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**Working Paper**

## Regional investment under uncertain costs of location

Dresden Discussion Paper Series in Economics, No. 01/12

**Provided in Cooperation with:**

Technische Universität Dresden, Faculty of Business and Economics

*Suggested Citation:* Broll, Udo; Roldán-Ponce, Antonio; Wahl, Jack E. (2012) : Regional investment under uncertain costs of location, Dresden Discussion Paper Series in Economics, No. 01/12, Technische Universität Dresden, Fakultät Wirtschaftswissenschaften, Dresden

This Version is available at:

<https://hdl.handle.net/10419/56065>

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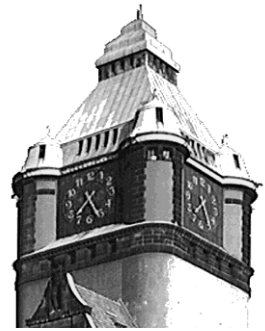
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*Dresden Discussion Paper Series  
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<http://rcswww.urz.tu-dresden.de/wpeconomics/index.htm>

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# Regional investment under uncertain costs of location

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## Abstract:

Due to globalization competitive firms face increasing economic opportunities for locating their activities in countries, regions and cities that provide the best business environment for their specific needs. In our study we focus on the impact of economic risk and risk preferences upon regional allocation of investments. The source of risk stems from the difference in stochastic costs of location across regions. A comparative static analysis shows that capital allocation depends upon the firms' risk preferences. As a result regional agglomeration of investments may occur although the objective of the regional policy is aimed at the opposite. Our findings demonstrate the suitability of the two-moment approach as an alternative to the expected utility approach. The impact of changes in distribution parameters, such as the expected costs of location, the variance of costs of location and the correlation between locational costs, can be fully characterized via the elasticity of risk aversion. Elements of risk preferences beyond risk aversion prove to be very important to evaluate regional politics. This insight is of interest for empirical research in regional economics.

JEL-Classification: R12, R30, R38

Keywords: Regional allocation, regional economics, regional policy, agglomeration, two-moment decision model

**Abstract** Due to globalization competitive firms face increasing economic opportunities for locating their activities in countries, regions and cities that provide the best business environment for their specific needs. In our study we focus on the impact of economic risk and risk preferences upon regional allocation of investments. The source of risk stems from the difference in stochastic costs of location across regions. A comparative static analysis shows that capital allocation depends upon the firms' risk preferences. As a result regional agglomeration of investments may occur although the objective of the regional policy is aimed at the opposite. Our findings demonstrate the suitability of the two-moment approach as an alternative to the expected utility approach. The impact of changes in distribution parameters, such as the expected costs of location, the variance of costs of location and the correlation between locational costs, can be fully characterized via the elasticity of risk aversion. Elements of risk preferences beyond risk aversion prove to be very important to evaluate regional politics. This insight is of interest for empirical research in regional economics.

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## 1 Introduction

Clustering and agglomeration can be observed worldwide on different geographical levels. The explanation of the regional economic structure and the existence of clusters is a central concern of regional economics and the new economic geography. About 4/5ths of the world's domestic product are generated in three geographical centers (NAFTA, EU and East Asia). However, there are still some significant economic disparities in many countries and regions: in Spain, the economic activity is concentrated around Madrid, Barcelona and the Navarra region. Between Tel Aviv and Haifa one can identify the so called Silicon Wodi. In Germany, there is an east-west division, whereas in Italy, the division is north-south. There are also sector differentiations. Computer and software productions are located in Silicon Valley and the Italian fashion industry is concentrated in the Po valley.

The literature in regional economics has developed a fundamental interest in the spatial allocation of resources and the role of its agglomeration to regions or countries.<sup>1</sup> In particular, welfare aspects of capital agglomeration

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<sup>1</sup>See, for example, Krugman 1991; Fujita, Krugman and Venables 1999; Johansson,

(Pflüger and Südekum 2008), the location decisions of firms (Pontes 2005; Pontes and Parr 2005) and the economics of the induction of a clustering process have been subject to thorough investigation stressing, among other things, the importance of spatial economies of scale and scope.

Many countries have spatial differences in production and productivity, mostly because of economic distance between lagging and leading areas. However all countries seek unity by lowering the barriers of internal divisions. For instance, the EU's economic and social cohesion policy is implemented by structural funds to support regions of low economic development (see, e.g., Baldwin and Wyplosz 2009). An interesting question that has been discussed in the context of the regional policy (in the European Union, for example) is whether or not globalization will promote regional mobility of capital in order to achieve economic efficiency and stability. Our study demonstrates that if economic globalization leads to a greater degree of correlation between local cost conditions, then - under some conditions - regional investment decision induces regional distribution of capital to be more concentrated than diverse.

