Application of input-output models for investment project evaluation: the economic efficiency approach

Prof. Tatyana S. Novikova

Novosibirsk State University and
The Institute of Economics and Industrial Engineering
of the Russian Academy of Science
Novosibirsk , Russia

Presentation overview

1. Introduction
2. The modeling system
3. The model of investment project
4. Results for the project of Eastern Siberia–Pacific Ocean-2
5. Conclusions

1. Introduction

Features of infrastructure projects (IP)

- ➡ assessment methods
- ➡ PPP mechanisms.

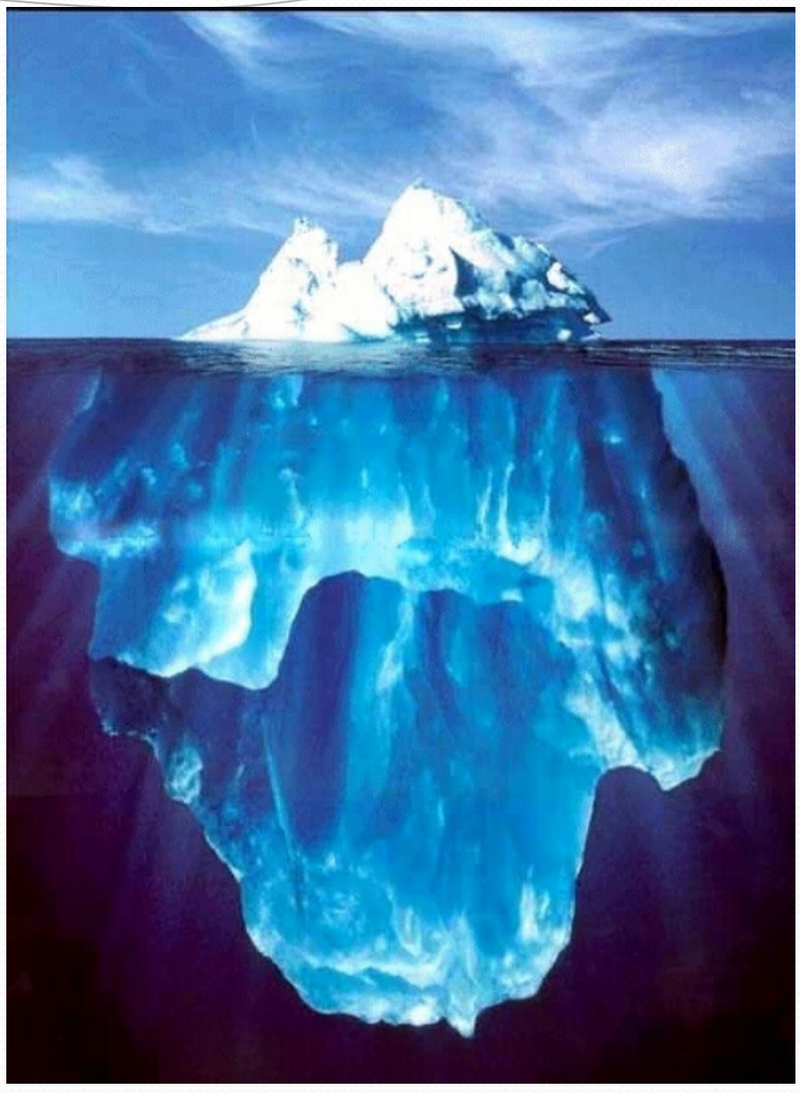
Developed approaches to assessing IP:

either analysis of commercial efficiency (micro level, but without an assessment of public efficiency),

or analysis of public efficiency (macro- and meso level, without passing on the micro level).

Financial efficiency considers benefits and costs from the point of view of private project's participants.

