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CHAPTER 14

TOWARDS A « SPATIALIZED » COST OF CAPITAL CONCEPT

Michel Mignolet

1.0 INTRODUCTION

The economic literature has long been concerned with the location of productive activities in space. The investor is viewed as selecting the region that yields the highest expected value of after-tax profits. The firm considers, among others, the intrinsic characteristics of regions (the factor endowments) as well as any net agglomeration benefits[1]. By the clustering of activities, externalities are exploited that modify the comparative advantages of regions. Agglomeration economies add to the attractiveness of some locations[2]. However as firms congregate competition among users may bid up local factor prices (land, in particular) lowering the advantage of congested zones. The individual maximization decision also accounts for any subsidies granted in the different regions and the tax burden on the income from invested capital.

In the neoclassical tradition, the investment demand (the setting up of a new firm, for example) is explained by the cost of capital. This indicator expresses the minimum rate of return (the marginal revenue productivity of one monetary unit of capital) the investment project must yield before taxes in order to provide the saver with an attractive net of tax return. It captures in a summary statistic the financial cost, the effective economic depreciation, all tax devices, and investment incentives that directly affect the return on capital. Today the models become more and more realistic. For instance, they are able to integrate the different systems of international double taxation, if any, when the investment is cross-border, the different regimes alleviating the economic double taxation of dividends and the complex interplay of both[3]. A large number of financing arrangements can also be taken into consideration as can be the risk related to a particular asset.

This approach has widely proved its relevance and its usefulness for comparing various location choices. The numerous applications give some evidence of that[4]. While commonly used, this approach is not exempt of criticisms. In particular the plausibility of the main assumption is questioned : *undifferentiated space*. This hypothesis renders the marginal productivity of an investment project being absolutely the same wherever it locates. The

[1] This way of setting out the location process does not exclude the possible part of history accidents that the recent literature showed to have influenced the past geographical pattern of activities.

[2] They are largely due to cost reductions in the exchange of intermediate inputs.

[3] See for instance Alworth (1988) extending the commonly used methodology of King and Fullerton (1984).

[4] See O.E.C.D. (1991), C.E.E. (1992), Jorgenson and Landau (1993), E.B.R.D. (1993) and Shah (1995) respectively for developed (the first three references), in transition and developing countries.

assumption mentioned above entails other undesirable consequences of diverse importance, too:

- the undifferentiated space involves that (fixed) capital has not to be split up into plant and equipment on the one hand, land on the other hand. Pricing both components is not required. Any difference in land price, for example, across space is therefore ignored;
- the framework of competitive analysis is no longer the most appropriate one.

The fact that some input suppliers are located closer to any locator than others is notably responsible of that.

The object of this paper is *to extend the cost of capital framework by accounting for space*. The theoretical base of this paper is derived from two main fields of the economic literature :

- a first inspiration source refers to the effective tax rate on income from capital theory in the neoclassical tradition of investment theory;
- a second branch of the literature belongs to regional and spatial science. Two topics are especially useful here : the spatial differences in productivity and the differential land prices.

Our approach draws on elements from both sources.

The present paper is made up of two main sections before concluding. The first one - section 2 - introduces the basic model when space is undifferentiated. In order to consider an investment composed of plant and equipment on the one hand and land on the other hand, the analytical expressions of capital cost are successively presented respectively for a depreciable asset, a non-depreciable asset and a combination of both. In section 3 the assumption of undifferentiated space is relaxed by including gradually spatial productivity differences, land differentiated prices and imperfect competition.

2.0 THE COST OF CAPITAL : THE A-SPATIAL CONCEPT

In the literature about effective tax rates on income from capital, two rates of return are distinguished :

- the pretax real rate of return on the investment and,

- the posttax real rate of return for the finance supplier (called the saver).

The first one corresponds to the (user) cost of capital. It is defined as the minimum rate of return[5] an investment project must yield before any taxes in order to provide the saver with the same net of tax return he would receive from lending at the market (risk-free) interest rate. This is the second rate of return mentioned above .The analytical expression of the capital cost is derived from an explicit optimizing framework[6] on the investment decision of the firm.

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[5] Eventually adjusted for risk (see McKenzie , 1994).

