SYSTEMS ANALYSIS OF INVESTMENT PROJECT EFFICIENCY EVALUATION

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Contents

Summary

A systems methodology is set forth for evaluating the efficiency of real (production) investment projects; the main notions used for evaluation are defined, and the most important principles, indicators and methods of evaluating projects under consideration are characterized. Considerable attention is also given to macroeconomic peculiarities of project realization conditions.

1. Introduction

In any country, socioeconomic progress is practically inconceivable without making appropriate changes in the production base through construction of new industries, application of innovations and so on. It demands effective usage of material and financial investment resources, directed to achieve such goals, their usage where it is most appropriate from the position of a managing system—society, state, firm, population, etc. All the investment problems (at the level of a country or a region, as

well as an actual individual business) often boil down to the following—where is it possible to find money for investment under acceptable conditions? And how to use investment funds? The latter is, they say, a simpler question. At last, if we cannot solve it ourselves, some experts (advisers, Russian and foreign) will prompt solutions.

It may be possible to take advantage of Russian or foreign experience that was proved to be effective. Such a position seems to be erroneous—the problem of where to get money for the required investment is really an important and a complex one, but this is only one side of the coin. There is also the other side that is neither less important nor less complex: how to use for investment and real production the available or potentially available financial resources in the most effective way? In other words, which potential production investment projects are really efficient under these or those conditions and their realization is desirable, and which projects do not merit investment. The decisions should not be taken just by analogy, as investment efficiency heavily depends quite often on internal and external conditions of realization and functioning of objects constructed according to a project. An investor obviously cannot control these conditions but they must be taken into account. Naturally, these very different conditions (we will limit ourselves to considering the most important cases of stationary and non-stationary economic conditions) not only influence the efficiency of certain investment measures but also directly find a reflection in methods of efficiency. This chapter will consider such methods, and the main point of the chapter will be concerned with evaluating the efficiency of real (production) investment projects (henceforth "IP"). The same questions concerning financial investment have been thoroughly considered in the chapter by Pervozvansky and Vilensky (see *Systems Analysis of Financial Markets: An Overview*). But let us first define the main concepts used in IP efficiency evaluation (another name for this process is **project analysis)**.

2. Glossary and Main Notions

The main notions used the following methodology of project analysis are defined below.

2.1. General Macroeconomic Notions

Stationary economy: is an economic system immanent to industrially developed prosperous countries, macro-economic indicators which are rather smoothly changing, either monotonically or within the bounds of normal market cycles and whose dynamics of values is predictable quite well, at least over short - and often over medium - term horizons. Such a definition of **stationary economy** does not fully coincide with a tougher classic one often used when **stationary economy** or **stationary market system** (stationary market) is understood either as balanced economic system with such ideal qualities as absence of arbitrage, or in the sense of stationary behavior of the corresponding random values (yield of securities at stock market, etc.) under non-correlation of consequent random values with small value of discrete step.

Non-stationary economy: an economic system with rather sharp and poorly predictable changes of macro-economic indicators, dynamics of which does not respond to a normal

market cycle of industrially developed countries; it sooner corresponds to crisis or post-crisis economic processes in developing countries.

Inflation: growth of general price level in time, characterized by inflation index (base index, i.e. in relation to a base step, or chain index - during one step) and showing how the prices have increased for the period under consideration.
An important parameter that is invariably in calculating efficiency is **prices of resources being used and products and services being produced**. More often while calculating the efficiency of all the kinds of investment projects the following **prices** are applied:

- **base prices** - prices at a fixed moment of time laid in a project without accounting for inflation
- **forecasted nominal prices** - expected prices (accounting inflation) at the future steps of calculation
- **deflated prices** - forecasted prices, having been reduced to price level at a fixed moment of time through division by the aggregate base index of inflation.

2.2. General Microeconomic Notions

In this section the main notions, directly connected with investment projects will be given, as well as notions, characterizing evaluation of investment project efficiency.

Investment – resources diverted from direct consumption with a certain aim. Among them **capital investment** (real, forming) and **financial investment** are marked out;

Capital investment – resources, directed mainly to maintenance and development of material production and service industries;

Financial investment - investing resources into acquisition of valuables stock of market (shares of companies, state securities and others) and monetary market (currency, deposits, interbank and commercial credits and others);

investment projects - any suggestions (measures) that are oriented to achievement of certain goals (economic, ecological, social and others) and demand for their realization spending or use of capital resources.

capital-production (real) investment projects - projects within the frameworks of which investments are mainly capital forming. Along with it a notion of capital-productive investment, as it is usually assumed, will be treated rather widely and will include not only resources directed straight to material sphere or service industries aiming at commercial profit or technical re-equipment and production development, but also resources being spent by the state and private business to solve socio-economic, ecological and other problems.

project life cycle - time interval (usually calculated in years) from project beginning (the beginning of its first, pre-investment phase) till the project completion (the end of liquidation phase).