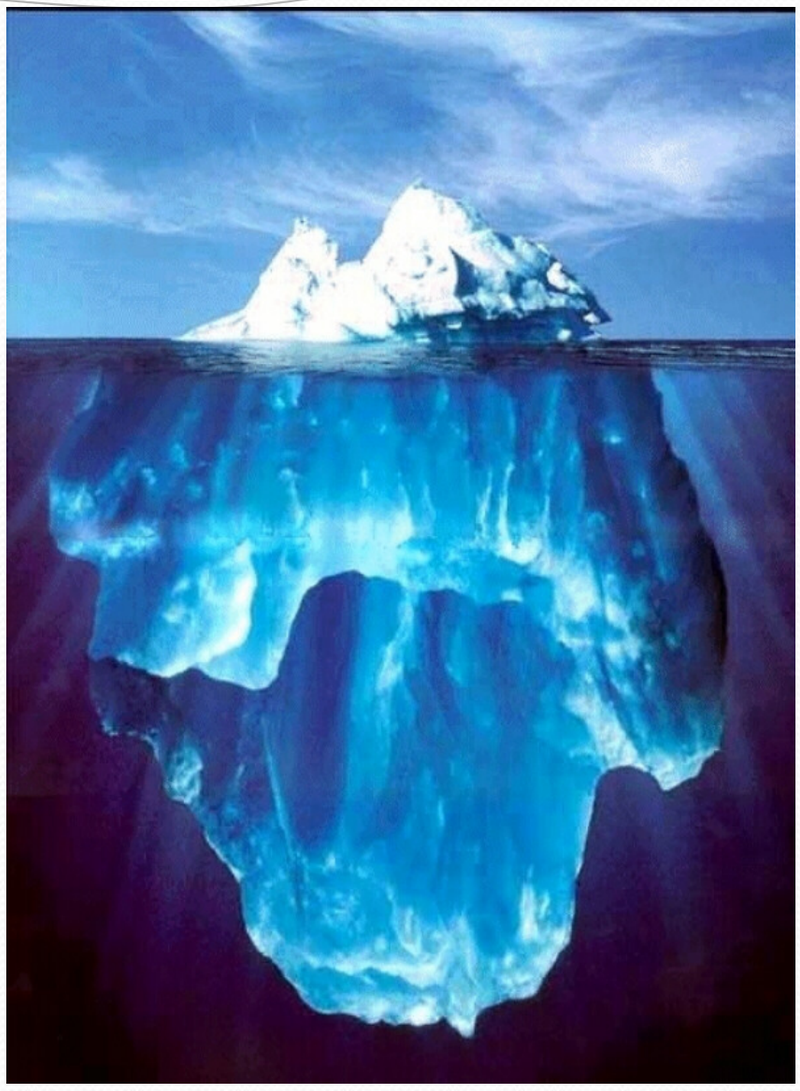
Economic efficiency considers project's benefits and costs from the point of view of region or society as a whole.



Simultaneous analysis of financial and economic efficiency and the possibility to influence on financial efficiency by PPP mechanisms.

Financial effects

+ Ecological effects
+ Other Externalities
+ Tax effects
+ Price effects
+
Indirect effects=
= Economic effects



*The input-output multiregional optimization model IOMOM as the main tool for endogenous decisions, particularly **indirect effects**.*

2. The modeling system models

The input-output multiregional optimization model IOMOM

The financial-economic model of investment project FEMP

The econometric model of demand

-regional, sectoral, macroeconomic indicators (final product);

-indirect effects.

sales forecast

-financial and Economic IP efficiency;
- efficiency of the project and efficiency of the participation in the project.

Modified IOMOM without a project

$$Z \rightarrow max,$$

$$A^p X + \lambda z \leq b - \Delta b^p$$

$$X \leq D - \Delta D^p$$

$(\Delta b^p, \Delta D^p)$ - the technological column of the project;
A^p –adjusted generalized technological matrix; **z** – variable of the final product; **X** –generalized production vector;
λ – the vector of the territorial structure of consumption;
b – fixed part of final consumption in 2030;
D generalized vector of constraints.

Initial IOMOM - with a project

The block of the investment project

	Year	№	Output 2010	Output 2020	Gross fixed investment 2010	Gross fixed investment 2020	Final consumption 2010	Final consumption 2020	Interregional relations 2010 Out	Interregional relations 2010 In	Interregional relations 2020 Out	Interregional relations 2020 In	Foreign trade relations 2010 Ex-port	Foreign trade relations 2010 Im-port	Foreign trade relations 2020 Ex-port	Foreign trade relations 2020 Im-port		Technological column of project
Balances of production and distribution of goods	2010	1															=	
		3																
		5																
	2020	2																
		4																
		6																
Constraints for labor	2010	7																
	2020	8																
Constraints for investment	2010	9																
	2020	10																
Constraints of trade balances	2010	11																
	2020	12																

The block of the investment project contains the information about the investment project, by modeling and measurement appropriating to IOMOM, but by moments of time appropriating to FEMIP.

