Alexei Moiseev

ANALYSIS OF INFLUENCE OF THE «DUTCH DISEASE» AND TAXATION ON ECONOMIC WELFARE. EXAMPLE OF THE RUSSIAN ECONOMY.

Working paper # BSP/99/030

This paper presents a Master Thesis completed at NES, 1999
This paper was prepared under the research program " Transforming Government in Economies in Transition" (GET) sponsored by the Ford Foundation and supervised by Professor Charles D. Kolstad and Dr. O.A. Eismont.

МОСКВА
1999

Moiseev A.V. Analysis of influence of the «Dutch Disease» and taxation on economic welfare. Example of the Russian economy. / Working paper #BSP /99/030 . Moscow, New Economic School, 1999.-46 p. (Engl.)

Since the 1970s, the «Dutch Disease» has been noticed to be a problem for several economies. In the end of 1980s-start of 1990s this problem also became actual for Russia.

The «Dutch Disease» is usually initiated by significant increase in revenues from raw material exports. The boom resulted from such, at a glance, a favorable market juncture, draws the production factors, labor and capital, out of traditional industries sector in the raw-material and service sectors of an economy and deteriorates the conditions for traditional manufacturing industries causing them to decline. Although in the short run the country enjoys the improved economic situation, in the long run it faces a risk to slow down its «cultural, technical and intellectual development which only a strong, healthy manufacturing industry … can provide» [Nicolas Kaldor, 1981]. Thus, the country should trade off the instant and short-living benefits of being a raw material «rantier» and the disadvantages of ever-lasting missing out on economic development.

In the work by O. Eismont and K. Kuralbaeva «Depletion of Natural Resources and Long-term Perspectives of the Russian Economy» (1998), NES GET Conference Papers, 1998, which served the basis for the present diploma, the latter view has been given analytical framework. The Master Thesis considers a modification of the paper's model of three-sector endogenously growing economy, in which the additional actor (government) and the means at his disposal (tax system) are introduced to find

if the effect from a rise of raw material exports is universally adverse or it depends crucially on the economy's characteristics and the nature of the rise;

if there are tax policies to mitigate the undesirable consequences of the raw material boom and, if yes, how fully they can help to cure the «disease».

Моисеев А.В. Анализ влияния «Голландской болезни» и налоговой политики на экономическое благосостояние. (На примере российской экономики). Препринт #BSP /99/030.- М.: Российская экономическая школа, 1999.-46 с.(Англ.)

В начале 70-х годов несколько стран столкнулись с проблемой так называемой «Голландской болезни». В конце 80-х - начале 90-х эта проблема стала актуальной также и для России.

«Голландская болезнь» обычно возникает после резкого роста доходов страны от экспорта природных ресурсов. В результате такого, на первый взгляд, благоприятного изменения коньюктуры на мировом рынке, факторы производства начинают перетекать из обрабатывающего сектора экономики в ресурсодобывающий сектор и сектор услуг, так как предельные производительности труда и капитала в этих секторах начинают превосходить предельные производительности в обрабатывающем секторе: на сырьевых производствах благодаря росту мировых цен, а в сфере услуг- за счет неторгуемости этого вида продукции и, сравнительно более быстрого, чем в обрабатывающем секторе, увеличения уровня заработной платы. Несмотря на рост благосостояния экономики в краткосрочном периоде развития, в долгосрочной перспективе такое перераспределение производственных факторов может вызвать замедление темпов экономического роста. Таким образом, страна становится перед выбором между эксплуатацией своих природных запасов в полной мере и временным благополучием, а затем вечным отставанием в развитии и осторожным использованием этих запасов, но отсутствием значительного замедления экономического роста

Налоговая политика государства в отношении производителей в экономике, подверженной влиянию «Голландской болезни», как долгосрочная мера, является подходящим средством борьбы с указанным нежелательным замедлением экономического развития. Таким образом, возникает задача определения компенсирующей реакции налоговой системы в экономике с «Голландской болезнью».