project steps - parts (measured in years) into which project life cycle is divided and with which the main kinds of activity in a project are connected (investment, operational, financial), as well as financial flows corresponding to them; steps are numbered in consecutive order - 0, 1, 2, 3… and one of them (often initial, null) is assumed as the base one.
project risk - a possibility of emergence of situations which are detrimental to the individual stake holders of an investment project.

project uncertainty – existing incompleteness and inaccuracy of objective information concerning terms of project realization and functioning.

results (economic and non-economic) - useful consequences of projects realization, their quantitative characteristics are calculated by certain algorithms or are ascertained by expert way;

costs (of all kinds: lump sum, current, etc.) - financial resources, required for construction of the objects, stipulated in a project, and their functioning;

effect, being understood as a difference in evaluation of corresponding results and costs;

efficiency - characteristic of correspondence of costs and results, their total benefit.

3. Investment Projects Classification

In the event of simultaneous consideration a set of projects, evaluation of their efficiency and working-out recommendations on realization of some of them, it is necessary to take into account relations between the projects. More often situations are met when projects of the set under consideration appear as:

independent, they assume both simultaneous and separate implementation, and characteristics of their realization do not influence one another;

alternative (mutually exclusive), i.e. that do not assume simultaneous realization. From a set of alternative projects only one of them can be realized during the period under consideration;

mutually complementary, their realization is possible only jointly;

mutually influential, in case of their joint realization some additional (systems, synergic, emergent) positive or negative effects appear, that do not become apparent in the realization of each project separately and, hence, are not reflected in indicators of their efficiency.

Some other classifications are also useful, for example:

- *by scale of a project*:

global, that involve several countries-participants;

national economic, that influence a country on the whole or its large components;

large-scale, that involve separate industries, regions;

local, small, the activity of which, in essence, is limited by the scale of a firm, realizing the project.

- *by the main orientation of projects:*

commercial, the main goal of which is to earn profit;

social, orientated towards solving problems of unemployment in a region, decrease of criminal level and so on;
ecological - the main component of which is improvement of habitat;

others.

4. Specificity of Macroeconomic Conditions

Due to complexity of evaluating investment project efficiency it is natural to assume as methodological tools applied systems analysis (methodology and procedures of its carrying out are given in *Systems Analysis and Modeling of Integrated World Systems*). For this purpose it is necessary first to determine its most important peculiarities inherent in various types of economic systems under consideration. It is convenient to show them in the following Table 1.

Factor	Systems Type	
	Stationary	Nonstationary
1. Dynamics of macro-indicators	1.1. Dynamics is calm, responding to a normal market cycle; 1.2. Usually growing trend and accordingly coordinated with it investment volumes; 1.3. Correspondence of macro-indicators values, close to the rational ones	1.1. Has fluctuating, often irregular character; 1.2. A considerable production decrease takes place, as well as a sharp decline of capital-productive investment; 1.3. Relations of macro-indicators values, noticeably different from stationary economy
2. Fiscal system	2.1. Balanced in accordance with phases of market cycle budgetary and borrowing policy, structure of state expenditures; 2.2. Rational taxation system, formed and relatively seldom changing; 2.3. Normally-law level of non-monetary payments	2.1. Non-rational structure of state expenditures, considerable costs of servicing a debt; 2.2 Complex unstable taxation system; 2.3. High level of nonpayment and "money" substitutes

3. Risks	3.1. Stable risks structure, absence or rather law level of variational non-systematic risks; 3.2. Absence (or a small value) of criminal, political and other risks; 3.3. Sufficiently good predictability of risks	3.1. Risks complex structure, including both systematic and non-systematic risks, the latter being especially considerable; 3.2. High and changeable risks of all types: political, criminal and others; 3.3. Poor predictability of risks
4. Markets	4.1. Having been formed, developed, effective stock market, nearly with absence of arbitration, that makes it possible to eliminate a considerable part of non-systematic risk through diversification; 4.2. High level of objectivity of the assets market value, its closeness to "fair value";	4.1. Not having been formed, especially stock market; non-effecient arbitration market; considerable both systematic and non-systematic risks; 4.2. Considerable differences between "fair value" of securities, real estate and others, and their market value;
5. Inflation	5.1. Relatively law, sufficiently homogeneous (including inflation on various resources, products and currencies); 5.2. Stable, with law trend and small cycle deviations from it	5.1. Rather high, heterogeneous, sometimes up to hyperinflation; 5.2. Variable in time with considerable changes by steps 5.3. Considerably different for different resources and different foreign currencies;
6. Credit and monetary system	6.1. Practically single-currency; 6.2. Stable; 6.3. Stable financial legislation, including tax one; 6.4. Normal, determined by risk characteristics relations between costs of different types of capital; 6.5. Stable and relatively law interest rates, close values of deposit and credit interest rates, stable discount rates and so on	6.1. Often multi-currency; 6.2. Unstable; 6.3. Unstable financial condition and corresponding legislation, including tax one; 6.4. High level of capital value, sometimes inversion relations between costs of equity, borrowed and other types of capital; 6.5. Rate of money values decline (discount rates) changing in time, high and variable interest rate, considerable difference between deposit and credit bank interest rates

Table 1. Specificity of stationary and non-stationary economic systems.

