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Dynamics of Regional Development in Regional and Municipal Economy

Vaclav Beran [1], Marek Teichmann [2,*], Frantisek Kuda [2] and Renata Zdarilova [2]

[1] Department of Economics, Faculty of Economics, University of South Bohemia in Ceske Budejovice, Studentska 13, 370 05 Ceske Budejovice, Czech Republic; beran@ef.jcu.cz

[2] Department of Urban Engineering, Faculty of Civil Engineering, VSB–Technical University of Ostrava, Ludvika Podeste 1875/17, 708 00 Ostrava-Poruba, Czech Republic; frantisek.kuda@vsb.cz (F.K.); renata.zdarilova@vsb.cz (R.Z.)

* Correspondence: marek.teichmann@vsb.cz; Tel.: +420-597-321-963

Received: 28 September 2020; Accepted: 26 October 2020; Published: 6 November 2020

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Abstract: This article deals with the dynamics of territory development in the regional and municipal economy. The development of the territory is and has always been limited or restricted by the available sources of capital, the dynamics of its use, and the localization of its distribution in the chosen territory. Today's limits are, under Czech conditions, laid down by the Building Act; namely, the land-use plan, the strategic plans for development, and the political mechanisms of the elected leaders. The verbalization of the democratization of the economy is swayed by the concepts of meritocratic holding and the attempts to create values, but also by already existing values. We interpret the term values as infrastructure developed in the past, but also as resources given by the natural, geographic, and other environments.

Keywords: regional development; optimization; investment budget; time limits; utility

1. Introduction

Regional development is an important topic of many professional groups, as is mentioned in [1,2]. It is the subject of a whole range of ideas, publications, and verbalizations, as well as of many faults and mistakes. According to [3–7], changes are needed in thinking, approaches, and strategies for the purpose of strengthening the path leading to the rational use of resources. However, the updated diction is not misleading even in the present.

The problems of decision-makers escalate under imbalances, turbulent developments, risks, uncertainties, disasters, etc. These rules determine the time and space. Can the right time and location of the activities be selected and recommended? Activities developed (investment, production, etc.) take place in a defined time and space and create new time–series states over time.

In general, the terminology of the urbanization of regions [8–10] should imply the protection of cultural and other values that have a considerate and respectful stance toward nature, fauna and flora, and data of quantification [2]. However, we do not know what limits are defined by optimal solutions. Limits are needed on extracted resources, exhalations, and pollution by a variety of characters in favor of financial income, visions of higher gross domestic product, and many other artificial or crafty concepts of development indicators [11–14]. Defining an optimal solution is also only an intention, as the authors' beliefs are placed on the right path that characterizes possible actions, but it is a long-term and unsure procedure. It is the intellectual design that marks boundaries of the possible with the constraints and sets the price for its achievement [6,15,16]. Optimization tools have been evolving since the middle of the last century. They are reachable from the viewpoint of the computing capacity of modern software. For practicing and optimizing the urbanization of regions, there are fewer divisions than it would seem at first glance. The parting line is the data available, evidence of existing data in the territory, transparency rights release to use land as a non-renewable resource, and transparency of investment sources drawing.

It cannot be argued that the idea of using capital, assessing and distributing benefits arising from an investment is thought to be new. Its solution has been part of the economy for a very long time.

On the one hand, it is true that regions contribute to the development of a large variety of means, and they believe that the effect of each investment is measurable. The fact, however, is that the measurement of real values, benefits, functionality, rational benefits is difficult [4,17,18].

If we favor quantization and the dynamics of quantification, the creation of values and benefits flowing from the implemented capital is basic. A new perspective on capital can be found in a number of papers and analyses. The robust work mentioned in [1] deals with the topic and has achieved extraordinary success. It aspires, inter alia, to deal with the temporal dynamic aspect of the phenomenon of capital and its metamorphoses in the 21st century.

The article deals with the dynamics of territory development in the context of affordable economies in regional and municipal budgeting. Financial limits are tied to utility priorities. Balancing them, and finding maximum benefits and minimum resource consumption is a long-term goal of sustainability and ecology. Formal mathematical tool optimization enables us to know this limit/optimal solution. The practical value of this limit is in the acceptance of past priorities. The terms' values are in regional and municipal life, for example, infrastructure developed in the past, but also as resources given by natural, geographic, and environmental trends.

2. Materials and Methods

2.1. Optimization Prerequisites/Investments and Budgets

Return-oriented capital is indisputably tied up, as a tool, with benefits to the capital-holders. The publication [19], focused on numerous arguments about the accelerating growth of inequality in the distribution of capital returns. The authors introduced a label for growth as the g rate. Beneficiaries of economic growth are regions, citizens, urban areas, etc. However, the extent and method of distribution are separate issues. Undoubtedly, for the creation of capital, the resources used derive from the breakdown of net outputs of the macroeconomic unit. They are referred to as savings and marked as s.

A monograph author [19] emphasized the history of existing inequalities $s > g$ as critical, which has created, over the long term, unsustainable disparity. The situation where inequalities growth $s >> g$ significantly dominates the economy leads to a degradation of ability of the economical unit to create outputs; let us denote them Y. The disparity of inequalities of benefits from outputs Y and production of the capital K disrupts relations in the social sphere, followed by degradation of efficacy factors such as performance, productivity, and efficiency of resources used. Internal relations, generally represented as democratic, contain meritocratic features. They mainly affect the area of benefits distribution and, consequently, the damaged social development [20,21]. The concept presented in [19] represents an increasing disproportion in relation to $s >> g$. The disparity is illustrated by a large set of statistical data of the last centuries, and the persuasiveness of the arguments is based on a long-term time series. The argument of the long-term growth in imbalances results in finding that the relation between the growing revenues in capital employed in times series K_t and output performances of the economic unit Y_t should be better balanced. Let us denote the factor that counterbalances them as the saving rate s from outputs Y_t against the rate of share g of the capital.

For a balanced growth process there has to be relational equality, when earmarked savings of the created source in period t are equal to a individual share of the capital in period t:

$$sY_t = gK_t. \tag{1}$$

In equation to (1) the savings are sY_t over long-term (historically) stable. Loosely completed in the sense [17,22]: "we give up the created outputs (available benefits and perquisites) of the size sY_t today so that we can enjoy more of the same in the future, at least to the extent as expressed by $(Y_t + sY_t)$."