В качестве базовой модели для изучения описанного явления была использована модель трехсекторной экономики с эндогенным ростом, в частности, ее модификация для случая экономики с правительством и налоговой системой. Для изучения эффектов от изменения налоговой политики и ценовых шоков была использована калибровка модели в соответствии с данными российской экономической статистики.

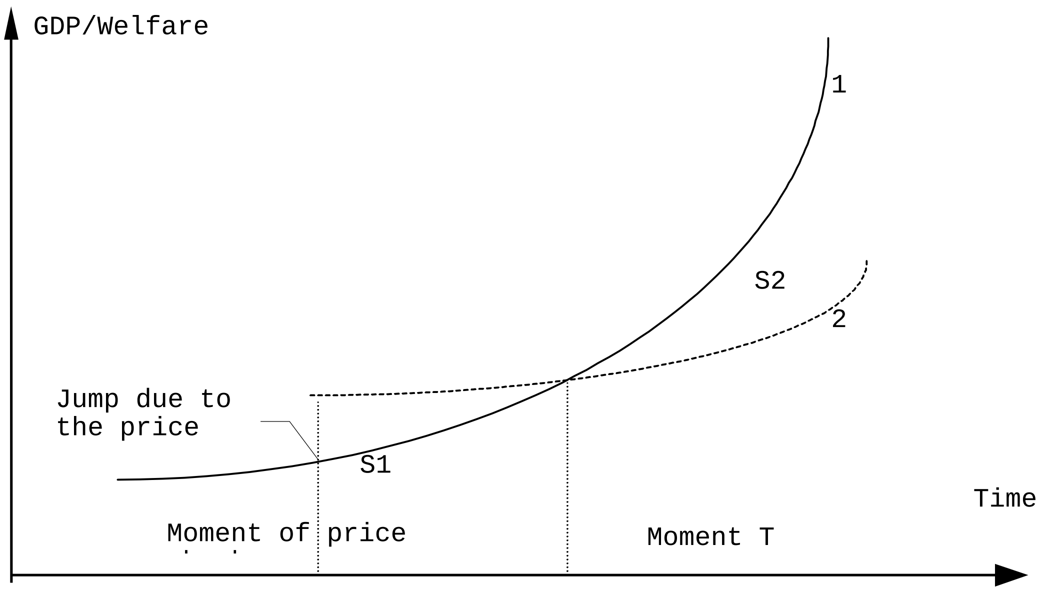
ISBN 5-8211-0084-4

Contents

PART 1. Introduction.

Since the 1970s, the «Dutch Disease» has been noticed to be a problem for several economies. In the end of 1980s-start of 1990s this problem also became actual for Russia.