Indirect effects in IOMOM

- Effects arising beyond the institutional framework of IP and taking into account changes in the chain of input-output and multi-regional interactions

  as a result of the project:

$$e^K = Z^o - Z^M$$

z^0 - final product in modified IOMOM (without the project);

z^M - final product in initial IOMOM (with the project).

The distribution of indirect effects over years of project implementation

$$\nu^t = \frac{x^t}{x^T}\nu^T$$

where x^t are the output volumes for the time $t = 1, ..., T$ defined in the FEMP;

x^T are the output volumes in the last year of the analyzed period in the IOMOM;

v^t are the indirect effects arising from implementation of the IP for the time $t = 1, ..., T$ defined in the FEMP;

v^T are the indirect effects arising from implementation of the IP in the last year of the analyzed period and determining in the IOMOM.

3. The model of investment project:
cash flows in the economic model

$$CFE^{rt} = CFF^{rt} + T^{rt} - S^{rt} + V^{rt} + W^{rt} + P^{rt},$$
$$t = 1, \dots, T,$$
$$P^{rt} = \Delta CFF^{rt} + \Delta T^{rt} + \Delta V^{rt} + \Delta W^{rt}, t = 1, \dots, T,$$

CFE^{rt} – CF in the economic analysis;

r- region; *t*- period of time;

CFF^{rt}– CF in the financial analysis;

T^{rt} and S^{rt}– tax and subsidy effects;

V^{rt}– CF for indirect effects;

W^{rt}–CF for externalities;

P^{rt} – CF for price effects.

Mechanisms of project realization and interrelation of efficiency indicators

$$NPV = \sum_{s} NPV^{s}$$

NPV – net present value of the project,

NPV^{s} – net present value of *s* -th participant of the project (both within the financial or economic analysis).

The net present value of the project is divided between participants of the project by means of its financing or providing GS with corresponding net present value for various participants, or efficiency of participation in the project.

A significant size of the net present value for every participant represents that the offered scheme of financing or providing GS creates interests for participants of the project in its successful realization.

Cash flows in the financial model

$$CFF_t^{NG} = CFF_t - \Delta T_t - \Delta L_t - H_t - I_t$$

CFF_t^{NG} – the net cash flows in the period *t* in the conditions *without GS* (NG – No Government Support);

CFF_t – the net cash flows in the variant *with GS* and separation of educational and training costs and other high-risk targeted investment and financing these costs by direct GS;

ΔT_t – the change in taxes due to GS;

ΔL_t – the change in liquidation value due to GS;

H_t – investments, financed by direct GS;

I_t – other investment and current costs, financed by budget.

Government support reduces the visible investment for business by an financing through direct support. Most types of *indirect support* acts similarly *by lowering of the tax payments and changing of the liquidation value.*

4. Results of evaluation for the project of Eastern Siberia–Pacific Ocean-2

The length: 2046 km.

Capacity: 50 million tons / year.

Investments in construction 312 billion rubles.