The idea incorporated into the Equation (1), which is introduced by [19], as a long-time series (1870–2010) substantiates the amount of separated savings s. Is burdened by insignificant volatility over time and s, therefore, can be considered as constant [20]. A time series of disposable savings is created S_t predisposed to accelerate future development. With the indicated factual determination-deferred consumption in the current time period t for a more efficient increase in the outputs Y in $t + 1$, the economy works with the concept of investment. The idea can be put into an explicit statement: current savings are meant for investments in the future.

$$sY_t = S_t = I_{t+x} \tag{2}$$

However, we operate in a macroeconomic notion, and with its assumptions affected by volatility in the microeconomic implementation, the differences in a range (±) are the result of disparities in the adherence to the basic rules of an economic unit growth: resources (investments) can be made only where they will generate gain (establish the ability to realize deferred consumption, i.e., additional new savings) [23].

This creates a growth spiral cycle of using savings for future investment purposes. A prerequisite for the notional growth spiral is that the new I_{t+x} will generate revenues $\tilde{v}$ higher than those of existing investments. In the opposite case, the new investment would be a simple renewal, and would establish the cycle of a degradation process.

Interpretation of the stated claims requires their projection into microeconomics, or to formulate rigorous answers to two microeconomic questions: to what extent is it obligatory to adhere to:

1. Investment limit;
2. Limit period for return on invested capital.

2.1.1. Maximal Limit Range of Investment in Design and Implementation

Investment costs and returns are bound by the requirement to maintain overall expected returns for the period of return on investment t_{eco}, over the limit of invested resources; for more details see Solow, M. R. p.49 (investment limit, and to what extent it is binding to require adherence) in [20]. For particular specification, limits are shaped by:

- Market conditions, from which it follows a maximum allowable scope of the investment as I_{max}, see Figure 1;
- Practices of the capital providers I_{eko}, (weighing market conditions and their risks);
- The standard of economical-technical solution of the project I_{pro}, that is, the ability to project the capital provider's requirements into the project design;
- The ability to reflect the project briefly into the functional unit, limit I_{real} during its implementation.

The visualization is shown in Figure 1. Let us suppose that this is a hypothetical project, which is provided with a commercial loan with interest of i = 5% per annum and the risk of an investment project r = 10% (illustrative example of investment return period t_{eko} =10 years). The hierarchy of individual limits is further elaborated, for example, in the Equation (10).

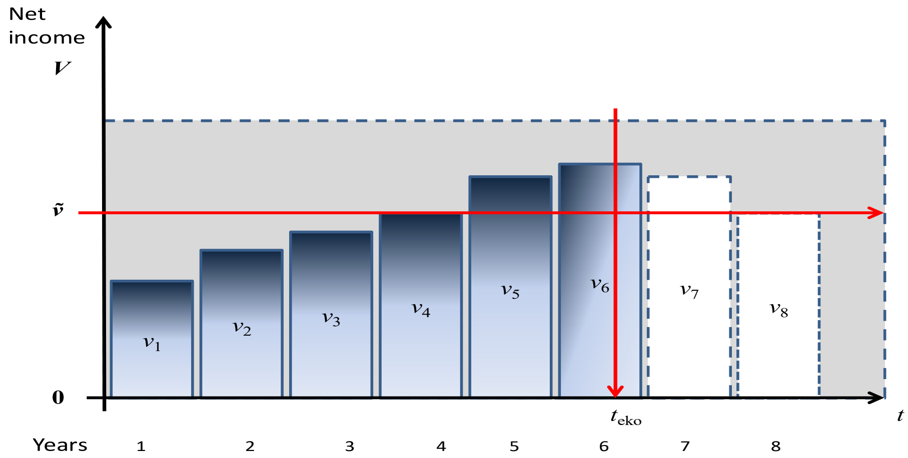

Figure 1. Maximum economic investment scope, $I_{max} = \sum_{1}^{teco} v_i$.

2.1.2. Maximal Limit Payback Time of Invested Resources

The invested resource on the one side is directly invested capital. At the same time, assets are pledged to cover risks, reserves, financial guarantees, and liabilities arising from unexpected situations. Generally, capital and other resources are bound for the duration of the settlement of the obligations from the realization of an unfinished investment unit.

The maximum allowable period for return of capital t_{max} is defined by the expected (or required by the cooperating partners) commercial level of annual returns i. The fact is that the expected returns from the investment project cannot be purposefully changed during its processing. The interpretation works with the assumption of constant yields set in the project assignment as $\tilde{v}$.

In general, the answers to the two preceding questions of (1) investment limit, and (2) limit period for return on invested capital, can be projected into Equations (3) and (4). We record the limit economic return as:

$$t_{max} = 1/i \quad (3)$$

where i is the commercial level of earnings from investment banking loans for the period of resources return from the project. The construction i reflects the expected value of:

- placement of investments in the location;
- interaction with the region;
- nature of commercial activity;
- chosen technical execution of plan.

If investment projects create a prospective excess of t_{max}, they lose rational economic justification; they overlook the existence of risks throughout the project lifecycle. For an acceptable t_{max}, the acceptable range of investment is defined by the relationship:

$$I_{\max} = t_{\max}\,\tilde{v} = \sum\nolimits_{1}^{teco} v_i \quad (4)$$

where I_{max} represents the maximum allowable total investment cost with the assumed economic return and normal commercial risk rate included in i. The expected annual net income $\tilde{v}$ is given by the calculation for the return period $\langle t_0, t_{eco}\rangle$, or based on the technical conditions of the expert-determined lifetime of the life cycle $\langle t_0, t_x\rangle$.

The commercial return limit is considered to be a relationship based on the commercial rate of required annual returns i (interest on bank loans) and the valuation of the commercial risks of the project r, it applies that:

$$t_{eko} = 1/(i + r) \quad (5)$$

We calculate the investment capital required as:

$$I_{eko} = t_{eko}\,\tilde{v} \quad (6)$$

By analogy, it is possible to quantify partial limits of project and implementation:

$$t_{pro} = 1/(i + r + r_{pro}) \quad (7)$$

$$t_{real} = 1/(i + r + r_{pro} + r_{real}) \text{ (Example: } t_{real} = 1/(0.05 + 0.06 + 0.05 + 0.05) = 5 \text{ years)} \quad (8)$$

Consequently, the investment limits in terms of the Equations (3), (4) and (6) correspond to the acceptability of the investment cost range. To enter a new investment, upgrade, or renewal it applies that:

$$t_{real} \leq t_{pro} \leq t_{eko} \leq t_{max} \quad (9)$$

and subsequently:

$$I_{real} \leq I_{pro} \leq I_{eko} \leq I_{max} \quad (10)$$

The ranges of the gains–benefits are calculated as three specific components of industry effects of research and development (R and D), proposal (proposal–pro), and implementation (real):

$$\Delta_{R\&D} = I_{max} - I_{eko} \quad (11)$$

$$\Delta_{pro} = I_{eko} - I_{pro} \quad (12)$$

$$\Delta_{real} = I_{pro} - I_{real} \quad (13)$$

The benefit here is the benefit of the investment proposal in terms of its new, rational, modernizing, or breakthrough solution. This is not the creation of an implementation reserve to cover risks of exceeding costs. It is necessary to propose shorter deadlines for implementation than t_{pro}. The permissible term of implementation of the investment unit is a separate sub-task of the time and cost schedule of the preparation of the investment project implementation. The causes of overall costs in the course of the investment economic cycle are shown schematically in Figure 2 as

$$I_{max} = I_{real} + \Delta_{real} + \Delta_{pro} + \Delta_{R\&D} \quad (14)$$

If one of the causes in Equation (14) approaches zero, it is a situation of failed application of higher standards (benefits, utilities, etc.) in the development of the project (a constant yield comparison is a prerequisite).