Agglomeration forces, e.g. market size force and economies of scale, favour regional concentration whereas dispersion forces, e.g. local forces of competition, favour regional dispersion of economic activity and location. Economic risks of regional returns on investments are also in the realm of regional and spatial economics. Optimum regional allocation of scarce resources and optimum decisions on the location of firms' economic activities are affected by a risk diversification force. That is, risk-averse investors and firms are attracted to regions which have higher expected net returns on investment and lower return risk. The correlation of stochastic regional returns is also important, as it measures the risk diversification potential of regional economic activities of firms. Hence one can relate regional risk diversification to economic regional integration and globalization.

Our paper concentrates on the interaction between the regional allocation of investments and the regional policy approach of harmonization, i.e. less uneven regional economic development. In a two-region country we study the optimal regional share of investment of a risk-averse firm. Regional policy affects the firm's decision-making process. We show that a higher correlation of risky regional business costs causes a disincentive to diversify. As a result

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Karlsson and Stough 2001; Duranton and Puga 2004; Combes, Mayer and Thisse 2008; Cole 2010.

agglomeration of capital to one region may occur although the regional policy approach focuses on the dispersion of capital across regions.

In order to identify economic risk diversification as a agglomeration force or as a force of dispersion we need a deeper insight into the structure of risk preferences. Our two-moment decision framework reveals that the magnitude of the elasticity of risk aversion with respect to risk parameters determines whether or not the correlation of regional costs works either as a regional agglomeration or a regional dispersion force.<sup>2</sup> Note that our decision model of regional allocation of capital under uncertainty is not in conflict with maximizing expected utility but has notably attractive properties (Meyer 1987).

We develop a model to demonstrate our claim that, whether or not a higher similarity of risky regional business costs will make capital allocation regionally more dispersed than concentrated, depends crucially upon the firm's risk aversion elasticity. Cost differences across regions are a basic element of our study. Random cost differences across regions can be explained by differences in productivity, business environment, industrial policy, trade policy, regulations, fiscal and tax policies and most notably differences in labour markets, geography and institutions. Acemoglu, Johnson and Robinson 2002 offer a thorough discussion of institutions and geography.

The paper is structured as follows. Section 2 provides a model of the firm's regional capital allocation under uncertain cost of location and risk aversion. We derive a symmetry result of regional investments which we use as a benchmark. Then in section 3 we discuss our main result: the impact of risk preferences upon the regional asymmetry of capital investments. In section 4 we discuss the relevance of our result for reality. Section 5 concludes.

## 2 Analytical framework and benchmark

A risk-averse firm, located in a two-region country, has  $M$  units of initial capital endowment which would earn a riskless gross return  $r_i$  from investment in either region  $i$  ( $i = 1, 2$ ). Let  $\tilde{c}_1$  and  $\tilde{c}_2$  be random percentage costs of doing business in region 1 and 2, respectively, in a two-region country or a two-country union. Random cost differences are based on different productiv-

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<sup>2</sup>See for a discussion of agglomeration and dispersion forces Broll, Rolán-Ponce and Wahl 2010.

ity, business environment, land price, industrial and trade policy, regulations, fiscal and tax policies and most notably differences in the quality of institutions which lead to random differences in the rates of return of the regions. We model regional random business costs of the firm such that  $(1 - \tilde{c}_i)r_i$  is retained as the uncertain net return per unit of investment in region  $i$  and, for simplicity, let  $r_i = r$ .

The stochastic income (i.e. the net earnings on investment) of the firm,  $\tilde{\Pi}$ , comes from doing business in both regions, where  $x = M_1/M$  denotes the share of investment that goes to region 1; capital share  $(1 - x) = M_2/M$  goes to region 2, i.e.  $M_1 + M_2 = M$ . Hence

$$\tilde{\Pi} = [(1 - \tilde{c}_1)x + (1 - \tilde{c}_2)(1 - x)]rM.$$

The firm maximizes expected utility of income, i.e.  $EU(\tilde{\Pi})$ , with respect to capital share  $x \geq 0$  invested in region 1.  $E$  denotes the expectation operator. Let us consider an interior solution of the firm's investment decision problem. Hence, the optimum investment proportions satisfy  $0 < x^* < 1$ .