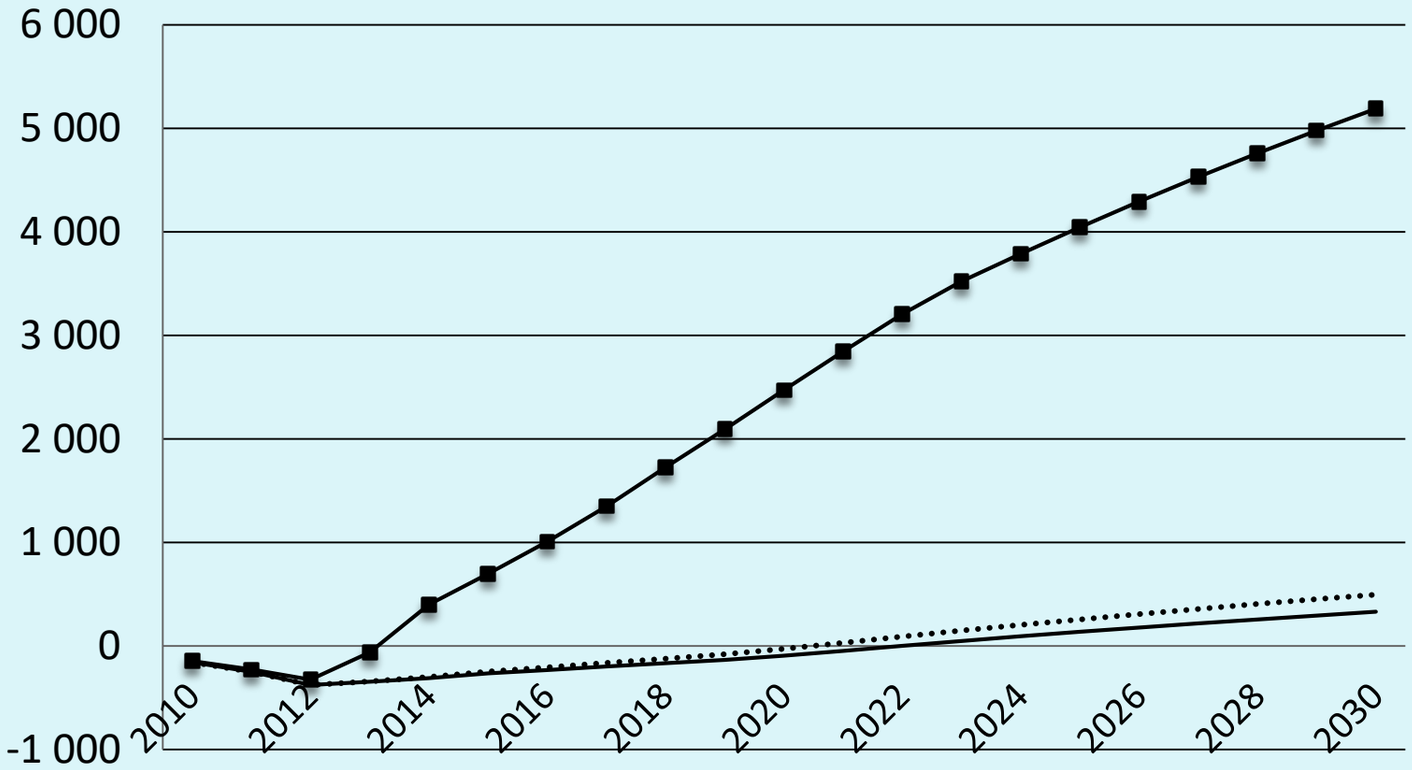
The goal is to increase Russia's presence in the APO oil market. The construction of the pipeline stimulates the development of new oil fields and an increase in oil production in the regions that act as a resource base for the pipeline, which contributes to the development of the oil and gas industry and the growth of the welfare of the regions and the country.