The markings used in the text and Figure 2:

- t_{eko} is the proposed economic return time for the project;
- t_{pro} is the payback time of the project is reduced by the limits created by the project solution;
- t_{real} is the payback time of the project is reduced by the limits created by the realization requirements;
- I_{eko} is the investment cost at the assumed economic return and the risk weight of the investment project;
- I_{prop} is the maximum investment cost created by the project solution;
- I_{real} is the maximum investment cost in the course of implementing the project solution;
- r is the level of costs and risks of accepted commercial commitments;
- r_{pro} is the level of costs and risks created in the technical design of the method of realization of the investment unit;
- r_{real} is the extent of costs and risks incurred in the execution of the investment scheme.

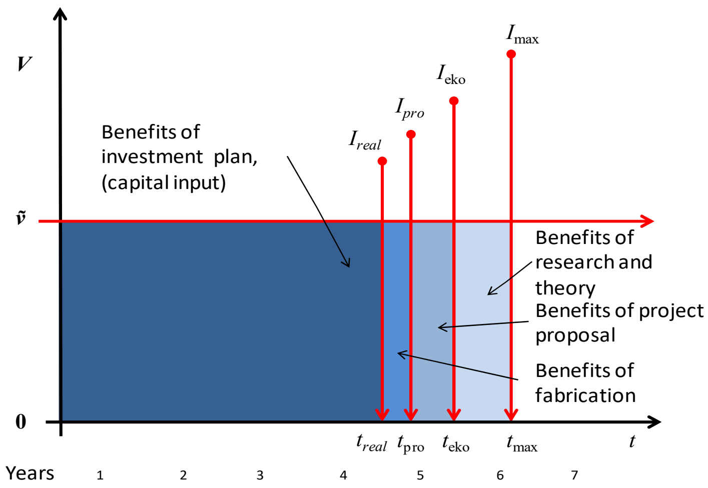

Figure 2. The causal quantum of benefits, a solo project.

2.2. Methods of Economic-Technical Breakdown of Investment Development Projects of the Region

Projects that require corrective adjustments or rejection become investment projects that do not generate benefits (11–13) for a regional entity. If the rules are not respected, this is a failed, emergency situation project. It establishes a space for non-compliance with production, construction, economic parameters, and legal and environmental standards. States of emergency arise with delays at various stages of the investment life cycle. These include life cycle reduction, failure to deploy anticipated capacities, malfunctions, excessive maintenance, downtime, premature renewal cycles, and more.

Investment projects as development tools are intended to operate in the long term. They require a functioning infrastructure and a rational choice of possible solutions. This is the domain of decision-making methods. It also undeniably includes the selection of investment plans, proposals, and their method of implementation. The decision-making methods are composed of qualification and choice of variable and alternative solutions. Decision-making methods undeniably have their use hierarchy (from defining the basic economic framework of the project to handing over the investment unit for use). Violation of basic rules tied to Figure 1 is an intervention in the economics of the investment project and creates the prerequisites for an economic emergency of the project, the need for modifications, restrictions in the course of use of the investment, and the need for new redevelopment costs. Examples of this can be investments that were not completed on time, or exceeded costs based on future revenues.

An elementary prerequisite is that the calculation of the economic framework of investment is based on expected returns, that is, on the time series elements $\{V_t\}$, respectively $\{v_1, v_2, v_3, \ldots, v_{tmax}\}$, for which the Equations (4) and (6) apply in particular.

Decisive methods within the economic framework are, from the perspective of methods, multifaceted, and further, also should govern the process procedures of investors.

3. Results and Discussion

3.1. Illustrative Data–Examples

Every project that exceeds the implementation deadline of t_{real}, or shows non-compliance with the investment scope I_{real} becomes an economically damaged project. Cause tracing generally leads to unresolved risks in technical design. These are usually applications of technologies, unmanaged organization and implementation, legal disparities and other clashes. The consequence is the drawing of benefits from the created causes—schematically shown in Figure 2.

The specific nature of individual cases requires crisis management. Its purpose is to reassess project design, initiate changes in project solutions, implements changes in financing and liquidity. Damaged projects are not exceptional in common practice.

For a current illustration, according to Section 2.2, we can present the Flughafen Berlin Brandenburg (BBA) project, shown in Table 1. The initial investment range according to [24] was about EUR 2.2 billion. Derivation of t_{eko} at the level of common commercial practice according to Equation (5) would be in the range of 5 years, the required annual yield could be around EUR 1.1 billion. Losses due to a crisis situation (currently the projected delivery for use is in 2020) represent a loss of opportunity over 10 years at around EUR 10–11 billion. In addition, the cost of eliminating defects and faults must be accepted, including new construction and technological changes totaling about EUR 4.6 billion [24]. The loss of opportunity costs for the BBA are thus increasing, at a very rough estimate, from EUR 14.5 billion to EUR 15.6 billion. Benefits include expansion of capacity, modernization of operating technologies, safety, and more. The project will undoubtedly be completed in high quality, but fulfilling its economic recuperation will be challenging and long-term [24–27].

Table 1. Milestones of selected projects–illustration t_{max}, I_{max} (Source: [20] and extensions).

Project	Start (Year)	Duration (Years)	Delay (Years)	Comments
Sydney Opera House	1958	15	10	
Elbe Philharmonic Hall, Hamburg	2007	3	16	3.26 × cost increase
Berlin Brandenburg Airport (BBA)	2006	5	9	6.00 × cost increase
Leaning Tower of Pisa	1173	177	94 + 35	
Suez Canal	1859	10	2	
Panama Canal	1880	13 + 4	34	
Temelin Nuclear Power Station	1979	24		

3.2. Investment and Optimalization of Land-Use Plan Infrastructure

The idea of the liberalized model of public investment assessment development is applied mainly on the expenditure side of public budgets. If we consider the revenue side of public budgets and decide to obtain their valuation, we will need a balanced optimization calculation. Here, we will appreciate the informative power and application of the previously mentioned Equations (3), (5), (7) and (8). The consequences are reflected in the limits of capital expenditures range; see (10) and (14). The limits are schematically transferred to the representation on Figure 2. Designing projects that do not generate positive revenue streams leads to project degradation and questioning of a project's economic or material justification [21].

