951), *Welfare and Competition: The Economics of a Fully Employed Economy*.

certainly is a necessity in that it is used in one form or another by virtually everyone. However, the extent to which it is used among individuals varies considerably, as does the extent to which land is devoted to transportation infrastructure from city-to-city and country-to-country<sup>15</sup>. There is no particular reason to treat transportation infrastructure distinctly with respect to land use relative to other capital investments that can also vary considerably while being considered necessities. It is difficult to envision, for example, a society with no office space or no residential housing. However, for those types of investments the cost of land is typically considered in full and the necessity of these types of investments does not interfere with this process. The reason for this is that the space (both in terms of the amount and location) occupied by these investments need not be fixed and they do indeed compete with other investments for land use.

Many types of investment can be considered necessities in the same way that transportation may be considered a necessity. Considering the costs of land use with respect to these investments would not eliminate these categories of investment but would instead facilitate a more efficient allocation of land resources to each type of investment.

## **B. The Reciprocal Relationship Between Transportation Infrastructure and Land Value**

When calculating the opportunity cost of land a rental value of the land must be determined. Typically, one would attempt to observe the land values using one of a variety of methods and then apply an opportunity cost rate to that value in order to determine the opportunity cost on an annual basis. However, those land values (which are themselves the capitalized value of expected future returns to the land) are affected by the infrastructure that is on or near the land itself.

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<sup>15</sup> Todd Litman (2006), "Transportation Cost and Benefit Analysis – Roadway Land Value."

This may cause some difficulty in terms of measurement when determining the opportunity cost of land used by transportation infrastructure. However, this reservation suffers from a problem that is somewhat similar to that in point A. That is, there is no obvious reason why transportation infrastructure should be treated distinctly relative to other types of investment. For example, it is clear that in many urban centres land values are driven, at least to some extent, by the presence of commercial office space. However, the users of this space are expected to and do pay the full rental value for the use of the space. If returns are not sufficient to cover these costs they will likely relocate to locations with lower land values, thereby allowing users who place a higher premium on the use of that particular land to occupy the space. There is no 'discount' for any users or types of investment that may actually be contributing to the increased land value itself.

Part of the discrepancy may arise due to the tendency to think of particular locations without any transportation infrastructure. But just as we accept that land values are driven by marginal changes in land use and capital investment, so we should with transportation land values. In fact, this is not unique to land, but applies to all capital. If one wanted to value the entire stock of automobiles in Canada, marginal transactions (as observed in the new and used car markets) would form the basis of the unit values, which would then be multiplied across the entire stock of vehicles. Attempting to measure the value based on the hypothetical scenario where all vehicles would be put up for sale at the same time would lead to a radically different value (perhaps even zero). The market capitalization of publicly-traded corporations is calculated in much the same way (with the share price being based on the last transaction multiplied by the number of shares outstanding). By similar rationale, rather than attempting to value the land occupied by transportation infrastructure under the hypothetical scenario of the entire removal of a road or rail network, we ought to value the land based on incremental changes of these networks. For this reason, recent transactions of nearby land values ought to serve as a useful basis for the unit value of land.



### **C. Land Occupied by Transportation Infrastructure Has No Alternative Use**

It may be said, at least in some instances, that there is no suitable or worthwhile alternative use for land currently occupied by transportation infrastructure. In other cases, the conversion costs required to put the land in an alternative use may exceed its value in that alternative use, thereby negating the alternative. In these particular cases a cost of land need not be applied to the total transportation costs. However, the same rules would apply to technical capital. In instances where the capital is not able to generate returns equal to the cost of capital (and the capital cannot be converted for an alternative use), there is generally no need to calculate an opportunity cost. In the long-run the capital would not be replaced (if investment decisions were made based on economic viability).

Cases of 'redundant' assets likely occur more often with regards to technical capital than with land. It is possible, for example, that an airport become redundant and the assets retain only a residual or salvage value because there is no suitable alternative application of the terminals and airside assets. However, at least in the long run, the land will usually be available for alternative purposes. In any event, there is no overwhelming reason to treat land as a unique case in this regard.