Results of evaluation of the project ESPO-2

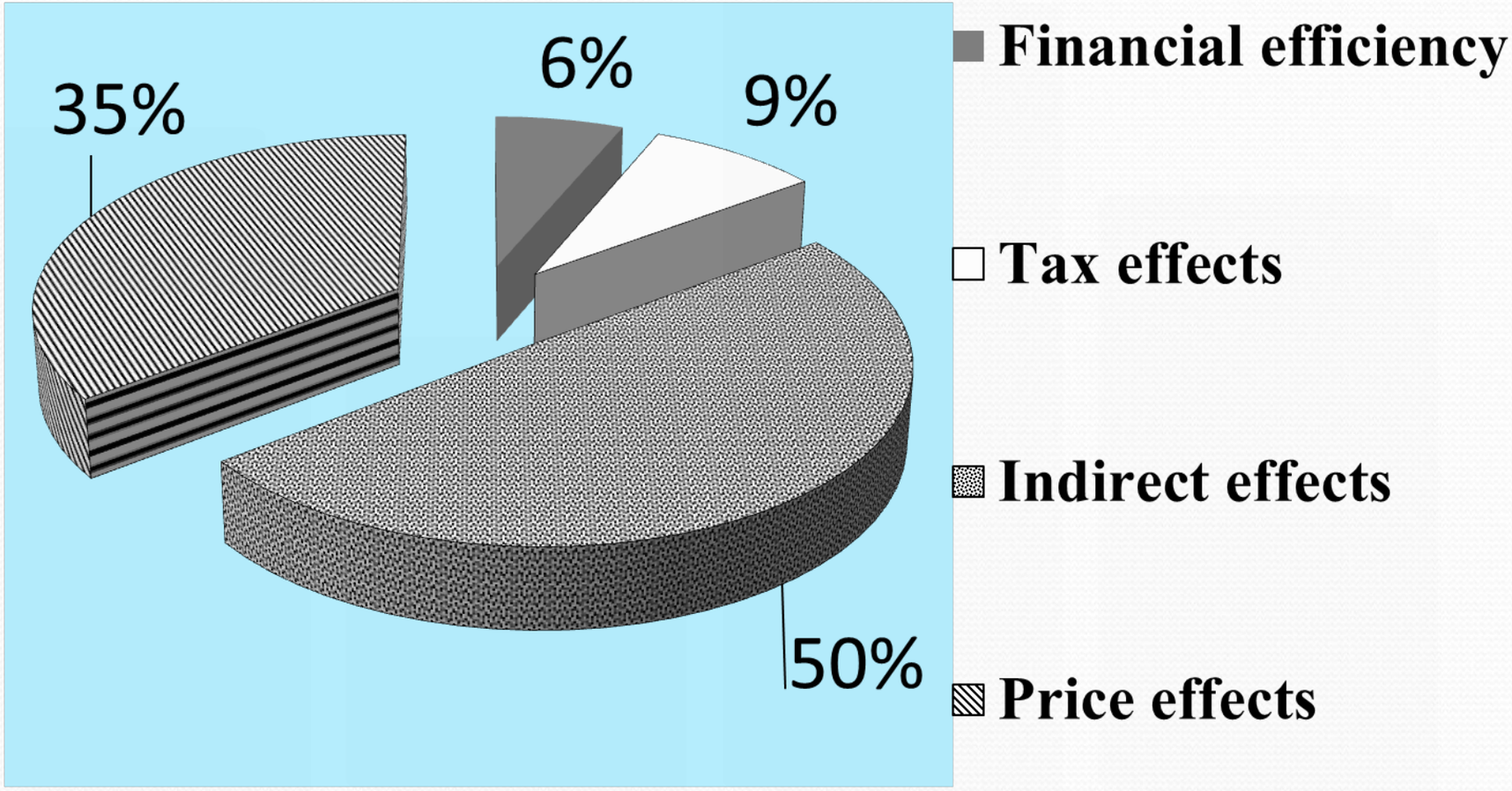
Indicator	**Financial efficiency**	**Economic efficiency**
NPV, million rubles		
$r = 4\%$	330 958	5 190 274
$r = 0\%$	752 129	8 220302
IRR, %	10.7%	63.4%
Payback period (at $r = 4\%$), year	12	6