Causes of emergency situations for random selected projects from Table 1, arose when creating the benefits (project concept). They were projected according to Equations (11)–(13). The application of relations to the Berlin Brandenburg Airport (BBA) project will necessarily draw attention to disparities in its early stages [23]. Overall, the increase in the cost of implementing BBA shows a high imbalance of $I_{real} \geq I_{pro}$. The benefit (rational) of the implementation of Δ_{real} took on unbearable values. The project proposal did not achieve the expected positive Δ_{pro} and became an encumbrance on the creation of an economic return on investment (12).

The development of territorial units is undoubtedly composed of successful localization of effective component investment solutions. They should create benefits in the area (see Figure 2). Localization in an area with unacceptable $\Delta_{(\cdot)}$ generates an increase in costs, almost all in parallel with the extension of execution time. The development of regions is linked to a number of diverse and parallel projects in the financial year. Their arrangement is professionally addressed by urban planning [28,29].

Land-use planning activities include: the acquisition of land-use planning documents, master plan, delimitation of the built-up area, planning permission, and issuance of territorial measures. In the Czech Republic, the requirements are defined under Act No. 183/2006 Coll. If the public administration act is in the public interest, it works to appreciate the territory (state, region, municipality). The internal aspects are then the management of things with which obligations of good administration, rights, and serving are associated: the public, public finances, the use of public buildings and equipment.

Nevertheless, in many cases in practice, it is possible to find regrettable violations of fundamental rules. Decrease in yields and extension of commissioning dates are almost a general problem in the implementation of projects to support regional development. Examples are provided in Table 1. The existing practice in the EU is looking for a way to implement more effective mechanisms for compliance with project award conditions—which is overwhelmingly quite difficult.

A possible way of financing similar projects is the PPP (Public–Private Partnership) approach according to [30,31]. However, this issue is not incorporated into this study.

3.2.1. Optimizing Procedures and Their Limits

Territorial units (this also applies to linear structures, industrial complexes, apartment complexes and other investment projects) and their budgets can be segmented into individual localized parts. Thus, the first prerequisite for using optimization is met. The individual investments invested receive their time specification according to the availability (release) of investment funds. Implementation mechanisms are annual budgets, territorial implementation priorities, and technical conditions.

Land-use planning works with land-use planning documentation makes available areas for individual activities to avoid collisions in their operation and use.

An illustrative example of segmentation into individual component parts is shown schematically in Figure 3. An Illustrative example of layout of functional areas inserted into a grid (i, j) for optimization solution. Individual sub-segments (i, j) determine the location and allow assignment of expected returns (benefits) u when deploying x resources. The resource distribution area is hereinafter referred to as matrix A.

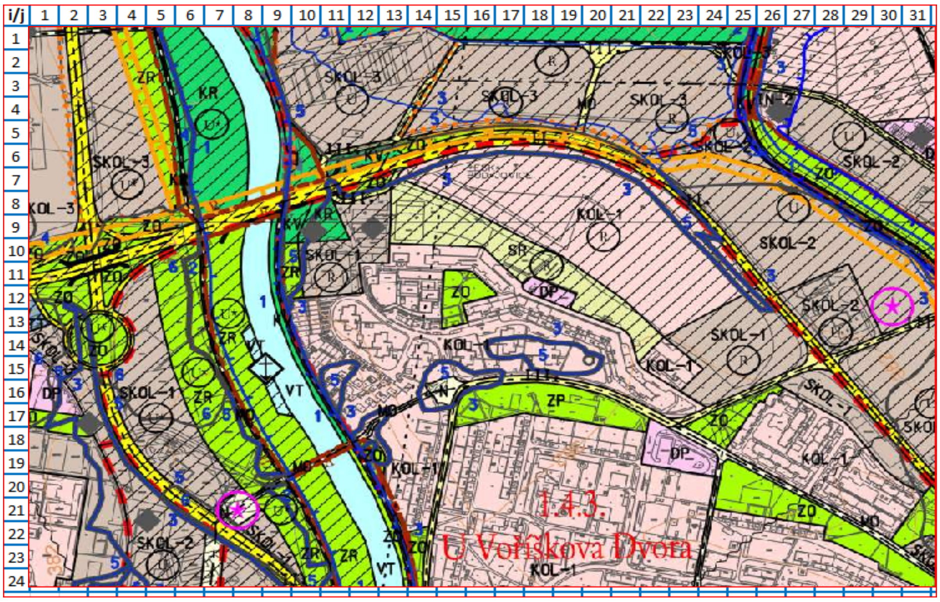

Figure 3. An Illustrative example of layout of functional areas inserted into a grid (i, j) for optimization solution (Source: prepared by the authors on the substrate from Spatial Plan of the city Ceske Budejovice, Czech Republic).

The lack of information on the functional areas of land-use plans is the determination of expected land-use benefits, commonly formulated as a requirement to evaluate the third axis (i, j, k) for the representation in Figure 3. It is referred to as a map of attractiveness, according to various interpretations. It includes composition of building height limits, maps of noise or emission pollution and more. How valuable the territory, area, or region is in terms of its contribution to the overall benefit, revenue, or other returns from the perspective of territorial management remains an open question. In other words, we ask about the achievable benefit in terms of the territory under investigation and in relation to the budget limit.

3.2.2. Analysis–Calculation of Achievable Limits

The answer to the question of what benefit thresholds can be achieved in a given territory can be found using optimization calculations in Figure 4. It is possible to follow the interpretation from the optimization application. The valuation of the benefits of an optimized (limit) solution is shown on the vertical axis. This is an illustrative example of a district city segment. The area of benefits is fragmented and shows differences in potential benefits with small changes in investment locations.

