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Economies of scope and economies of agglomeration: The Goldstein-Gronberg contribution revisited

John B. Parr

Department of Urban Studies, University of Glasgow, Glasgow G12 8QQ, U.K.
(e-mail: J.B.Parr@socsci.gla.ac.uk)

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Abstract. Following on from the work of Goldstein and Gronberg, it is argued that under certain conditions, internal economies of scope form the bases for two types of agglomeration economy. These differ from two better known types, which are based on internal and external economies of scale. A further two types of agglomeration economy are shown to derive from particular forms of external economy. Attention is then given to the conditions under which economies of scope may be accompanied by either agglomeration economies or agglomeration diseconomies, both internal to the firm. The discussion is extended to the setting of a simple urban system, where agglomeration economies and diseconomies internal to the firm may each exist alongside agglomeration economies or diseconomies deriving from externalities. A scheme is then outlined, in which the various types of agglomeration economy are drawn together within a common framework.

JEL classification: R12, R32

1. Introduction

The first effort to relate the concept of economies of scope, which had been recently developed by Panzar and Willig (1981), to the longer established concept of agglomeration economies, introduced by Weber (1909), was undertaken by Goldstein and Gronberg (1984). Prior to their work, the scale of economic activity at a particular location (whether relating to the firm, the industry or the urban area) was generally seen as the explanatory factor underlying agglomeration economies, these having been classified by Hoover (1937), following Ohlin (1933), as large-scale economies, localization economies and urbanization economies. The purpose of this note is not to take serious issue with the findings of Goldstein and Gronberg, but rather to modify and extend their argument in several ways. In particular,

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consideration is given to the nature of the relationship between economies of scope and agglomeration economies. After outlining the various forms of agglomeration economy, it is demonstrated that economies of scope may exist in relation to diseconomies as well as economies of agglomeration. Attention is then focused on the co-existence of different types of agglomeration economy. Given the fact that agglomeration economies have attained a recent prominence in the so-called new economic geography (Fujita et al. 1999) and also in the analysis of clusters of economic activity (Steiner 1998), such a discussion is clearly not out of place.

Goldstein and Gronberg (1984) tended to view economies of scope as internal to the firm, and agglomeration economies as external to it. Here some additional perspectives are offered. Following Panzar and Willig (1981), Goldstein and Gronberg argued that economies of scope occur when the total cost of producing two or more products within a firm is less than the total cost of producing these by separate firms. They further argued that economies of scope in a multi-product firm are dependent on the existence of a resource or input which is not fully utilized (in the production of a single product), and which is of a sharable nature, e.g., a piece of machinery, certain technical facilities, a particular design or marketing expertise, etc., Economies of scope were seen as providing the incentive for lateral integration (they used the term "horizontal" which in this paper refers to the dimension of scale), as well as for vertical integration, both involving multi-product output on the part of a firm. In the former case the multi-product aspect refers to different product markets, whereas in the latter case it refers to different processes or different stages of production. This distinction, which will be considered in Sect. 5, was not exploited by Goldstein and Gronberg, probably in the interest of generalizing the argument.

With certain additions we rely here on their notation, which was taken from Panzar and Willig (1981), with d used in place of their l. This is summarized as follows:

N = $\{1, 2, \ldots, n\}$ denotes the set of products under consideration;
y = $(y_1, \ldots, y_n)$ refers to the respective outputs of this set (the term q is used when more than one location is involved);
y_s = vector n, the elements of which are set equal to those of y for $i \in S \subset N$, and 0 for $i \notin S$;
R = $\{1, 2, \ldots, z\}$ represents the potential locations for production;
w^r = the vector of factor prices at location r (assumed to be constant for all r);
$C(.,.)$ = the multi-product minimum-cost function;
T = $\{T_1, \ldots, T_d\}$ refers to a non-trivial partition of $S \subset N$, that is, $\cup T_i = S$, $T_i \cap T_j = \phi$ for $i \neq j$, $T_i \neq \phi$;
d = number of products belonging to the subset S with $d > 1$.