Accumulated NPV of the ESPO-2,

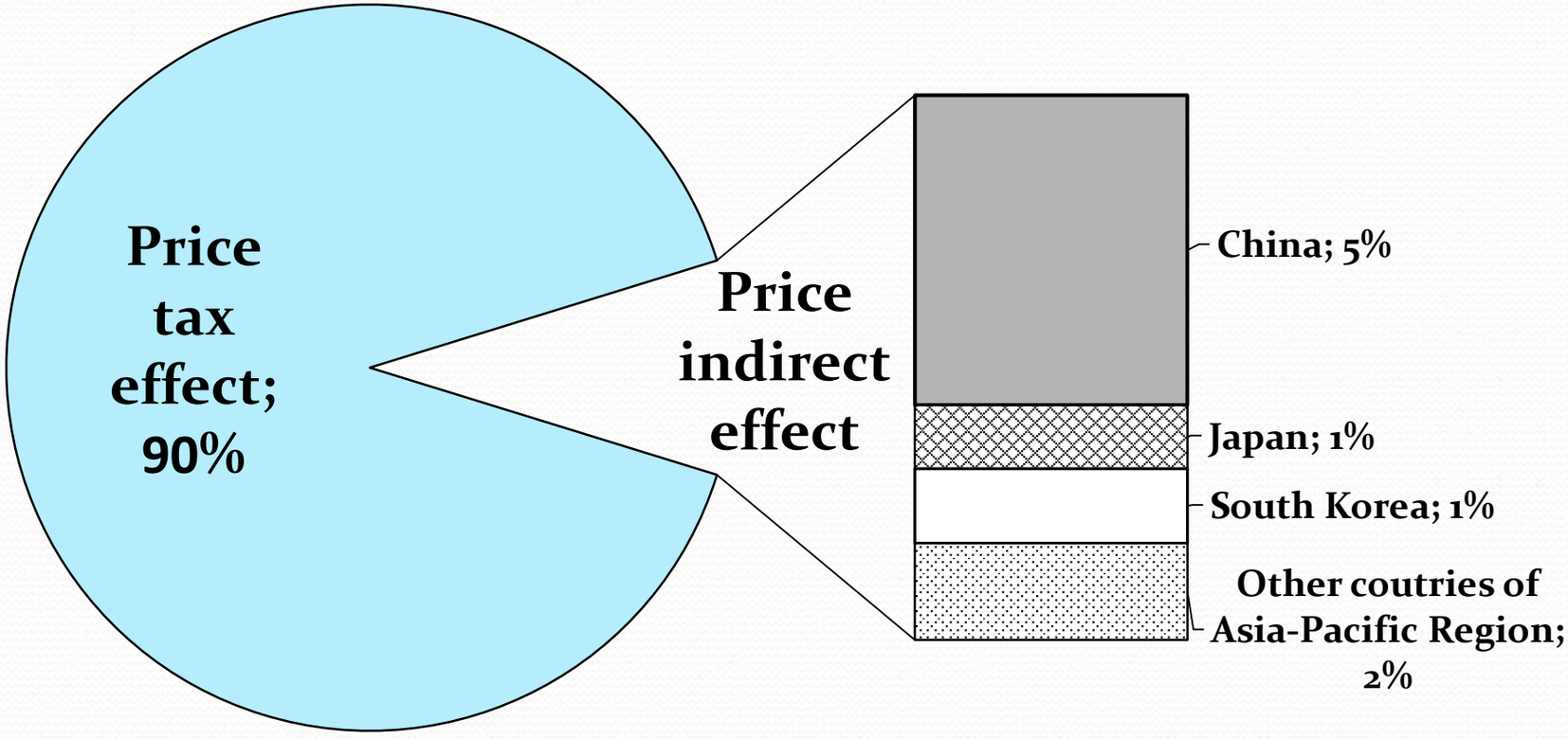
rbl mln, r = 4%



Structure of the economic efficiency of the project ESPO-2



Structure of price effects for the project ESPO-2



5. Conclusions

1. Modern scientific and technological development requires a significant change in the appraisal of infrastructure projects, taking into account the increasing interdependence of participants both within and beyond the institutional frameworks of such projects.
2. The modeling system of three interrelated models (IOMOM, project FEM, and EMD) showed the efficiency of the integrated approach as a tool for evaluating the projects efficiency.
3. Models and methods of the simultaneous evaluation of financial and economic efficiency with presentation of the results of different economic effects and types of GS were tested for real infrastructure ESPO-2 project and innovative projects of the Siberian Branch of the Russian Academy of Science.

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Thank you for your attention!

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Results of evaluation of the project ESPO-2 without price effects

Indicator	**Financial efficiency**	**Economic efficiency**	**Regional efficiency**
NPV, rbl mln :			
$r = 4\%$	343 364	2 643 738	471 969
$r = 10\%$	32 581	1 243 988	102 213
$r = 0\%$	767 329	4 518051	973 342
IRR, %	11.0	32.7	13.1
Payback period (at $r = 4\%$), yr	12	6	11

Model complex changes

- To conduct a marketing analysis of the project, a third, econometric model for the analysis and forecast of oil consumption in the proposed international sales markets has been developed.
- the sequence of calculations for OMMM has been changed, in which the model is considered as the initial model taking into account the project, and to obtain the model without taking into account the project, OMMM is adjusted
- FEMP was modified due to the need to build it for an existing enterprise and the availability of source data.

Effects of government support of investment

To determine the effects of the project's GS in monetary terms, the *NPV* indicators are used, which are calculated on the basis of the corresponding changes in cash flows.

Effects of direct GS G_1 *depend only on amount of budgetary financing of the educational and training programs and other target costs. Every additional i-th effect of indirect GS* ΔG_i *depends on discounting changing of liquidation value and taxes as a result of this support.*

$$G = \sum_{t=0}^{T} \frac{(H_t + I_t) + (\Delta L_t^2 + \Delta T_t^2) + (\Delta L_t^3 + \Delta T_t^3) + (\Delta L_t^4 + \Delta T_t^4)}{(1+r)^t} = G_1 + \Delta G_2 + \Delta G_3 + \Delta G_4$$

ΔG_2 – the effect of secondary indirect GS;
ΔG_3 – the effect of indirect support in the form of tax *exemptions*;
ΔG_4 – indirect support effect due to accelerated write-off of R&D expenditures;
G – the overall effect of the GS of the project.

Stages of the EMD

(1) Economic factors that hypothetically affect oil consumption in a particular country are analytically determined.

(2) Multiple regression equations are constructed to identify significant economic factors and to rank them according to the degree of influence.