[6] The representative firm is assumed generally to maximize its equity value in the tradition of Hall and Jorgenson (1967). Alternatively Auerbach (1983) calculates the cost of capital when the value of both equity and debt is maximized.

Let us consider in turn a depreciable asset, a non-depreciable asset and a combination of both.

2.1 The Depreciable Capital Case

The standard expression (Boadway and Shah, 1995) of the gross cost of capital for a depreciable asset is reproduced in (1). Let us admit that perfect competition holds in all markets and denote the useful variables as follows : P and P_{dK} respectively are the prices of output and of investment goods, π and π_{dK}, the inflation rate and the real capital gains on the depreciable asset[7], A_{dK}, the present discounted value of any grants and tax allowances[8] given for the same asset, ρ, the nominal financial cost, τ, the corporate tax rate[9], δ, the economic depreciation and f'_{dK}, the marginal productivity of capital. The cost of capital expression for a depreciable asset, c_{dK}, can be written as follows :

$$c_{dK} = \frac{P.f'_{dK}}{P_{dK}} = \frac{1-A_{dK}}{1-t}.\left[(\rho-\pi)+(\delta-\pi_{dK})\right] \qquad (1)$$

Equation (1) shows that the cost of capital is the marginal value productivity of one monetary unit of capital. When public policy is neutral ($A_{dK} = \tau$), the cost of capital, c_{dK}, reduces to a sum of two terms :

- the real financial cost (ρ - π) plus,
- the effective economic depreciation rate (δ - π_{dK}).

The financial cost, ρ, most often differs in a world of distortionary taxes according to the source of financing. For domestic arrangements, King and Fullerton (1984) calculate separately the cost of capital for different financing methods. Boadway, on the contrary, measures a weighted average of financing mix (Boadway, 1987; Boadway and Shah, 1995). Transnational arrangements are considered by Alworth (1988)[10].

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[7] π_{dK} expresses the difference between the growth rate of the investment price and the inflation rate.

[8] Including any tax savings due to the future depreciation deductions.

[9] In a cross-border financial arrangement, τ is representative of the net tax burden resulting from tax regimes in host and home countries (i.e. the potential international double taxation and any relief methods).

[10] In order to illustrate the measurement of financial costs, only the case of a closed economy will be considered here for the sake of simplicity. Moreover the finance supplier is supposed to be a domestic household. Since nominal interest payments are tax deductible for the company, the financial cost for debt finance is $\rho_E = (1-\tau).i$ where i is the interest rate. If ψ expresses the nominal after-tax rate of return required by existing shareholders on retained earnings, the financial cost of retaining profits ρ_R is equal to ψ / (1-m_g) where m_g is the shareholders' personal tax rate on capital gains (transformed into an effective rate on accruals). If one assumes that σ is the required return to new shareholders (which may differ from ψ for generality), the financial cost associated to a new shares issue ρ_S becomes [$\sigma + \pi$ (m_g - 1 + [1-m_d]. θ)] / θ. [1-m_d], where θ and m_d respectively denote the opportunity cost of retained earnings in terms of gross dividends forgone and the personal tax rate on dividend remittances (see King and Fullerton, 1984; Boadway and Shah, 1995). θ is greater than 1 when methods of alleviating economic double taxation of dividends (the imputation regime, for instance) are implemented. The term (m_g - 1 + [1-m_d]. θ) is representative of the net tax penalty attributable to the fact that a purely nominal return is taxed at θ rate but escapes from any capital gains tax.

2.2 The Non-Depreciable Capital Case

Transposing the cost of capital expression for land (a non-depreciable asset) is straightforward : economic depreciation and capital allowances for tax purposes are put equal to zero (see Boadway and Shah, 1995). Accordingly the cost of capital for land, c_L, becomes :

$$c_L = \frac{P.f'_L}{P_L} = \frac{1-A_L}{1-t}.\left[\rho - \pi - \pi_L\right] \qquad (2)$$

where P, ρ, τ and π have been defined above. P_L, f'_L, A_L and π_L can be interpreted in the same way as the corresponding variables P_{dK}, f'_{dK}, A_{dK} and π_{dK}. They express, respectively, the land price, the marginal productivity of land, public advantages[11] and the real capital gain on land.