Let us note that far from all the major specific features of stationary and non-stationary economy are shown in this Table, but just a part of them that should be taken into account while evaluating capital-production further - "production investment projects" investment projects - in particular, they quite fully correspond to the conditions of non-stationary transition economy of Russia and other countries of the former Soviet Union that are being reformed now.

In the analysis of investment projects efficiency in different countries with non-stationary economy, other local and regional peculiarities certainly should be taken into account while carrying out algorithms and procedures of evaluating efficiency in relation to actual projects.

5. Main Tasks of Project Analysis

What are the main tasks that are necessary to solve while evaluating investment projects efficiency? They seem to be the following ones:

Task A: evaluation of project's realizability, i.e. testing if it satisfies all the real conditions- technical, ecological, financial and other character.

Task B: evaluation of potential benefits of project realizability, its absolute efficiency, i.e. testing a condition, according to which joint results on a project are not less valuable than costs of all kinds necessary for investment project realizability.

Task C: comparative evaluation of advantages of the project variant under consideration relative to the alternative ones, i.e. **evaluation of project comparative efficiency.**

Task D: evaluation of the most efficient subset of projects from the given set of investment projects; each of them is efficient by itself, but there are some additional restrictions (for example, concerning a sum of investment) that do not allow to realize them all. Along with it a set of projects under consideration can include various relations between them - projects can be both alternative and independent, and so on, but restrictions (of investment volume, environment pollution and others) can relate to the whole set of projects, as well as to its separate subsets. Essentially, this task is an optimization task, and to a certain extent it generalizes the previous ones.

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Task E: evaluation of project stability, i.e. testing if a project is able to save its efficiency under different possible realization scenarios that come into existence in terms of risk and uncertainty with variation of parameters and external conditions of investment projects realization.

Let us note that, essentially, under project analysis, for solving task A it is necessary to carry out testing just financial realizability of investment projects, because usually all other restrictions are tested at an earlier, engineering stage of forming a project (project variants). As to testing restrictions on financial resources (projects financial realizability) this testing, as a rule, cannot be carried out at the previous engineering stage, as at that time neither investors nor concrete conditions (including financial ones) of their participation in the project under consideration are known. Accordingly, solutions of tasks B and C determining absolute and comparative efficiency of separate projects (or their variants) make it possible to exclude economically non-viable solutions. While solution of task D gives an opportunity of choosing the most effective investment program, as well as implementing, if necessary, a certain ranking of projects (or their aggregates). The necessity of solving Task E arises due to the fact that in terms of risk and uncertainty not only project efficiency should be evaluated, but stability of such evaluation should be studied too.

While solving the mentioned tasks A-E it is necessary to deal with notions of total (integral) costs and results. They are determined by summing-up not only by their

separate kinds, but by all the moments of time (**steps**) during all the **calculated period - project life-cycle** too.

With these steps **cash flows** are directly connected (**inflows** and **outflows** and their balance, further assumed as a **step flow**), meeting the time of receiving these or those monetary results or execute these, or those costs. Let us note at once that solving task A is necessary to fulfil directly by values of financial flows which are supposed to take place at a corresponding step under conditions being considered, i.e. calculations of flows and testing by them project financial realizability should be introduced in nominal (projected) prices. Solving the rest of the tasks - evaluation of efficiency, stability and optimization is to be conducted in deflated prices, i.e. in nominal prices, divided by general inflation index for that step.

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Biographical Sketch

Livchits, Veniamin Naumovich - doctor of economics, professor, Honoured Scientist of the Russian Federation, Member of a number of national and international scientific associations and academies, Laureate of the Russian Academy of Siences' V.S.Nemchinov Prize of 1999 in economics , Head of department "Analysis of Strategies and Valuation of Systems Development Efficiency' of The Institute for Systems Analysis Russian Academy of Sciences, Head of laboratory "Models of Investment Projects Efficiency Assessment" of the Central Economic and Mathematical Institute, Russian Academy of Sciences, professor of the International University in Moscow, of the Moscow Institute of Physical and Technology. Specialist in the field of evaluation of investment projects' efficiency, economic and mathematical modeling, transport economics. In 1959-2001 280 scientific works were published on economics, mathematics, transport, energetics and a number of monographs in various Russian and foreign journals. The most important ones are the following:

1. Choice of Optimal Solutions in Tecchnical and Economic Calculations. M., "Economica", 1971.

2. Optimisation with Perspective Planning and Designing, Moscow, "Economica", 1984.

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Since 1969 up to the present V.N.Livchits regularly takes part in the activity of the State Expert Commission under the Ministry of Economics and Expert Council under the chairman of the RF Government. On the whole he took part in the expertise of more than 50 projects.