2. Economies of scope and agglomeration economies

It may be seen in Goldstein and Gronberg (1984, Table 1) that for the individual firm, economies of scope exist at factor prices w with respect to partition T, when

$$C(y_S^r, w) < \sum_{i=1}^{d} C(y_{T_i}^r, w) \tag{1}$$

This is the reverse of their inequality (1b), the condition for diseconomies of scope. In inequality (1) multi-product output takes place at a single location r. The left side refers to the single multi-product firm, while the right side is concerned with d independent single-product firms, each producing a different product i (instead of one single-product firm there may be a group of firms, each producing product i, and this possibility is assumed throughout, whenever reference is made to a single-product firm). There are various alternative conditions for the existence of economies of scope, which do not involve the agglomeration of all multi-product output at r. One of these may be inferred from Goldstein and Gronberg (1984, Table 1):

$$\sum_{r=1}^{z} C\left(\sum_{i=1}^{d} q_{T_i}^r, w\right) < \sum_{r=1}^{z} \sum_{i=1}^{d} C\left(q_{T_i}^r, w\right) \quad (1 < d, z \text{ and } \sum_r q_{T_i}^r = y_{T_i}) \tag{2}$$

The left side of (2) refers to a single firm having a multi-product division at each of its z locations, while the right side is concerned with d single-product firms (each producing a different product i) at each of the z locations.

In their definition of agglomeration economies, Goldstein and Gronberg (1984, p.97) assumed the presence of internal diseconomies of scope. They argued that agglomeration economies exist at location r at factor prices w with respect to partition T, when

$$\sum_{i=1}^{d} C(y_{T_i}^r, w) < \sum_{r=1}^{z} \sum_{i=1}^{d} C(q_{T_i}^r, w) \quad (1 < d, z \text{ and } \sum_r q_{T_i}^r = y_{T_i}) \tag{3}$$

where each side is defined as above. The agglomeration economies, which are external to the firm and result from the co-location of different single-product firms, are considered in the next section. The reverse of inequality (3) would indicate the presence of agglomeration diseconomies for the different single-product firms at a single location r. An alternative condition for the existence of agglomeration economies, but one involving the presence of economies of scope, is given by Goldstein and Gronberg in their inequality (1a):

$$C(y_S^r, w) < \sum_{r=1}^{z} C\left(\sum_{i=1}^{d} q_{T_i}^r, w\right) \quad (1 < d, z \text{ and } \sum_r q_{T_i}^r = y_{T_i}) \tag{4}$$

where each side is defined as previously. Here, however, the agglomeration economies are internal to the firm, in contrast to the situation in inequality (3). The reverse of inequality (4) would imply that the multi-product firm at the single location r is subject to agglomeration diseconomies, a possibility that will be considered later.

At this point two qualifications are introduced, the second of which concerns the question of scale. Goldstein and Gronberg (1984, p. 97) argued that the term $C(y_S^r, w)$, as in inequalities (1) and (4) above, "represents the cost function of a multi-product firm which locates all production facilities at site r. The firm benefits from both economies of scope and economies of agglomeration." This is true, of course, but only in a restricted sense. No further details are available on the benefit to the firm

of producing all products at a single location r, and as shown in inequality (2), the presence of economies of scope does not require the output of all products to be at a single location. In the absence of additional information we can only conclude that for this multi-product firm the two kinds of economy inevitably amount to one and the same thing, i.e., the agglomeration economies do not exist independently of the internal economies of scope. Evidently, the economies of scope are in some way spatially constrained, and could not be exploited to the same extent if the firm's production facilities were dispersed. Given this spatial constraint (requiring the concentration of all product output at a single location) and bearing in mind that economies of scope may involve lateral or vertical integration, it is perhaps more appropriate to argue that spatially constrained economies of scope provide the bases for two types of agglomeration economy. These two types are clearly internal to the firm, and thus differ from the agglomeration economies defined in inequality (3), which are external to each single-product firm at location r.