Meyer (1987) and others have shown that under some conditions the expected utility decision problem can be transformed into the mean-variance framework. That is to say, the expected utility from uncertain income  $\tilde{\Pi}$  with utility function  $U$  can be written in terms of the mean of risky income,  $\mu$ , and the variance of risky income,  $\sigma^2$ :

$$EU(\tilde{\Pi}) = \int_a^b U(\mu + \sigma y) dF(y) \equiv V(\mu, \sigma^2),$$

with  $b > a$  as support of  $y$  and  $F$  is its distribution.

The first-order condition for the optimum capital share  $x^*$  to region 1 of the investment decision problem reads:

$$x^* = \frac{1}{\gamma} \left( \text{cov}(\tilde{c}_2, \tilde{c}_2 - \tilde{c}_1) + \frac{\bar{c}_2 - \bar{c}_1}{2rMS^*} \right),$$

where  $\gamma = \text{var}(\tilde{c}_2 - \tilde{c}_1)$ .  $\text{var}$  and  $\text{cov}$  denote the variance and covariance operators, respectively.  $S^*$  stands for the marginal rate of substitution between return  $\mu$  and risk  $\sigma^2$ . We have

$$S(\mu, \sigma^2) = \frac{\partial \mu}{\partial \sigma^2} = \frac{-V_{\sigma^2}(\mu, \sigma^2)}{V_{\mu}(\mu, \sigma^2)} > 0,$$



where the partial derivatives are given by

$$V_{\sigma^2}(\mu, \sigma^2) = \frac{\partial V(\mu, \sigma^2)}{\partial \sigma^2},$$

$$V_{\mu}(\mu, \sigma^2) = \frac{\partial V(\mu, \sigma^2)}{\partial \mu}.$$

The second part on the right hand side of the first-order condition for optimum investment share of region 1 describes the impact of the expected cost differential across regions. The impact of the absolute difference in expected regional costs is modified by gross earnings, risk preferences and the variance of the cost differential, i.e. the variances  $\sigma_i^2$  ( $i = 1, 2$ ) and the covariance  $\text{cov}(\tilde{c}_1, \tilde{c}_2)$ , which determine  $\gamma$ . The first term on the right hand side is the variance minimizing part of the optimal investment proportion.

In the literature, it has been shown that there is a relationship between the risk aversion measure in the Arrow-Pratt sense under the expected utility hypothesis and the marginal rate of substitution between return and risk in the mean-variance framework (see Meyer 1987 and Levy 1989). We use  $S(\mu, \sigma^2)$  as the measure of (absolute) risk aversion to discuss the impact of risk preferences on optimum regional investment.

Note that the optimal investment share for region 1,  $x^*$ , is not a result in reduced form, since the level of risk aversion,  $S^*$ , is endogenous. However, what we observe in case of regional symmetry is the following. When expected costs between regions and all regions risk parameters are equal, the optimal share of investment in region 1 is 1/2. Allocation of 50 percent in each region is the well-known reference point in regional economics and in the periphery-center model of the economics of geography (see, e.g., Fujita, Krugman and Venables 1999; Forslid and Ottaviano 2003, Pflüger and Südekum 2008).

First, we study the impact of differences in expected business costs across regions upon regional capital allocation. Second, we investigate the effect of a mean preserving spread in the random regional business cost *differential* upon regional investments. We argue that globalization by international trade, foreign direct investment and convergence in institutions induces a higher degree of correlation of locational costs. Does this lead to dispersion or agglomeration of capital in the region/country or a union? We will show that the outcome depends upon the risk aversion elasticity of firms.

As an illustration of the aim of our investigation consider former Western and Eastern Germany and today's federal and local governments' regional

economic policy. We observe many political initiatives intending to harmonize the regional economic environment and especially to improve the infrastructure to make specific location more attractive. What are the conditions under which firms have an incentive to diversify investments across regions in order to achieve similarity in capital endowments?

We now introduce our benchmark by the following

**Proposition 1** (Regional symmetry) *If expected costs of location and locational cost risks are identical between regions, then optimum regional investment allocation is symmetric, i.e.  $x^* = 1/2$ . If expected locational costs differ across regions, c.p., the region with the lower expected costs gets the higher investment proportion.*

**Proof** Observe that under  $(\mu, \sigma^2)$ -preferences, under the definition of the firm's uncertain income and in the case that all risks are equal,  $\sigma_1^2 = \sigma_2^2$ , we obtain  $\text{sign}(x^* - 1/2) = \text{sign}(\bar{c}_2 - \bar{c}_1)$ . The claim follows.