2.3 An Investment Made Up Of Depreciable And Non-Depreciable Assets

When the capital stock consists of depreciable assets and land, the expression of capital cost becomes more complicated. For the sake of simplicity, one assumes that the production technique is fixed in terms of depreciable capital and land wherever the investment is located[12]. Without loss of generality, this hypothesis can be expressed as follows : an additional unit of investment, dK, is composed everywhere of one unit of depreciable asset (dK_d = 1) and one unit of land (dL = 1). As shown in (3), the investment expenditure in value, P_k.dK, is equal to the sum of expenses for the purchase of depreciable asset, $P_{dK}.dK_d$, and land, P_L.dL :

$$P_K.dK = P_{dK}.dK_d + P_L.dL. \qquad (3)$$

In an a-spatial universe, there are no transportation costs. Moreover, under perfectly competitive conditions - the standard framework for the cost of capital study - every firm is a price-taker. Factor prices are therefore fixed and equal wherever the investment location.

As $dK = dK_d = dL = 1$, equation (3) reduces to :

$$P_K = P_{dK} + P_L\,. \qquad (4)$$

Let us define λ as the part of land in the total capital expenditure, namely

$$\lambda = \frac{P_L}{P_K}. \qquad (5)$$

King and Fullerton (1984) consider an arbitrage mechanism in such a way that the saver is indifferent between the three financing choices. In order to obtain this result the authors impose that $\psi = \sigma + \pi\,(m_g - 1 + [\,1-m_d\,].\,\theta) = (1-m_i).\,i$ where m_i is the personal tax on interest.

[11] The scale of public advantages for land, A_L, is weaker than for a depreciable asset because the only aids are potentially a subsidy and an investment tax credit.

[12] This hypothesis will be discussed below when the undifferentiated-space assumption is relaxed.

I am now in a position to derive the cost of capital expression for a mix of depreciable and non-depreciable assets. Using (1), (2) and (4), one can write

$$P_K.c = \frac{1-A_{dK}}{1-\tau}.[(\rho-\pi)+(\delta-\pi_{dK})].P_{dK} + \frac{1-A_L}{1-\tau}.(\rho-\pi-\pi_L).P_L . \qquad (6)$$

Integrating (5) into (6),

$$c = \frac{1-A_{dK}}{1-\tau}.[(\rho-\pi)+(\delta-\pi_{dK})].(1-\lambda) + \frac{1-A_L}{1-\tau}.(\rho-\pi-\pi_L).\lambda . \qquad (7)$$

Now let us examine how the cost of capital expression is modified when the undifferentiated-space assumption is relaxed.

3.0 THE COST OF CAPITAL IN A DIFFERENTIATED SPACE

In Section 2, I provide an overview of the standard model measuring the cost of capital. This model enables us to calculate the minimum rate of return an investment must yield in order to be implemented. The variables included in the analytical expression of capital cost may differ from region to region. It is the case of general environment variables such as interest rates or inflation rates. It is also the case of public variables namely the investment incentives and the tax parameters and regimes on income from capital. The indicator defined in (7) turns out to be valuable as well for the investor as for public authorities : it enables us to compare performances of various investment locations in terms of capital cost with respect to the variables taken into account. It may also be used in order to simulate alternative public policies aimed at fostering investment : the differentiated efficacy of some tax devices or capital grants may, for example, be examined by this method.

While pertinent, this approach comes up against some limitations : it is, for instance, unable to determine if a regional policy generates a sufficient or an insufficient differential cost of capital to attract new plants. Space is indeed not undifferentiated. The productivity of any production technique may be higher in one region and lower in another because of natural endowments or agglomeration (dis)economies. One can reasonably assume that firms take the spatial differentials in productivity into account in their location decision making. At the opposite side, the productivity advantages of some regions are offset to some extent by higher factor prices (land, labour, plant or equipment) that must be paid.

This section sets out to integrate progressively space-specific variables into the cost of capital framework. One will successively examine an accounting for differential productivity between regions, consideration of differences in factor prices, and finally - because one cannot presume firms to act in an environment characterized by perfectly elastic demand or supply in all markets - an imperfect economic environment. Through the transformations, the cost of capital is progressively converted from a general factor explaining investment demand into an actual indicator of interregional attractiveness.