The second qualification was raised by Goldstein and Gronberg (1984, p. 98, Footnote 5), and concerned the possibility that the two conditions for agglomeration economies, expressed here in inequalities (3) and (4), might reflect (partly or in full) "spatial economies of scale rather than spatial cost complementarities across products." Spatial economies of scale which are within the control of the firm (i.e., spatially constrained internal economies of scale) refer to the cost savings resulting from the concentration of output of a given product at a particular location. These economies may occur within the multi-product firm at location r, the setting for the left side of (4), which could represent an isolated location or "company town," as referred to by Goldstein and Gronberg in their example. Such spatial economies of scale may also occur within any single-product firm at a multi-firm location, the setting of the left side of (3). Alternatively, within this setting there may exist spatial economies of scale which were external to the firm. Thus, if in place of a given single-product firm producing product i, there existed a group of firms producing the same product, certain cost savings might be present, which were a function of the overall scale of output of product i at location r and not therefore dependent on spatial cost complementarities across products. These spatially constrained external economies of scale were regarded by Marshall (1892) as advantages of localization.

Goldstein and Gronberg (1984, p. 98, Footnote 5) dealt with this problem of definition by specifying the conditions under which spatial economies of scale would be absent from the multi-product company town and from the multi-firm location. In reality, of course, their presence could be expected in both cases. Following Hoover (1937), the two forms of spatial economies of scale (those internal to the firm and those external to it) are treated here as distinct types of agglomeration economy. Up to this point, therefore, we may identify four types of agglomeration economy. Two of these are based on spatially-constrained internal economies of scope, as outlined earlier, which reflect the advantages of lateral integration and of vertical integration. The other two are based on spatially constrained internal economies of scale and spatially constrained external economies of scale, the latter usually termed "localization" economies. These four types are in addition to the agglomeration economies implied in inequality (3), which are now examined.

3. Other agglomeration economies

In addition to proving certain propositions concerning the existence of urban areas, Goldstein and Gronberg considered the nature of agglomeration economies given in inequality (3), these being external to the firm and based on spatial cost complementarities. The primary interest here was summed up by their comment that firms may find it advantageous to merge in a spatial sense though not in a corporate sense, with urban areas thus acting as "vehicles" for such a process of spatial merger (Goldstein and Gronberg 1984, pp. 94–95). To approach this question, they laid stress on the sharing of an input by independent firms producing different products (rather than the sharing of an input across different products within a single firm), this sharing being an important source of external economies for the firms concerned. Goldstein and Gronberg (1984, p. 95 and p. 101) argued that in the case of unrelated firms the "sharable input" is infrastructure (typically supplied by an agency of government) and/or specialized business services (supplied by the market), while in the case of related or technically linked firms the sharable input is co-ordination, relating to the processing of information, transportation-cost reduction, the assurance of input supply and market outlets, decreased uncertainty, etc.

The multi-product nature of the urban area can therefore be seen to stem from the presence of: i) unrelated firms which rely on agglomeration economies of the "urbanization" type, these representing the external-economy counterpart of (or even the alternative to) spatially constrained economies of lateral integration within the individual firm; and ii) firms which are related to oneanother in terms of backward and/or forward linkages and which depend on agglomeration economies of the activity-complex type, these being the counterpart of spatially constrained economies of vertical integration within the firm. The term "activity-complex economies" appears to fill an awkward gap in the existing nomenclature (Parr 2002). Thus, to the four types of agglomeration economy identified in Sect. 2, we may now add a further two, both of which are based on spatially constrained external economies. These will be considered further the Sect. 5.

Throughout most of their analysis, Goldstein and Gronberg deliberately treated the value of w, the vector of factor prices, as constant for all locations. To some extent this assumption weakens the concept of agglomeration economies. It is often the case that a firm's decision to locate in an urban area rather than in isolation (at a company town) depends on factor-price differentials, and factor-price advantage usually represents a crucial (though not exclusive) element of both urbanization and activity-complex economies, as well as localization economies. Against all this must be weighed the real merit of treating w as spatially invariant, namely, that it focuses attention on how the co-location of economic activity may be the cause of production externalities.

4. A further perspective

We return to the notions of scope and agglomeration, and show how these may be interrelated in a variety of ways. Three considerations are important: i) internal economies of scope may sometimes form the bases for

agglomeration economies, as already discussed; ii) in other cases the exploitation of economies of scope may require the dispersion of production in order to avoid agglomeration diseconomies; iii) when such spatial dispersion occurs, the exploitation of economies of scope does not necessarily involve the production of all products at each location. Consider three multi-product firms: Firms 1, 2 and 3. Each firm is subject to internal economies of scope, and each supplies the same set of products. For convenience, we disregard the complication of scale, discussed above.