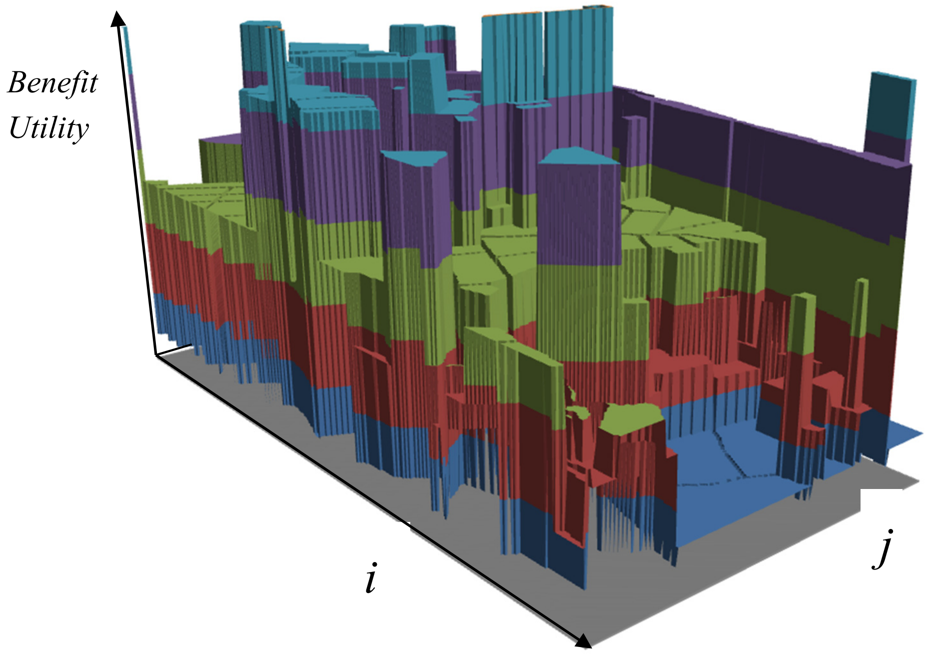

Figure 4. Optimization of land-use functions, utility valuation: fragment of the city center, vertical axis hypothetical benefit (Source: prepared by the authors according to [4]).

Generally, the optimization of benefits, in the area of the territory defined as matrix A, such as proposal occupancy of the individual available areas of the territory (I, j) is sought, which maximizes the total return (benefit). At the same time, the applicable land-use restrictions are respected. These include, for example, the extent of public investment, their structure, the volume of investment capital invested, and its ownership structure. The formulation of the optimization task is mainly based on respect for material continuities. These can be referred to as follow-up processes N to which a specific function of maximization (benefits, revenues, profits, etc.) is linked. Formal enrolment of the optimization task [32,33] is introduced as a further explanation:

$$\min/\max F(x) = (u^T x),\ x \in M,\ \mathrm{N} = \{x \in R^m \mid Ax \leq b\} \quad (15)$$

where:

- $u^{\mathrm{T}}x$ is a linear relation, the product of the utility matrix $\boldsymbol{u}$ and the range proposal vector (volume) x; interpretation for determining the sought optimal range of functional activities x^o in the area is based on yields, benefits (maximizing u^{T}), alternatively minimizing (resources, capital, etc.);
- M set of managerial solutions, optimal for proposals A, B, C . . . ($x^o|proposal$), optimal for critical(é) resources (e) b_x, b_y . . . ($x^o|resources$), or optimal for use standards u_x, u_y, . . . , ($x^o|benefit$);
- N set of proposals (downstream processes) of the land-use concept;

- N_p examined downstream process p;
- A matrix characterizes structure of use (territory, areas, legislation, requests, etc.) is of the order of $m \times n$;
- b vector of available resources, order of m;
- u vector of valuation of returns, an order of m;
- x vector of proposed solution, *an* order of n.

The product Ax defines the drawdown in the area of the resources used b, for calculation, it is necessary to define their limits. For matrix A, its elements reflect the degree of demand for resources. For example, in technical consumption or internal standardized form of usability, such as $0 \leq a_{ij} \leq 1$.

The output of the optimization calculation is the limit of the potential target solution. The choice between proposals allows for a prediction of the degree of efficiency interpreted as capital, efficiency, value of the goal (effectiveness = solution/solution goal; the relationship is a measure of effectiveness given by the relationship between the achieved goal and the stated goal, the Numerator/Denominator—expressed predominantly in the same units (standard, utility, cost, budget, functionality, efficiency, goal achievement, etc.). The goal of efficiency is to indicate the right *proposal* for implementation. The evaluation of options, within the design of the chosen solution, enables indicators of effectiveness. Comparing proposals and their variant solutions serves to trace and eliminate weaknesses, quantify the benefits achieved, and make changes more effective. It is an independent technical and economic issue of the use of optimization calculations.

The Equation (15) forms both a benefit of one of the proposals A, B, C ... as $N^{(\bullet)}$ for $x = 1$ that is full-hypothetical use of all areas, without regard to limitation of resource $(u^T x)$, as well as the optimum solution $(u^T x^o)$ while respecting limitation of the resource b. We read the relationship $(u^T x)$ as the limit of growth (capacity) of the material proposal of the land-use arrangement, the relationship $(u^T x^o)$ as the limit of rational urban planning economical arrangement while respecting the limitation of the resource.

Evaluation of individual proposals A, B, C ... and their variants of using resources b^A, b^B ... assessing the utility standards u^A, u^B ... using concepts of efficiency and effectiveness (efficiency = solution/effort; is an expression of economical–business extent).

For the purposes of interpretation, let us consider as an indicator of the effectiveness of the available budgetary mean (schematically for example: annual investment budget EUR 100 t./available investment potential goal EUR 1000 t = effectiveness 0.1. Efficiency indicates the correct method of proposal implementation):

$$\text{Budget}/(u^T x) \Rightarrow \text{Effectivity} \tag{16}$$

Indicates the effectiveness of the invested funds for the proposed use of the territory over time (e.g., the efficiency of the municipal budget).

To evaluate the partial indicators of the functionality of individual proposals (solution), the efficacy indicator is used:

$$\text{Budget}/\text{b}^{(\bullet)} \Rightarrow \text{Efficiency} \tag{17}$$

Design-based land use is carried out in stages. Additionally, each of these can be implemented in phase variants.

Decision-making in the time-limited phases with variant designs is a challenging decision-making task. In real tasks, its sophistication increases by assessing the practically achievable maximum and mathematically formally determined optimal solutions. Indicators of effectiveness and efficiency of invested resources can ensure orientation in the strengths and weaknesses of individual variant proposals. This deepens the understanding of the rationality of management interventions for monitoring development.

3.2.3. Illustrative Example–Investment in the Territory

The maximum benefit for land-use design is the solution of the criterion of finding x in (15) as the optimum x^o. Restrictions are the drawdown of limited resources—the product of A x^o. The resource requirements are created from the territorial background as parameters a_{ij} in A. In the example of the area Figures 5 and 6. Delimit the achievable upper limit of use of the assessed proposal while adhering to the drawing of limited resources, in the sense of optimization according to the Equation (15).