(3) Oil consumption is forecast in the countries under consideration based on statistical data on existing trends.

The proposed econometric model extends the possibilities of marketing planning in the context of analyzing the conditions of foreign oil markets.

Results of evaluation for project of Eastern Siberia–Pacific Ocean-2

Indicators	Financial efficiency	Economic efficiency	Regional efficiency
			
PP (years)	12	6	10
IRR, %	11,6%	33%	13,6%
NPV , bln rub.	**377**	**2 661**	**504**

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Results of experimental calculations on the modeling system

The complex of the input-output multiregional models was approved in experimental calculations.

For **modified IOMM** a small-sized conventional sample was used. There are

three regions: West (with a focus on North-Western and Central regions), Center (Volga, South and Ural Federal District), East (Siberian and Far Eastern federal district);

seven sectors: two mining (fuel and not fossil fuels), two manufacturing industries (investment, including metallurgy and machinery, and other manufacturing), agriculture, services, transportation;

two periods – five- years and ten-years.

Discounted final consumption in a variety of calculations

(million rules, 2005 prices, variant number)

Projects	Balanced development			Transport deficit		
	Ine-rtial deve-lopment	Techno-logical change in the project	Technological change in the project and the rest of the economy	Inertia l deve-lopment	Techno-logical change in the project	Technological change in the project and the rest of the economy
Initial versions without projet	46248 (1)			43426 (2)		
Innovative multilateral project: basic optimistic	49742 (3)	50041 (4) 50132 (6)	51822 (5) 52953 (7)			
Innovative specialized project: basic optimistic	49009 (8)	49635 (9) 49831 (11)	51425 (10) 52620 (12)			
Infrastructure project: basic pessimistic optimistic	46762 (13)	47125 (14)	48043 (15) 47114 (19) 48985 (20)	44357 (16)	44591(17)	45138 (18)
Fuel project: basic	47766 (21)	48035 (22)	48877 (23)	44719 (24)	44896 (25)	45673 (26)

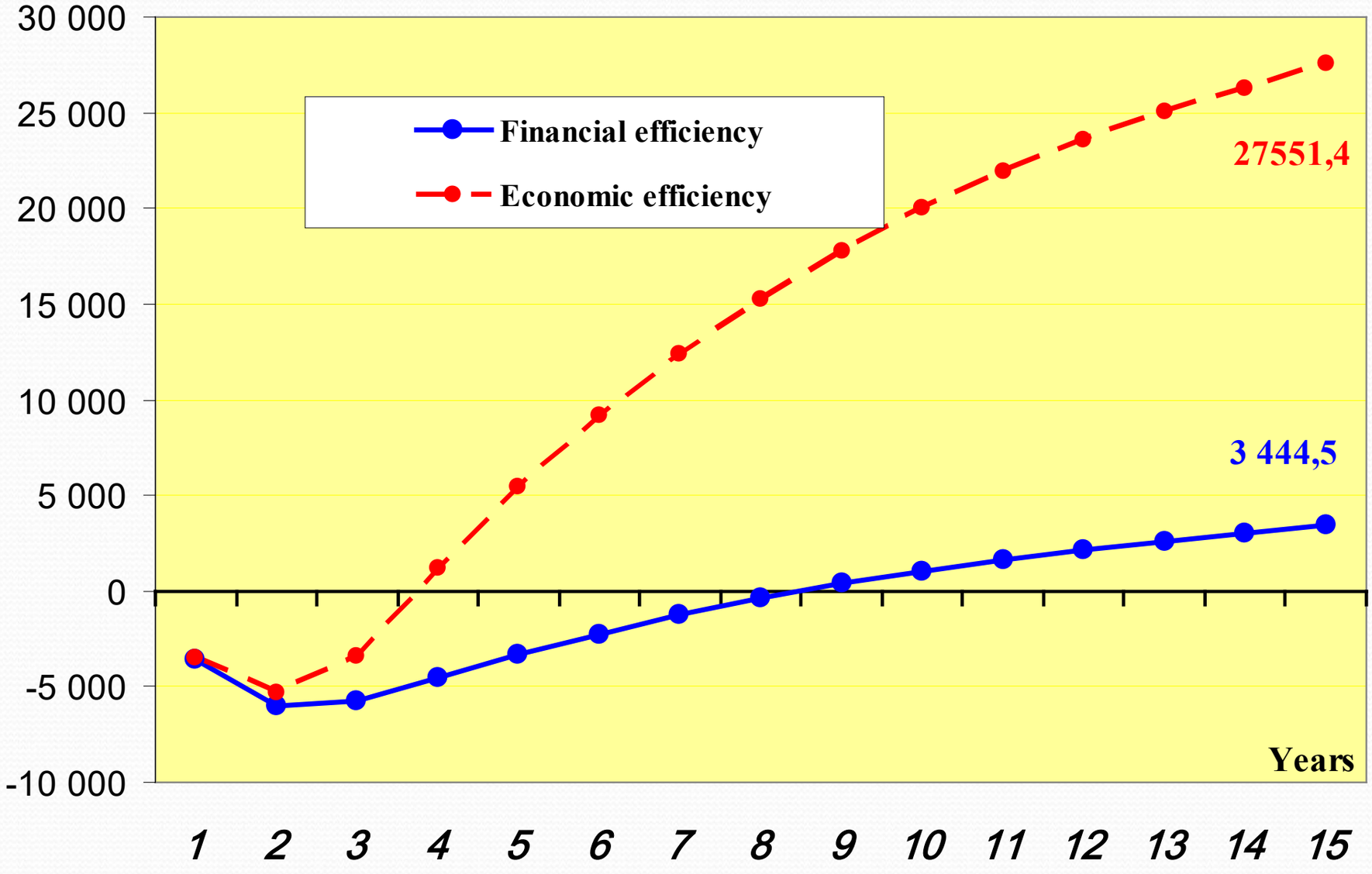
The main indicators of financial and economic efficiency of investment projects*