Expected business costs  $\bar{c}_i$  can be interpreted as reflecting some sort of regional differences or comparative (dis)advantages of region  $i$ . For example,  $\bar{c}_1 < \bar{c}_2$  implies that there is an intrinsic bias in favour of investing in region 1. Given the impact of the costs differential across regions, the magnitude of the asymmetry of optimum investment allocation to both regions also depends upon gross earnings, the degree of firm's risk aversion and the firm's assessment of the probability distribution of its business costs.

### 3 Locational effects of integration

In this section, we investigate the interaction between the degree of asymmetry of regional investment allocation and the harmonization of regional economic conditions by government or union policy. The two-moment framework proves to be especially useful in conducting a comparative static analyses. We concentrate our study on the variance/covariance structure of the random regional business costs.

Let us consider the following questions: If political activities are such that risky business costs act more similar, meaning that there are more (positively) correlated, does this support capital dispersion across regions? Or, does such political and economic approach lead to regional agglomeration of capital? For example, north and south, east and west, core and periphery.

**Assumption** Let  $\sigma_1 = \sigma_2 \equiv \sigma$ . Regions only differ in expected cost of location, where w.l.o.g.  $\bar{c}_2 > \bar{c}_1$ .

Our assumption implies that the variance of the random business costs differential across regions becomes  $\gamma = 2\sigma^2(1 - \rho)$ , where  $\rho = \text{corr}(\tilde{c}_1, \tilde{c}_2)$  and  $\text{corr}$  denotes the correlation operator. We consider the range  $0 \leq \rho < 1$ . We call  $\gamma$  a divergence parameter, since it measures the degree of the variability in regional cost differences. If  $\gamma$  increases, then, c.p., regional income risks of the firm are less connected. Furthermore, there exists an intrinsic bias in favour of investing in region 1, which has the lower expected business costs. Hence, our analysis starts with  $x^* > 1/2$ .

By assumption, the optimum capital share of region 1 reads in detail

$$x^* = \frac{1}{2} \left( 1 + \frac{\bar{c}_2 - \bar{c}_1}{rMS^*\gamma} \right) > \frac{1}{2}.$$

Before analyzing the economic impact of divergence upon the optimal investment ratio, we introduce the concept of risk aversion elasticity (Battermann, Broll and Wahl 2002, Broll, Wahl and Wong 2006, Eichner and Wagener 2003, 2011).

**Definition** (Elasticity of risk aversion) The percentage change in the degree of risk aversion over the percentage change in the variance of the cost differential, the mean being fixed, is defined as  $\varepsilon = -\partial \ln S / \partial \ln \gamma$ .

Suppose regional policy fails to achieve more regional integration, i.e. risky regional business costs are less correlated, i.e.  $\rho$  decreases. Other things being equal, this implies that the variance of the business costs differential increases, i.e. the divergence parameter  $\gamma$  increases. In our context, more regional divergence leads to a mean preserving spread of the risky regional business costs differential.

The following result illustrates the economic relationship between the optimum share of regional investment allocation, regional economic correlation and risk preferences of the firm.

**Proposition 2** (Regional divergence) *More divergence in uncertain costs of different locations does not necessarily lead to more uneven regional capital investments, unless risk aversion elasticity exceeds unity.*

**Proof** From the first-order condition with respect to investment share to

region 1, by applying the implicit function theorem we arrive at

$$\text{sign} \left( \frac{\partial x^*}{\partial \gamma} \right) = -\text{sign} \left( S^* + \gamma \frac{\partial S^*}{\partial \gamma} \right) = \text{sign}(\varepsilon^* - 1).$$

In order to satisfy the first-order condition, optimum capital share  $x^*$  invested in region 1 must be adjusted if the correlation of regional business costs changes. As a result, if the correlation happens to decrease, i.e. regional divergence increases, it depends upon risk preferences how the firm reacts. The firm will concentrate its capital allocation more to region 1, if and only if risk aversion is elastic, i.e.  $\varepsilon^* > 1$ . In this case, regional divergence works as an agglomeration force. On the other hand, regional divergence may well work as a dispersion force. This requires that risk aversion is unelastic, i.e.  $\varepsilon^* < 1$ . Hence, risk preferences determine whether or not regional divergence/convergence acts in favour of the even distribution of capital across regions.

**Corollary** *Suppose globalization or a regional policy action is aimed at reducing the risk of business costs differences across regions. The resulting regional convergence does not effect regional capital allocation if (and only if) risk preferences exhibit unit risk aversion elasticity, i.e.  $\varepsilon^* = 1$ .*

Our result reveals that firms' risk preferences play a pivot role when one evaluates the impact of globalization or the effectiveness of integration policy upon capital allocation across countries or regions. This especially is important when a currency area is to be considered with free capital mobility, for example, the Euro zone. Risk preferences of investors determine whether or not diversification of investments occurs in a free market economy.