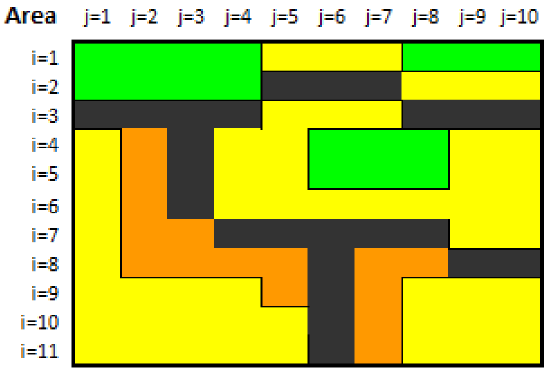

Figure 5. The initial available functional areas for optimization–the basis for the assembling of matrix A.

Area	j=1	j=2	j=3	j=4	j=5	j=6	j=7	j=8	j=9	j=10
i=1	1	1	1	0	1	1	1	0	0	0
i=2	0	0	0	0	1	1	1	1	1	1
i=3	1	1	1	1	1	1	1	0	0	0
i=4	1	1	0	1	1	0	0	0	1	1
i=5	1	1	0	1	1	0	0	0	1	1
i=6	1	1	0	1	1	1	1	1	1	1
i=7	1	1	1	0	0	0	0	0	1	1
i=8	1	1	1	1	1	0	1	1	0	0
i=9	1	1	1	1	1	0	1	1	1	1
i=10	1	1	1	1	1	0	1	1	1	1
i=11	1	1	1	1	1	0	1	1	1	1

(**a**)

Cost	j = 1	j = 2	j = 3	j = 4	j = 5	j = 6	j = 7	j = 8	j = 9	j = 10
i = 1	15.0	15.0	15.0	0.0	11.0	11.0	11.0	0.0	0.0	0.0
i = 2	0.0	0.0	0.0	0.0	30.0	30.0	30.0	11.0	11.0	11.0
i = 3	30.0	3.0	30.0	30.0	11.0	11.0	11.0	0.0	0.0	0.0
i = 4	11.0	6.0	0.0	11.0	11.0	0.0	0.0	0.0	11.0	11.0
i = 5	11.0	6.0	0.0	11.0	11.0	0.0	0.0	0.0	11.0	11.0
i = 6	11.0	6.0	0.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
i = 7	11.0	6.0	6.0	0.0	0.0	0.0	0.0	0.0	11.0	11.0
i = 8	11.0	1.0	6.0	6.0	6.0	0.0	6.0	6.0	0.0	0.0
i = 9	11.0	11.0	11.0	11.0	6.0	0.0	6.0	11.0	11.0	11.0
i = 10	11.0	11.0	11.0	11.0	11.0	0.0	6.0	11.0	11.0	11.0
i = 11	11.0	11.0	11.0	11.0	11.0	0.0	6.0	11.0	11.0	11.0

(**b**)

Benefit	j = 1	j = 2	j = 3	j = 4	j = 5	j = 6	j = 7	j = 8	j = 9	j = 10
i = 1	10.0	10.0	10.0	0.0	50.0	50.0	50.0	0.0	0.0	0.0
i = 2	0.0	0.0	0.0	0.0	20.0	20.0	20.0	50.0	50.0	50.0
i = 3	20.0	20.0	20.0	20.0	50.0	50.0	50.0	0.0	0.0	0.0
i = 4	50.0	30.0	0.0	50.0	50.0	0.0	0.0	0.0	50.0	50.0
i = 5	50.0	30.0	0.0	50.0	50.0	0.0	0.0	0.0	50.0	50.0
i = 6	50.0	30.0	0.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
i = 7	50.0	30.0	30.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0
i = 8	50.0	30.0	30.0	30.0	30.0	0.0	30.0	30.0	0.0	0.0
i = 9	50.0	50.0	50.0	50.0	30.0	0.0	30.0	50.0	50.0	50.0
i = 10	50.0	50.0	50.0	50.0	50.0	0.0	30.0	50.0	50.0	50.0
i = 11	50.0	50.0	50.0	50.0	50.0	0.0	30.0	50.0	50.0	50.0

(**c**)

Figure 6. Optimal solution: (**a**) area, (**b**) investment costs and (**c**) benefits (utility), budget structure 50, 220, 700, 190, coincide with Table 3, benefit/utility 3320 units.

3.2.4. Usability–Design Solution Limits

Urban planning defines the space of the proposal from the perspective of its functionality, as schematically shown in Figure 5, does not contain more detailed guidance on how to implement individual investments. For the given example, we will take as guides the budget of the municipality, links to the time sequence of implementation, and possibly other material limitations [29].

The use of all available design areas is shown in Table 2, requires a cost subsidy of EUR 3800 t. and can provide a benefit of 1659.0 units. For the stated budget subsidy of EUR 1160, the full benefit of the areas in Figure 5 is not reachable. The budget allocation for full land use is 30.5% of the total need (1160/3800). The question of whether by changing the initial budgeting of Table 2 it would be possible to achieve better results remains open. The answer can be provided by optimization.

Table 2. Proposal limits—budget, costs, utility.

Symbol	Function in Region	Limits of Space Units *	Resource Cost t.€	Utility	Budget/B. Structure t.€
	Green, park	17.0	EUR 10	15.0	EUR 50
	Communication, transport	24.0	EUR 20	30.0	EUR 220
	Housing construction	54.0	EUR 50	11.0	EUR 700
	Civil construction	15.0	EUR 30	6.0	EUR 190
	Total	110.0	EUR 110	1659.0	EUR 1160

Comments: * Limit of resources-available proposal space.

3.2.5. Optimization–Effectiveness and Efficiency of the Proposal

The budget for the implementation of the proposal is an important regulatory element for achieving the objectives (urban planning, architectural, investment, and others). From a material point of view, the important aspects are (a) the volume of the budget, and (b) the structure of the budget defining the individual (urbanization) activities. Table 2 shows a budget of EUR 1160 t. for the material structure of use of EUR 50, 220, 700, 190 t.

The optimization calculation will verify both the accuracy of the budget structure and the expected functionality after investing. The data from the performed optimization calculation performed is concentrated in Table 3.

The areas of optimal solution used are shown in the upper part of Figure 6 and are assigned the designation of 1, whereas the unused areas have a designation of 0. Localization of investment costs and benefits achieved (utilities) are shown in the lower part of the same figure.