Let us consider that N regions apply for the location of the investment project. In each region, any location site is supposed to face the same conditions about factor endowments and prices so that location and region are here considered to be interchangeable.

3.1 Accounting For Differences In Regional Productivity

Spatial productivity differentials are more often apprehended in the specialized literature by estimating production function models[13].
A general expression is given in (8). Output in region r, Q_r, is represented by a homogeneous production function of degree h :

$$Q_r = A_r \, f\,(K_r, L_r)\, \lambda^{hr} \qquad (8)$$

where K_r and L_r denote the capital stock and labour input in region r, respectively. Differences in productivity from region to region are generally[14] captured by the Hicks-neutral shifter term[15], A_r, by returns to scale[16], or by both[17].

In contrast with factors enhancing only the productivity of one given factor of production, regional factors are supposed to affect output in general[18]. Accordingly they are absorbed by the independent shift parameter. A_r refers therefore to *business milieu*. It accounts for differences between regions due to site specific characteristics (e.g., proximity to transport nodes as well as to cities, land topography), local infrastructure, metropolitan structures, climate[19], natural resources endowments, industry mix, and so on. In this first approach, A_r is estimated by econometric methods, assuming that $f(.)\lambda^h$ is the same in every region.

Agglomeration economies, in the standard classification due to Hoover (1936) are composed of three terms : (i) **scale economies** internal to the firm depend on the firm's scale of production; (ii) **localization economies** external to the firm but internal to the industry relate to the size of the industry; and, (iii) **urbanization economies** benefiting all industries link to the scale of the city. Localization and urbanization economies originate in large pools of skilled

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13 Some studies rely on the general framework of the Constant-Elasticity-Substitution production function. Others use the Cobb-Douglas or the translog forms. Because capital stocks series are not generally available at the regional level, most studies estimate a labour demand equation derived from a CES production function. See for example Carlino and Voith, 1992.

14 Alternatively to this standard approach based on the average production function, Beeson and Husted (1989) use a frontier production function approach. Spatial productivity differentials are then measured by the deviations from the "best practice" frontier (e.g., the maximum output achievable using that vector of inputs).

15 See for instance Sveikauskas (1975). Recent examples are provided by Moomaw and Williams (1991) and Carlino and Voith (1992).

16 See Shefer (1973) and Carlino (1982).

17 See Beeson (1987). Catin (1991) applied her approach to French regions.

18 That factors are supposed to be captured by f (.). Some richer specifications of the production function include efficiency terms affecting K and L : the age of the physical stock or educational attainment and experience. See for instance Ke and Luger (1996). If the function is poorly (richly) specified, the shift parameter will concentrate the effect of a large (small) set of variables not captured by f(.).

19 In a broadened sense, climate incorporates social climate, enterprise culture, presence of innovative milieux, and so on.

labour, entrepreneurial talent, wholesalers of specialized items and specialized business services, and inter-firm technological spillovers. Carlino (1982) notes that agglomeration economies are technical in nature due to increasing returns[20]. Hence he comes to the conclusion that they may be more directly measured by h, the homogeneity degree of the function . So, through parameter h, he seeks to capture productivity differentials due to variation in increasing returns to scale. In this second approach, for estimating differentiated returns to scale over space Carlino must assume that A is constant across locations.

The border separating variables affecting A_r and h is not absolute. Moomaw (1983), for example does not follow Carlino. He classifies urbanization and localization economies into the Hicks-neutral shifter term, putting forward the argument that these effects are outside the firm's control.

Lastly, spatial productivity differentials may be apprehended by the combination of shift parameter and returns to scale. Both factors are then allowed to vary between regions. Expressed in an additive framework, the total factor productivity growth is measured by the sum of the growth attributable to both terms.

Whatever the method, the literature provides interesting solutions for measuring the differential productivity supplied by every region. From any three approaches it is *a priori* possible to build an index expressing productivity in the *r*th region relative to a benchmark entity (the nation, for instance). In order to illustrate the method, for the sake of simplicity, only the first approach will be considered here. Following Moomaw (1983), A_r is assumed to capture all factors explaining productivity variation across locations, namely interregional differences in factor endowments on the one hand, localization and urbanization economies related to the number of nearby firms, on the other hand.