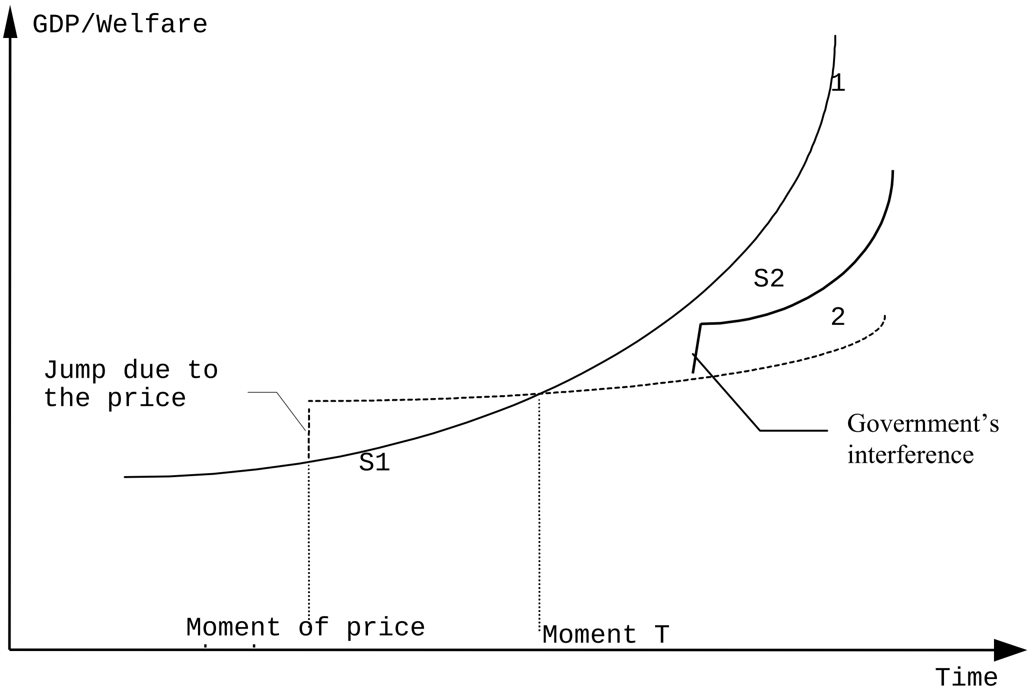
The «Dutch Disease» is usually initiated by a significant increase in revenues from raw material exports. The boom resulted from such, at a glance, a favorable market juncture, draws the production factors, labor and capital, out of traditional industries sector in the raw-material and service sectors of an economy and deteriorates the conditions for traditional manufacturing sector causing it to decline. Although in the short run the country enjoys an improved economic situation, in the long run it faces a risk to slow down its «cultural, technical and intellectual development which only a strong, healthy manufacturing industry … can provide» [Nicolas Kaldor, 1981]. Thus, the country should trade off the instant and short-living benefits of being a raw material «rantier» and the disadvantages of ever-lasting missing out on economic development. The intuition behind this trade-off can be best illustrated by the graph below.



In figure above, the country's gain from the increase in value of its export is represented by the square S1 between the solid and dashed development trajectories before the moment of stagnation prevalence T. This is the moment when the effect from squeezing out on manufactures starts playing its adverse role. Since this moment, the economy finds itself in a less advantageous position than it would follow did it not experience the market condition change, and moves along a less well-off path of development. Would the loss in the present value of utility on trajectory 2 after the «turn-over» moment T go beyond the benefit before this moment depends on several factors, some of them being the value of discount rate, presence of other disturbances to the path of development and the size of the price shock.

The discount rate is responsible for the relative sizes of squares S1 and S2. The greater is this rate, the more valuable are the increased oil revenues S1 and the less important is the gap S2 between the welfare along the two patterns of growth 1 and 2. For economy with arbitrary characteristics, provided it is described by rudely the same picture of growth, it seems plausible to find a discount rate that, ceteris paribus, would provide any in advance specified relationship between the squares and thus the adversability or favorability of the effect from the price shock.

«Other disturbances» may imply, first of all, the domestic policies designed to eliminate the negative influence of the phenomenon. Rudely, these policies (adjustment of tax code) can themselves be thought of as shocks opposing that from rise in raw material prices.



The size of the shock originated by the government seems to affect the economy's welfare in the same as discount rate does: the greater is the change in raw material exports value the more likely it compensates for the relative handicap in development.

State tax policy is an appropriate long-run measure to deal with the undesirable slowing-down of the economic growth. Thus, the problem of compensating tax code reaction in an economy with the «Dutch Disease» can be stated.

In the paper, the set of possible government policies is restricted to the policy of subsidizing the manufacturing sector at the expense of taxing all the other industries of the economy. Moreover, the government can alter only two tax rates of many in use in those industries: the rate of investment subsidy in the manufacturing sector and the rate of excise in the resource extracting sector. All the other tax rates are suggested constant and equal to those in use in Russia.

The Master Thesis investigates the conditions under which short or long run benefits are preferable. The consideration proceeds within the framework of a model of three-sector endogenously growing economy, in which the equilibrium results from actions of three types of players: the producers in each sector, the consumers in the economy and the government, introduction of the latter being author's modification of the model introduced in Eismont and Kuralbaeva (1998).

The analysis is facilitated with numerical simplifications done on the basis of the Russian economy statistic figures.

The paper is organized as follows.

Part 2 contains a literature review.

Part 3 describes the model.