The economic intuition is as follows: Globalization and regional policy measures affect the probability distribution of regional business costs. Therefore, globalization and regional policy actions may destroy stochastic differences and/or change incentives for regional investments. Given specific risk preferences that govern investment decisions of firms, regional policy measures in harmonize create barriers to regional diversification of investments. As a result regional agglomeration of capital will occur although the objective of regional policy is aimed at the opposite.

To sum up, suppose policy measures are concerned with the firms' income risk, that is, the correlation between regional business risks. Regional governance and strategies of higher authorities have an ambiguous practical

outcome regarding the similarity or dissimilarity of capital allocation under uncertainty across regions. The impact of global policies depends upon regional risk preferences and, therefore, is endogenous.

## 4 Empirical relevance

We know from the literature of empirical economics that the investigation of elasticities is an important task. In our modelling, suppose some regressability between regional business costs:

$$\tilde{c}_1 = \alpha + \tilde{c}_2 + z\tilde{u},$$

where  $\tilde{u}$  is an independent noise with zero mean and constant variance.  $z$  can be interpreted as divergence parameter, since an increase in  $z$  implies in increase in our regional divergence index  $\gamma$ . Hence, we get

$$\text{sign}\left(\frac{\partial x^*}{\partial z}\right) = \text{sign}(\varepsilon^* - 1).$$

Hence, the spatial impact of risk preferences with respect to regional allocation of capital is testable via an empirical study of risk aversion elasticities.

One of the goals of the EU regional policy is to strengthen the competitiveness and attractiveness of the regions, as well as regional employment. Therefore regional endowment of capital is most important. Often policy makers require the support of particular cluster initiatives.

A so-called cluster refers to the tendency of some companies to concentrate in certain locations. The explanation for the emergence and the advantage of a cluster is based on the relationship between the geographic concentration of firms, industries (multisectoral) and local knowledge production and diffusion. In general, this fact is more the result of the creation of networks between companies in an area rather than the product of cooperative decisions. These networks are established between universities, research institutes, businesses, financing services and public agencies in an environment of internal policy coordination and external competition.

In the theoretical and empirical literature there are different ways to identify a cluster. One may employ different measures: business multisectoral interdependencies, geographic industry output concentration, the existence of cluster externalities, the presence of central actors, export orientation, and finally significant differences in costs of location.

The correlation coefficient  $\rho$  denotes the random costs interaction between regions. In our model,  $\rho$  is also seen as a variable concerning adaption and innovation of the business environment across regions. Intensifying regional policy is fostering this process, which means an increase in the correlation  $\rho$  or a decrease in the divergence index  $\gamma$ .

Given the regional specific difference in expected costs of doing business due to cluster policy, concentration occurs in the region exhibiting the comparative cost advantage. This holds for example in Dresden, Germany (Broll and Roldán-Ponce 2011). Additionally, a higher degree of regional correlation reduces the relevance of diversification and, therefore, gives the regional expected cost advantage a greater weight. This is in contrast to the traditional view of EU regional policy, which promotes the narrowing of income equality across regions, and may be due to an unelastic risk aversion presumption.

## 5 Conclusion

Regional economics and economic geography have become a highly diverse and interesting field of research, incorporating different theoretical and empirical approaches (see, e.g., Mackinnon and Cumbers 2007; Kosfeld, Eckey and Lauridsen 2010). In our study it has been shown that risk preferences of firms or investors play a pivotal role in the allocation of regional capital investments. Many open economies have spatial differences in production and productivity, mostly because of economic distance between lagging and leading areas (Baldwin and Wyplosz 2009).

It is reasonable to argue that given historical political and economic conditions certain regions may have natural advantages in attracting capital investments. Lower expected transaction costs in doing business in one region can be interpreted as an intrinsic regional advantage to attract capital, for instance. Our modelling starts with an economic setting in which there exists an initial attractiveness for capital investments to a specific region. Whether or not economic integration is magnified by globalization or regional policy approaches depends primarily upon the firms' risk preferences. The intended symmetry of regional investments may not be achieved by regional policy because firms have an incentive to concentrate investments in one region as a reaction to globalization or policy harmonization measures. Therefore, the agglomeration/dispersion of capital is endogenous. We argue that regional divergence/convergence may hinder the equal spatial allocation of capital.

The elasticity of risk aversion, which comes from risk preferences, determines the final practical outcome of regional policy. Even a neutral outcome is possible: With unit elasticity of risk aversion capital allocation is unaffected by regional policy.

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