Table 3 has been assembled from the data of the optimal solution in Figure 6. It is evident that next to the fully usable areas for housing and civil constructions (100%) transport infrastructure (17.6%) and greenery (29.2%) remain unprovided for. The budget (EUR 1160 t.) is only drawn up to the amount of EUR 939 t. It is limited by the proposed structure of factual determination of budgetary activities. The housing budget has been overestimated by 9.6 of area units (9) with a budget demand per area unit of EUR 11.0 t., for housing there is an unused amount of EUR 106.0 t. (700.0 − (54 * 11.0) = EUR 106.000). A similar situation arises in the case of civil construction, where the number of designated areas in the territory is 15 units, and the budget could allow use of 31.7 units. The result is an under-drawn budget in the amount of EUR 100 t, and under-use of investments in greenery, parks, roads, and transport of EUR 5.0 and EUR 10.0 t. The area utilization structure can be seen from the data in the upper part of Figure 6. Housing and civil construction do not have a primarily provided-for transport infrastructure. Incomplete drawing of the available budget in the amount of EUR 221.0 t (1160 − 939 = EUR 221.000 according to the territorial functional compilation 5.0 + 10.0 + 106.0 + 100.0 = EUR 221.000 is furthermore considered as an inconvenience for the user and functionality.

Table 3. Inputs data and optimal solution for Budget 1160 t.€, structure 50, 220, 700, 190.

Symbol	Function in Region	Applied Space Units *	Limits of Space Units **	Budget Limit of Units ***	Resource Cost t.€	Utility	Budget t.€ (EUR)	Budget Spending
	Green, park	3.0	17.0	3.3	15.0	10.0	50	17.60%
	Communication, transport	7.0	24.0	7.3	30.0	20.0	220	29.20%
	Housing construction	54.0	54.0	63.6	11.0	50.0	700	100.00%
	Civil construction	15.0	15.0	31.7	6.0	30.0	190	100.00%
Units: Applied/Proposal limit/Budget limit		79.0	110.0	106.0			1160	
Cost optimal/Proposal limit/Budget limit (EUR)		939	1659	1160				56.60%
Benefit Applied/Proposal limit/Budget limit		3320	3800	4312				87.40%

Comment: * Spent resources *b* in Equation (14), optimal the proposal, ** Limit of resource space available in the proposal, *** Structure of cells; limits set by the budget.

Modification of the budget structure, which is supposed to improve the situation, is indicated by the arrows in Table 3. Restructuring of the budget of EUR 1160 t.€ is the starting point for optimizing the composition of 150/470/500/40. The data provided by the optimizing is shown in Figure 7 and concentrated into relationships in Table 4.

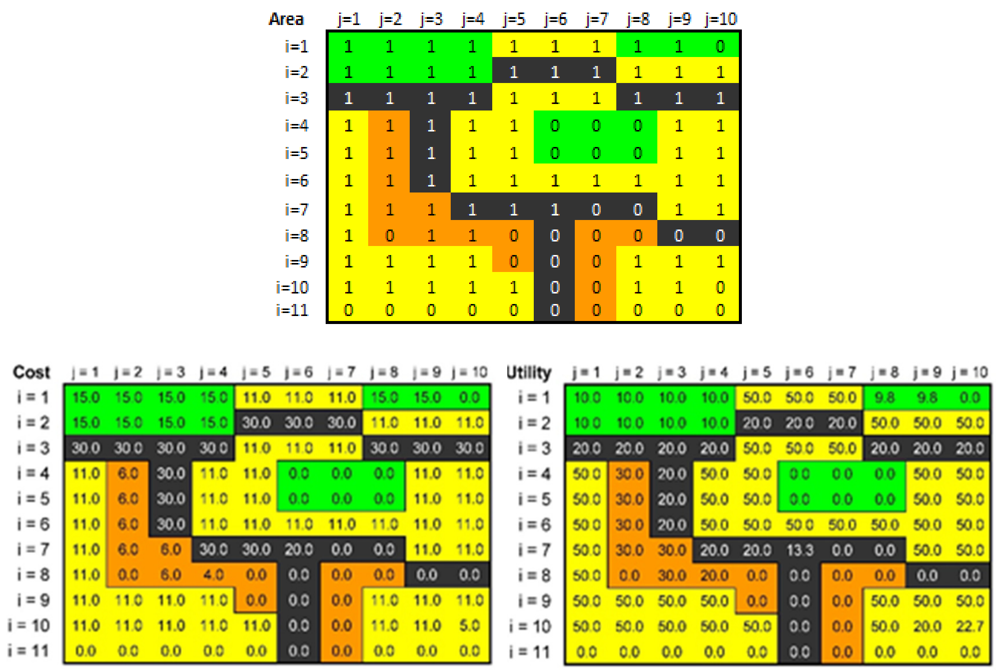

Figure 7. Optimal solution—budget structure 150/470/500/40, benefit/utility 2886 units.

Table 4. Optimal solution for budget structure 150/470/500/40.

Symbol	Function in Region	Applied Space units *	Limits of Space units **	Budget limit of Units ***	Resource Cost t.€	Utility	Budget t.€ (EUR)	Budget Spending
	Green, park	10.0	17.0	10.0	15.0	10.0	150	58.80%
	Communication, transport	15.7	24.0	15.7	30.0	20.0	470	65.30%
	Housing construction	45.5	54.0	45.5	11.0	50.0	500	84.20%
	Civil construction	6.7	15.0	6.7	6.0	30.0	40	44.40%
Units: Applied/Proposal limit/Budget limit		77.8	110.0	77.8			1160	
Cost optimal/Proposal limit/Budget limit (EUR)		1160	1659	1160				69.90%
Benefit Applied/Proposal limit/Budget limit		2886	3798	2886				76.00%

Comments: * Spent resources b in Equation (14), optimal proposal, ** Limit of resource space available in the proposal, *** Structure of cells; limits set by the budget.

From the columns budget limit of space units and budget spending in Table 4, it is evident that the breakdown of a budget in the new structure allows full drawing of budget resources and to use/block 69.9% of the proposal area while obtaining maximum benefit/utility from the territory in the amount of 76.0%. The benefit is lower by 11.4% as compared with the state in Table 3 (87.4–76.0). The decrease is caused by investments in infrastructure. The investment will be appreciated in the following time stages of use of the territory.

A preview of the use of areas is provided in Figure 7 in the form (0|1) concurrently with the qualification of costs and benefits.

The structure of drawing from budgets (investment priorities) is a demanding issue in practice, calling negotiations in representative bodies, and public administration (municipalities, communities, regions, etc.).

The factual limits of optimization calculations require sensitive proportions of ties between areas, and proportions between budget chapters of anticipated investments. Additional constraints, well beyond the illustrative example, can create new priorities and limits on the use of investment resources. The material fulfilment is then, for example, measures to restore selected areas, buildings, infrastructure, and social needs.