Let us define $\hat{A}_.$ and $\hat{A}_r$ as the Hicks-neutral shifter terms measured by estimating a homogeneous production function of degree h respectively for the benchmark entity and the region r[21]. Hence the productivity index[22], α_r, for region r equals :

$$\alpha_r = \hat{A}_r / \hat{A}_. \quad (9)$$

If one assumes that the productivity index, so estimated from past data, is representative of the contemporaneous differential of productivity for any new investment in region r, one can incorporate it into (7). The neo-classical theory states that the firm decides to invest up to the point where marginal productivity of capital is equal to its additional cost. At present, the marginal product of

[20] In connection with this, Fujita and Thisse (1996) stress the essential role of increasing returns to scale for explaining the geographical distribution of productive activities.

[21] Carlino and Voith (1992) for instance use a three-stage estimation procedure. First, they estimate $\hat{A}_r$ for every region r. A second model is fitted in order to explain $\hat{A}_r$ by a set of region-specific variables (e.g. industry mix, human capital characteristics, public investment in infrastructure, metropolitan structure). Thirdly the average productivity shift (for the benchmark entity), $\hat{A}_.$, is measured by the linear combination of estimated parameters from a regression in the second step and means for every region-specific variable.

[22] When variables representing business milieu are industry-specific, it may be desirable that the estimation be made at the industry level, i. In such a case, productivity indexes by region and by industry, α_{ir}, are to be estimated.

capital is affected by differential productivity provided by region r. Accordingly the first member of the equality is replaced by $\alpha_r.c$, such that

$$c^r = \left\{ \frac{1-A_{dK}}{1-\tau}.[(\rho-\pi)+(\delta-\pi_{dK})].(1-\lambda)+\frac{1-A_L}{1-\tau}.(\rho-\pi-\pi_L).\lambda \right\}.\frac{1}{\alpha_r} \qquad (10)$$

3.2 Accounting For Regional Differences In Factor Prices

Let us admit now that assets prices notably the land price may vary between regions. For every location choice r (= 1,...,N), the investment expenditure in value is equal to the sum of expenses attributable to depreciable asset, P_{dK}^r, and land, P_L^r, as follows :

$$P_K^r .dK^r = P_{dK}^r .dK_d^r + P_L^r.dL^r \qquad (11)$$

The hypothesis of fixed production technique[23] with each factor increment being counted for one unit allows us to omit suffix r attached to dK, dK_d and dL. This assumption is particularly strong ; it is made here for the sake of simplicity[24]. When land prices vary across space, if factors are substitutable, one would rather expect variable proportions of factors. In the standard models (under perfectly competitive conditions) « output is produced the less (depreciable) capital and labour intensely and the more land intensely the farther away from the center production takes place »[25].

Let us consider a particular region R as a benchmark. For region R, we have $P_K^R = P_{dK}^R + P_L^R$ because of the fixed-production-technique assumption, where each factor increment is counted for one unit. Following section 2, I define the proportion λ as the ratio of P_L^R to P_K^R and multipliers χ^r as the ratios of P^r to P^R for any subscript dK or dL. Accordingly for any region r the following equality holds :

$$P_K^r = P_K^R . [\chi_{dK}^r . (1-\lambda) + \chi_L^r . \lambda] \qquad (12)$$

and the cost of capital expression for region r, c^r, is defined as the marginal value product of one monetary unit of capital in the benchmark region R,

$$c^r = \left\{ \frac{1-A_{dK}}{1-\tau}.[(\rho-\pi)+(\delta-\pi_{dK})].(1-\lambda).\chi_{dK}^r+\frac{1-A_L}{1-\tau}.(\rho-\pi-\pi_L).\lambda.\chi_L^r \right\}.\frac{1}{\alpha_r} \qquad (13)$$

Let us turn now to the last extension of the cost of capital expression by taking into account the imperfectly competitive markets due to space.

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23 This is the Weber (1909)'s assumption. See Paelinck and Nijkamp (1975) p. 34.