In the case of Firm 1 the economies of scope are spatially constrained (i.e., are dependent on all products being produced at the same location) as in the left side of inequality (4), and thus give rise to agglomeration economies. For Firms 2 and 3, however, which are also subject to economies of scope, the production of all products at a single location r would result in agglomeration diseconomies, these being internal to the firm. Such agglomeration diseconomies could be directly related to the exploitation of economies of scope, as when the concentration of all product output at a single location results in congestion or rivalry within the firm. More plausibly, the agglomeration diseconomies are likely to be independent of the economies of scope, as when spatial concentration of product output involves high transportation costs due to the locational pattern of raw materials or markets. The agglomeration diseconomies referred to here should be seen as of a potential character, inasmuch that these are avoidable, as will be discussed shortly. Note that while we adhere to the Goldstein-Gronberg assumption of a spatially invariant vector of factor prices w, we depart from their related assumption that "There are no initial differences in the relative attractiveness of various sites."

For Firm 1 we have

$$C(y_S^r, w) < \sum_{r,i=1}^{z=d} C(q_{T_i}^r, w) \quad \left(q_{T_i}^r = y_{T_i}\right) \tag{5}$$

the right side referring to each product i being produced at a different location r. Inequality (5) would hold if the input, which was shared in the production of the various products, was both spatially indivisible and immobile during the production process. The shared input is indivisible if it cannot be utilized simultaneously at more than one production location, and is immobile if it cannot be physically shifted among locations or cannot be made available at these locations from a single location.

For Firm 2, inequality (5) is reversed. Efficient production (and thus the avoidance of agglomeration diseconomies) requires the spatial separation of output by product. This spatial structure would emerge, for example, where each of the d products was drawn to the location of a particular non-factor input (e.g., a weight-losing raw material), the various inputs being at different locations. Such an outcome would be possible if the shared input was divisible or mobile among the locations at which the different products were produced.

In the case of Firm 3 efficient production involves the spatial dispersion of multi-product output among particular locations, thereby avoiding agglomeration diseconomies. For Firm 3, therefore,

$$C(y_S^r, w) > \sum_{r=1}^{z} C(\sum_{i=1}^{d} q_{T_i}^r, w) \quad (1 < d, z \text{ and } \sum_r q_{T_i}^r = y_{T_i}) \tag{6}$$

the right side indicating that the firm produces all d products at each of the z locations. This spatial structure would emerge, for example, where each of the z locations represented a market or distribution point for all d products, and where the freight rates on finished products were high. For this outcome to exist the shared input would have to be divisible or mobile. Such a spatial structure was, in fact, considered by Goldstein and Gronberg (1984, Table 1 and p.100). In their case, however, it involved the avoidance of agglomeration diseconomies which were external to the firm, apparently resulting from the common location of various multi-product firms. Our concern, however, has been with agglomeration diseconomies internal to the firm. We now examine the issue of spatial structure in more detail.

5. The plurality of agglomeration economies

Several issues underlie the argument of this section. First, the different types of agglomeration economy recognized above should not be seen as necessarily existing separately from each other. Second, in the case of the three firms examined in Sect 4, no account was taken of their locations within the urban system, and this needs to be specified. Third, according to Goldstein and Gronberg (1984, p. 95): "we may observe some cases of large vertically integrated firms in isolated locations, but there exist as well urban areas with many firms related in some way through production or marketing, but not under the same corporate umbrella." Not mentioned was the possibility that the integrated firm may be located within a given urban area. In fact, this was ruled out by the assumption of diseconomies of scope, which involved the imposition of their inequality (1b), or the reverse of inequality (1) above.

5.1. The co-existence of agglomeration economies (diseconomies)

The previous section considered three firms which were all subject to economies of scope in production, reflecting the advantage of lateral or vertical integration. For Firm 1 these internal economies of scope were spatially constrained (and thus gave rise to either of two types of agglomeration economy), so that multi-product output took place at a single location. For Firms 2 and 3, however, the exploitation of internal economies of scope was accompanied by potential agglomeration diseconomies (also internal to the firm), which were avoided with dispersed spatial structures of production. For all three firms we now introduce two types of location: a type-a center, representing a diversified urban area where agglomeration economies of the urbanization type (or conceivably the activity-complex type) are present, but where agglomeration diseconomies external to the firm also exist; and a type-b center, representing an isolated location or company town, where neither urbanization economies nor diseconomies are present. For each of the three firms the selection of one type of center as an efficient production location depends on the input structure (and more generally the production function) of the firm. It is assumed that the frequency and location of type-a centers and of the potential type-b centers are such as to be consistent with the firm's preferred spatial structure of production. Also, recall from Sect. 4 that we are disregarding the influence of internal economies of scale.