The illustrative example contains a total of 10 basic constraints for optimization. Intuitive solutions significantly widen the gaps between the benefits and costs of design and current solutions. The orientation provided by optimization is an objective limit, making the information valuable. This is an important component in decision making in ex-ante situations. On the other hand, the situations in practice may be more challenging than formal optimization prerequisites. They are projected, for example, into disputes over the priorities of investments, and are accompanied by disparities in opinions on the resulting effects and benefits. The materialized consequence is the under-utilized resources of some budget chapters and the delayed launch of other investment activities for lack of resources.

The volume of benefits is both a measure of proposal value and a measure of the effectiveness proportionality of the budget as a whole. The upper limit of benefits is a tool for comparing the budget options for the implementation of the proposal in terms of individual functional chapters effects: greenery, roads, housing, and public amenities construction.

3.2.6. Productiveness of Investment Resources Used—Effectiveness and Efficiency

The budget is linked to the need to shape the priorities for implementing individual investments and influencing the structure of downstream investments (infrastructure and others). Optimal use of available budget of 1160 t.€ for the modified structure 150, 470, 500, 40 is given in Table 4 with Total benefit EUR 2886 t. The available budget resources are exhausted by the proposed solution. The space for investment in the next time period (budget year) is 110.0–77.8 = 32.2 area units.

Their structure is subtracted from unoccupied areas in Figure 7 such as 7, 8, 9, and 8 (rounded). Completion of the project proposal in the next budget period, for an initial cost structure 15.0|30.0|11.0|6.0 requires EUR 492 t in the next budget period. The overview of the implementation of the proposal $N_{\text{urban plan}}$ with a budget limit of EUR 1160 t is shown in Table 5 for two budget lines (structure).

Analysis and alternation with other possible variants go beyond the illustrative example. Obviously, optimization creates quantification data for decision-making processes on area investment development measures.

Table 5. Proposal Evaluation-Effectivity, Efficiency.

Budget Structure	Proposal and Solution Data				Effectivity			Efficiency			
	Units Engaged	Cost [t.€] Incurred	Potential Utility	Optimal Utility obtained	Units Involved	Cost *** Incurred	Utility (Benefit) obtained	Cost per Unit [t.€]	Utility per Unit	Cost of 1 t.€ Utility	Utility of 1t.€ Cost
$N_{\text{urban plan}}$ *	110	1659	3800		100%	100%	100%	15.08	34.55	2.29	0.44
$N_{50/220/700/190}$ **	79	939		3320	71.8%	56.6%	87.4%	11.89	42.03	3.54	0.28
$N_{150/470/500/40}$ **	78	1160		2886	70.7%	69.9%	75.9%	14.91	37.10	2.49	0.40

Comment: * Potential data of proposal, ** Budget data 1160 t.€/Year, *** Year Schedule %.

4. Conclusions

Sections 1 and 2 of the article dealt with the question of setting a limit scope for investment activities. The fact is that the real investment limit should be based on future income (benefits). The causal quantum of benefits is structured by work on research, design, manufacturing process, and capital.

In the third part, attention is paid to the example of optimization calculation and trade-of possibilities in relation to the benefits of spent budgetary resources. The development of the territory is and has always been limited or restricted by available sources of capital, and dynamics of its use, localization of its distribution. Limits are laid down by the Building Act, namely, the master plan, strategic plans for development, and political, and social mechanisms.

Optimization calculations allow us to define limits of achievable benefits. The use of the calculations can be seen especially in the assessment of the spatial arrangement design (urban design), the comparison of alternative solutions, the comparison of the chosen alternative solutions, the assessment of the benefit structure from the draft annual budget, the evaluation of alternatives, and the benefit options for budget proposals and other quantitative and quantitative parameters linked to the development of the territory. The spatial plan creates a structure of land use, analyses land-use planning data and produces studies of possible solutions to specific problems (infrastructure, ecology and others). Investment economic frameworks and optimization documentation can, in a number of cases, facilitate decision-making on the direction of investment support for development and simplify the argumentation on the effectiveness of the proposed controlling interventions [34,35].

The method used in the paper is based on optimization calculations, as markers (indicators) of the achievable. It graphically displays the structure of the investment variant in relation to the availability of sustainable benefits (benefits) of deployed resources. It assesses resources in a broader context, such as sustainability limits: financial, infrastructure, material and raw material benefits, land, human capital, environmental stability, technology, etc. The implemented resources are endogenously valued in the optimization calculation of variants. A partial variant of the annual fulfilment of the master plan is tied to the benefit it provides. Decision-making processes of sustainable development of the territory thus become a balance of expansion reciprocity, compression of individual activities, and available resources in the territory.

The model implemented thrusts that the decision-making rules shape future opportunities in time and space constructed on history of the past events. However, the target is to predict the future development of application disciplines and purposefully shape decision-making rules. The resulting benefit is that prediction of time series in individual application fields indicates the appropriate time and location opportunities for new activities. The calculations are a contribution to the static and dynamic disparities in research areas dealing with sustainability.

The paper focuses on the interconnection of macroeconomic perspective and its microeconomic part in the evaluation of investment process. One of the most important aspects is its growth or breakdown in a national economy (in the meaning of "economic climate" in national unit); balancing the relationship between the benefit of an investment property that is subjectively attributed to it by an imaginary communal individual, on the one hand, (in the meaning of the social group, the council, the voter's representative, etc.) and, on the other hand, the objective (cost) view of investment goods, read as budget limits, prices, liquidity in the future, and yields. The history of economic theories has been dealing with the issue of value since its inception [7], yet in a certain sense it remains unresolved. In particular, the application of objective (cost) theory in proposing new progressive solutions has cast doubt on the legitimacy of its dominant position. It is correct that it creates the framework within which the project proposal should move. The proposals of technical and economical projects rest on subjective decisions and ex-ante usage. The above [7] presents an opinion tied to the so-called Austrian Economic School: *"It was a fatal mistake of economic science that cost theory was pushed in without respect to subjective-utility theory."*

The benefit of the contribution lies in the exact decomposition of the budget into segments of the master plan while maximizing the benefits and minimizing the consumption of resources. The example of spatial planning harmonizes the financial cycle of public and state administration with the dynamics of the benefits of resources used for the economy of medium-and long-term territorial development.

Author Contributions: V.B. and M.T. provided the core idea, collected the data, wrote the manuscript and analyzed the data statistically. F.K. and R.Z. revised and constructively commented on the paper, checked the formal correctness. All authors have read and agreed to the published version of the manuscript.

Funding: The work was supported by funds for Conceptual Development of Science, Research and Innovation for 2020 allocated to VSB–Technical University of Ostrava by the Ministry of Education, Youth and Sports of the Czech Republic.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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