24 Relaxing this assumption can be only made at the expense of great complexity in the analytical expressions. The fixed quantity of factors could be replaced by a variable assortment. The best combination of factors would be provided for every relative cost between depreciable asset and land by the tangency of the isocost straight line and the isoquant curve in a partial equilibrium model.

25 See Stahl (1987) p771 .

3.3 Accounting For Imperfectly Competitive Markets

Spatial competition is by nature oligopolistic (Gabszewicz and Thisse, 1986) so that the framework of competitive analysis used for measuring the cost of capital is not the most appropriate one. One would prefer the framework of strategic interactions between agents (Fujita and Thisse, 1996).

However let us remember the purpose of our paper, which is to determine an analytical expression for the cost of capital that accounts for **differentiated spatial characteristics**. The ultimate aim is to find an indicator empirically measurable able to compare the performances of various location choices. If market power characterizes the agents in a regional context any value chosen for elasticities of commodity demand or input supply[26] would be purely speculative. Furthermore, the same values have to be given *a priori* to the elasticity parameters, wherever the investment is located, in such a way that they are not discriminating across locations[27]. Even if the perfectly competitive context is less realistic, it provides a convenient benchmark that is every bit as good as any other hypothesis.

In order to illustrate how some market power may affect the analytical expressions for capital cost, I shall consider two limiting cases : a pure monopoly for the commodity market and a pure monopsony on the capital market[28]. When the firm acts as a pure monopolist, the price for the good is fixed at a higher level than it would have been in perfectly competitive conditions. Taking into account this case requires replacing P in expressions (1) and (2) by

$$P.\left[1-\frac{1}{\eta}\right] \quad , \tag{14}$$

where η denotes the (negative) elasticity of commodity demand to price (Boadway, 1987; Boadway and Shah, 1995). Symmetrically, when capital price (for instance, the land price) is sensitive to quantities of the input used, the expressions (1) and (2) have to be modified by replacing P_K by

$$P_K.\left[1+\frac{1}{\theta}\right] \quad , \tag{15}$$

where θ expresses the elasticity of land supply.

4.0 CONCLUSION

Regions step up efforts to stimulate the setting up of new plants : capital grants and tax incentives are abundantly used, for example, to foster investment formation. How should the impact of economic policy tools on the investment decision be assessed ? The economics literature on effective tax rates upon

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26 Which would express the expected deviation from the perfectly competitive conditions.

27 Unlike the other extensions developed to the model in sections 3.1 and 3.2 : spatial productivity differences and differentiated land prices.

28 In each case, quantity is supposed to be a function of its own price and not of other prices.

income from capital provides convenient models able to measure the rates of return (after any taxes and public aids) required for the investment between regions. These models have been widely used at the national level or at the regional level, including for regional policy purposes[29].

While convenient and commonly used, this approach is bounded by some restrictive assumptions. The following example illustrates some of these limitations. In the standard model higher taxes increase the cost of capital. As a result investment is supposed to be deterred in all cases[30]. But those taxes may finance a more generous provision of public goods and improve the general productivity of a project. Including taxes on the capital income (and public financial aids) but ignoring the productivity gains due to public goods only gives a partial view of the regional attractiveness that may involve some misleading conclusions.

What lies behind such approximations ? In the standard models, space is not considered : it is supposed to be undifferentiated. The productivity of an investment project is absolutely the same wherever it locates. Land prices are also set equal across space.

This paper set out to integrate these factors within the cost of capital framework. It also examined, but more briefly, the question of the opportunity to consider imperfectly competitive market conditions due to space. So developed the model provides a first measure of a « spatialized » cost of capital.

Obviously this contribution does not exhaust the matter. Some further extensions could be thought of : the integration of adjustment costs following Goulder and Thalmann (1993) or Boadway (1987), for example, or the taking into consideration of irreversibility phenomena ; most location decisions involve an irreversible capital commitment.

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29 Some recent examples are given by Guiot and Mignolet (1995) and by Mignolet et al. , 1997.

30 Alworth (1988), O.E.C.D. (1991), Head et al. (1994) and more systematically Mignolet (1997) have already shown for cross-border financial arrangements that the deterrent effect of taxes on investment and even more the incentive effect of tax breaks are a function of tax regimes both in the subsidiary and in the parent countries.

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