### **D. Land Use is Shared For Many Purposes in Addition to Transportation**

This reservation presents a practical problem in many cases where rights-of-way are shared among transportation and other uses. However, this would generally serve only to reduce the proportion of the cost of land that is allocated to the transportation activity, not eliminate it entirely. Examples of this may include shared use with hydro and telephone lines, sewage systems and sidewalks. In addition, land devoted to roads would generally at least be partially

devoted to other 'basic access'<sup>16</sup> to commercial and other developments, access that would exist whether a road was built or not. While these examples certainly produce some measurement difficulty, they do not eliminate the opportunity cost of land allocated to transportation entirely and instead require some thought regarding the proportion of costs that would be allocated to the various uses.

### **3 CALCULATING THE VALUE OF LAND**

A number of practical difficulties, in addition to the ones described above, arise when attempting to value the land occupied by transportation infrastructure. Much of the difficulty stems from the lack of market transactions for transportation land, whereas the transactions for other land uses (such as commercial and residential land) are numerous. Across-the-fence land values are often used as proxies<sup>17</sup> but this can lead to measurement errors where those values vary considerably within a small area and are affected by land-use regulations (so that the observed values would not be representing the value in the land's alternative use as that use may be prevented due to regulation)

A thorough methodology for the purpose of calculating transportation land values is not discussed here. In a study by Woudsma, Litman and Weisbrod for Transport Canada a detailed methodology for calculating transportation land values was developed and results indicated that urban transportation land values were typically in the \$100 per square metre range.<sup>18</sup>

However, these land values do not reflect the costs required to convert the land to alternative uses. Associated costs may include the removal of the current infrastructure as well as land redevelopment and clean-up costs. Furthermore, the period of time in

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<sup>16</sup> Litman (2006).

<sup>17</sup> Canadian Transportation Act Review (2001).

<sup>18</sup> Woudsman, Litman and Weisbrod (2006), A Report on the Estimation of the Unit Values of Land Occupied by Transportation Infrastructures in Canada

which the land is under development and therefore not generating any returns must also be considered.

These costs can be accounted for indirectly by discounting the observed gross values of land. Technically, the value of land itself is the discounted present value of future returns to that land. This gross value would then be netted of the investment needed to convert the land to its best alternative use, then discounted further for the amount of time that the land is out of service.<sup>19</sup>

Accounting for these costs could generate a significant difference between the gross land values (observed land values before any discounting) and the net land values (land values discounted for the above factors). The extent to which the land would be discounted depends on the current state of the land as well as the type of alternative use. Furthermore, some of the discount can be reduced if the removed infrastructure retains a net salvage value. Reasonable estimates for the net value of land as a percentage of the gross value may range from 20 – 50 percent.<sup>20</sup> This was the range applied to the gross land values used for the estimation of transportation costs in the Full Cost Investigation (FCI).

#### **4 CONCLUSION**

Using the interim results from the FCI we are able to obtain an estimate of the land costs as a percentage of total transportation costs (infrastructure and carrier/vehicles). As a percentage of total costs (not including externalities), land costs in the road mode are in the 5 to 6.5 percent range, depending on the opportunity cost of

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<sup>19</sup> If  $V_{L(\text{gross})} = CF/(r-g)$ , where  $V_L$  is the gross value of land, CF equals annual cash flows, r equals the annual discount rate, or opportunity cost of capital and g equals the growth rate, then the net value of land,  $V_{L(\text{net})} = [CF/(r-g)]/(1+r)^n - I$ , where n is the number of years the land is out of service and I is the current investment needed in order to convert the land. It is more likely that I would occur over a number of periods as well, a portion of which would be subject to discounting.

<sup>20</sup> Ronald Hirshhorn, (2003) Concepts and Practical Values of Land Costs and Capital Charges for a “Full-Cost Accounting” of Transport Infrastructure in Canada.

capital rate applied.<sup>21</sup> However, these total costs only include infrastructure and private vehicle costs. When commercial vehicle costs are included, land costs as a percentage of total costs would be lower. For air transportation, the equivalent figure is in the 1 to 2 percent range, while rail transportation land costs are estimated to be in the 3 to 4 percent range of total costs.

Although these are only rough estimates, they provide a good idea of the scope of the land costs in the context of total transportation costs. Accounting for these costs has implications for efficient and affective land use, particularly in urban areas where land values are high. This warrants a level of effort attributed to the evaluation of land occupied by transportation infrastructure similar to the effort devoted to evaluating other categories of costs.

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<sup>21</sup> These land costs may also be overestimated due to intersections between the different components of the road network, and double-counting as a result. The issue is under review.

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