In the case of Firm 1, where economies of scope are spatially constrained, multi-product output occurs at a single location. Of the two possibilities the first requires the firm to have access to a range of infrastructure and specialized services which it shares with other firms. As a consequence the multi-product firm has to be located at a type-a center, where urbanization economies can be realized, these outweighing any urbanization diseconomies such as congestion. Thus for the first possibility, we have

$$C(y_S^a, w) < C(y_S^b, w) \tag{7}$$

where a refers to a type-a center and b refers to a type-b center. With this first possibility, therefore, the agglomeration economies deriving from spatially constrained internal economies of scope, which result in all product output being at a single location, co-exist with externality-based agglomeration economies of the urbanization type, which require location at a type-a center. Under the second possibility, however, Firm 1 encounters urbanization diseconomies in a type-a center which outweigh any urbanization economies. As a consequence the firm is located in a type-b center, so that inequality (7) is reversed. Thus although there are agglomeration economies based on internal economies of scope, favoring production at a single location, the firm is also subject to externality-based agglomeration diseconomies, which are avoided if a location at a type-b center is selected.

In the case of Firm 2, economies of scope in production are accompanied by potential agglomeration diseconomies, both internal to the firm. The agglomeration diseconomies do not materialize, however, if output is spatially separated by product, as specified in Sect 4. Here there are several possibilities. Under the first possibility each product must be produced at a type-a center, in order to realize net urbanization economies. Therefore,

$$\sum_{a,i=1}^{A=d} C(q_{T_i}^a, w) < \sum_{b,i=1}^{B=d} C(q_{T_i}^b, w) \quad (a = 1, \ldots A;\ b = 1, \ldots, B; \quad A = B; q_{T_i}^a = q_{T_i}^b) \tag{8}$$

With this first possibility internally based agglomeration diseconomies are circumvented by the output of each product taking place at a separate specified location, and externality-based agglomeration economies are achieved if each location also represents a type-a center. Under the second possibility, however, each product must be produced at a type-b center, so as not to incur net urbanization diseconomies. As a result, inequality (8) is reversed. The spatial structure of the multi-product firm reflects the co-existence of potential agglomeration diseconomies. In other words, the firm is subject to internally based agglomeration diseconomies, which are absent if the output of each product takes place at a separate specified location, but is also subject to externality-based agglomeration diseconomies, which are absent if each location also represents a type-b center. A number of other possibilities for Firm 2 exist, including the situation where some products each require a location in a separate type-a center, while other products are each efficiently located in a separate type-b center.

Finally, for Firm 3 economies of scope are again accompanied by potential agglomeration diseconomies (both internal to the firm). The latter do not emerge if multi-product output is dispersed, as indicated in Sect. 4.

The first of the two possibilities requires each multi-product division of the firm to be located at a type-a center, in order to realize net urbanization economies. Thus

$$\sum_{a=1}^{A} C\left(\sum_{i=1}^{d} q_{T_i}^{a}, w\right) < \sum_{b=1}^{B} C\left(\sum_{i=1}^{d} q_{T_i}^{b}, w\right)$$

$$\left(a = 1, \ldots, A;\ \ b = 1, \ldots, B;\ \ A = B;\ \ \sum_{a} q_{T_i}^{a} = \sum_{b} q_{T_i}^{b}\right) \tag{9}$$

With this first possibility, internally based agglomeration diseconomies do not arise because multi-product output occurs at designated locations, and access to externality-based agglomeration economies is assured if these locations also represent type-a centers. The second possibility requires the firm to have each of its multi-product divisions located at a type-b center in order not to incur net urbanization diseconomies, so that inequality (9) is reversed. Under this second possibility there is a further co-existence of potential agglomeration diseconomies. Those which are internal to the firm are avoided if multi-product output occurs at designated locations, while those which are externality based are avoided if these locations also represent type-b centers.