Indicators	Financial efficiency			
	Innovative multilateral project	Innovative specialized project	Infra-structure project	Fuel project
NPV , million rubles, d= 15%	3444.5	3952.0	2203.9	2052.7
IRR, %	26.2	27.1	24.2	24.4
Payback period, years	7.6	8.0	9.5	9.3
	Economic efficiency			
NPV , million rubles, d= 15%	27883.2	29249.3	14369.3	23365.6
IRR, %	83.4	80.0	52.4	74.9
Payback period, years	3.2	3.3	6.5	4.8

*Basic variants with tax and indirect effects

Dynamics of accumulated NPV in the innovative multilateral project

(r = 15 %), million rbl.



Structure of NPV for economic efficiency, %

	Innovative multilateral project	Innovative specialized project	Infra-structure project	Fuel project
Financial efficiency	**12,4**	**13,5**	**15,3**	**8,8**
Indirect effects	**44,9**	**43,5**	**38,5**	**19,5**
Tax effects	**42,7**	**43,0**	**46,1**	**71,7**
Economic efficiency	**100,0**	**100,0**	**100,0**	**100,0**

*Basic variants with tax and indirect effects

Internal and external indirect effects, %.

Reduction of input coefficients		Internal indirect effects	Technological effects in the project	Technological effects in project and region	External indirect effects	Full indirect effects
	Innovative multilateral project					
Material	5%	81,0%	2,5%	16,5%	19,0%	100,0%
Labour	10%	75,2%	4,1%	20,7%	24,8%	100,0%
Material	15%	70,7%	5,7%	23,6%	29,3%	100,0%
Material and Labour	5% 10%	62,7%	5,3%	32,0%	37,3%	100,0%
Material and Labour	5% 15%	55,9%	6,9%	37,2%	44,1%	100,0%
	Innovative specialized project					
Material	5%	76,7%	3,4%	19,9%	23,3%	100,0%
Labour	10%	65,1%	11,9%	22,9%	34,9%	100,0%
Material	15%	59,8%	15,3%	24,8%	40,2%	100,0%
Material and Labour	5% 10%	53,3%	12,1%	34,6%	46,7%	100,0%
Material and Labour	5% 15%	43,3%	12,9%	43,8%	56,7%	100,0%

*Results of government support of investment projects**

Calculations of financial efficiency were carried out for the initial situation without budgetary financing and for the situation with granting of budgetary financing. In both projects 40% of investments are financed from the budget. Economic efficiency remains invariant when financing change.

It allows raising significantly the financial NPVs:

- in the innovative multilateral project by 1.4 times,
- in the innovative specialized project by 1.2 times,
- in the infrastructure project by 1.9 times,
- in the fuel project by 1.96 times.

It allows to conclude that budgetary financing creates sufficient stimulus for private participants in realization of all projects.

*Basic variants with tax and indirect effects