It becomes evident that under certain conditions the entire multi-product firm may be drawn to a diversified urban area (a type-a center), while under alternative conditions each of its single-product plants or each of its multi-product divisions is efficiently located in a different type-a center. In this respect the location of the relevant ouput of the laterally or vertically integrated firm at a type-a center is no different, in principle, from the location of a small and/or new single-product firm which, it is often argued, is typically located in a metropolitan area, particularly its inner districts. In both cases, infrastructure and commercial support systems tend to be shared or used in common, frequently being supplied by a third party, and pointing to a dependence on agglomeration economies, largely of the urbanization type. Similar arguments apply with respect to the large-scale firm (in the terminology of this paper, a horizontally integrated firm), which locates its entire single-plant operation not in a company town (a type-b center) but in a diversified urban area (a type-a center) or, if it is a national firm serving various regional markets, each of its regional plants in a different type-a center. It is noted in passing that whatever the nature of integration within a firm, the tendency for the pendulum of locational choice to swing between the diversified urban area and the company town represents an important underlying factor in the changing size distribution of centers and thus the changing spatial structure of the economy over the long run.

5.2. The classification of agglomeration economies

The fact that in certain situations more than one type of agglomeration economy can be observed, prompts the question (implied in much of the foregoing discussion) as to whether it is possible to arrange agglomeration economies in some classificatory scheme. In dealing with the individual firm, Teece (1980) alluded to the distinction between its scope (involving lateral

integration or multi-product output for different product markets) and its complexity (involving vertical integration or multi-product output as part of a sequential or a convergent pattern of production for a single product market). Making broader use of this distinction, already touched upon in Sect. 3, the nature of the six agglomeration economies considered at various points above may now be generalized in the following terms: an agglomeration economy of a given type owes its existence to either an internal economy or an external economy, each being spatially constrained and each referring, as appropriate, to the dimension of scale, scope or complexity. Consequently, for any spatially constrained internal economy of scale, scope or complexity (i.e., an economy of horizontal, lateral or vertical integration) there exists, as a counterpart, a spatially constrained external economy involving the corresponding dimension, this being respectively termed a localization, urbanization or activity-complex economy (Parr 2002).

The resulting classification goes beyond the tripartite division originally proposed by Ohlin (1933) and elaborated upon by Hoover (1937) and Isard (1956). It is broadly consistent with the various categories considered by Goldstein and Gronberg, although they tended to place emphasis on those agglomeration economies stemming from externalities. There are only two differences, and these are slight. First, their term "scope" refers to lateral *and* vertical integration, whereas in the above scheme the term refers only to lateral integration (with complexity referring to vertical integration). Second, while they always regard urbanization economies as a function of urban scale, such economies (termed in the above scheme "spatially constrained external economies of scope") are viewed here as a function of urban diversity. But since the scale of an urban area is very closely related to the diversity or what Goldstein and Gronberg (1984, p.102) termed "the scope of the urban area," this difference in characterization is minor.

6. Concluding comments

In examining agglomeration economies from the perspective of economies of scope, Goldstein and Gronberg were able to draw together the rather disparate concepts of urban economic structure and industrial organization. In this connection, they argued that multi-product urban areas do not necessarily contain multi-product firms. The concern here has been with qualifying and elaborating certain of their findings. An important result to emerge was that there is no unambiguous relationship between economies of scope and agglomeration economies: the existence of economies of scope need not involve the presence of agglomeration economies, any more than agglomeration economies are necessarily concerned with economies of scope. In certain cases a firm's exploitation of economies of scope forms the bases for agglomeration economies, these being internal to the firm and thus distinct from those based on externalities. In other cases, however, a firm's exploitation of economies of scope could be accompanied by avoidable agglomeration diseconomies, internal to the firm. It was also shown that such agglomeration economies and diseconomies may each co-exist with either externality-based agglomeration economies or diseconomies, these possibilities resulting in a variety of spatial structures. Finally, attention was drawn to the fact that an agglomeration economy based on an internal economy of

scale, scope or complexity can be said to have a counterpart based on a corresponding external economy.

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