Part 4 presents some data and computations of several important parameters

Part 5 describes the estimation of effects from the price shock and government's interference.

Part 6 discusses the results and

Part 7 concludes.

PART 2. Literature review.

The several works, to which the present diploma must give acknowledgements, belong to two distinct areas of research: studies in the problem of the «Dutch Disease» and studies in taxation and its influence on growth.

Works on the «Dutch Disease» can broadly be divided into two groups: those that deal with short-term analysis and those that concentrate on the long-term effects of the problem. The overwhelming majority of papers belongs to the first group and analyzes short-to medium term effects of a boom in natural resource sector on the other sectors (usually, manufacturing and services) of an economy. A boom in natural resource sector, caused by rallies in world resource market, results in increased current prosperity of a country and subsequent increased demand for traded and non-traded goods. Since prices of traded goods are fixed internationally, this effect leads to rising prices of non-traded goods relative to traded ones, which results in labor and capital moving from traded into non-traded and resource sectors. Though these effects of squeezing out manufacturing sector may have some negative effects (e.g. structural unemployment in case of low labor mobility), in general, from the point of view of total wealth of a country, short-term effects of a «Dutch Disease» are positive, rather than negative.

However, the long-term consequences of the «Dutch Disease» may go beyond temporary unemployment. One of the surprising features of long-term patterns of the economic growth has been poor performance of resource-rich countries. There are many examples of these phenomena in the distant past (17-19 centuries), as well as in the relatively recent years (1970-1990). Though, long-term analysis of the «Dutch Disease» has been performed in a number of papers (Aarrestad, 1979; Dasgupta et al, 1978; Siebert, 1985) only recently this phenomenon has been given special treatment (Matsuyama, 1992; Sachs and Warner, 1995). While Matsuyama (1992) concentrates on the role of land in economic development, Sachs and Warner (1995) analyze the role of mineral resources. Sachs and Warner (1995) performed an extensive empirical cross-country research (which included about 100 countries) and obtained convincing arguments that per capita GDP growth is negatively correlated with the shares of mineral production and natural resource exports in GDP. Explanation of this phenomenon (i.e. relatively low rates of growth of per capita GDP in resource-rich countries) may lie in positive externality resulting from the accumulation of knowledge in the manufacturing sector through the process of learning-by-doing. Booming in the resource sector, followed by expansion of non-traded good sector, leaves manufacturing sector short of capital and labor and thus slows technical progress.

It should be noted that Russia differs from most resource exporting countries in that, it is, contrary to Middle East countries, a highly industrialized country, while, unlike Norway and UK, its manufacturing sector is not competitive not only on the world but also on domestic markets. These peculiarities of the Russian economy could result in even more adverse effects of the «Dutch Disease».

Recently, in the literature on economic growth, much attention has been paid to the determinants of the divergent development paths across countries. A part of research has been devoted to tracing differences in the development paths to differences in government policies.

Several examples, among others, of works on the quantitative effects of dynamic tax policies in a general equilibrium include Chamley(1981), King and Rebello(1990) and Jones, Manuelli and Rossi (1993).

These studies differ greatly in both the models they analyze and the types of fiscal experiments they undertake.

Chamley explores both marginal and global effects of tax changes in a model with exogenous growth and a representative agent.

King and Rebello consider the effects of policy changes in a simple model of endogenous growth and compare them to tax effects in an exogenous growth model.

Jones, Manuelli and Rossi examine two types of models of the process of growth. The first type of models views the government expenditure as exogenous for a planner. The second one is concerned with the government expenditure endogenous to the planner's problem.

The present paper is an effort to incorporate elements of both two streams of research, on the Dutch Disease and Taxation and Growth, into one problem, a problem of counteracting the adverse long-run effects of the «Dutch Disease » by means of taxation. The foundation for the research has been provided by the model of a three-sector economy with endogenous growth, presented in Eismont and Kuralbaeva (1998), thus having to be referred to as the major source among listed above.

PART 3. The model.

Section3.1. Tax system.

In the Russian Federation the most collectible taxes are pay–roll taxes, value-added tax, corporate tax and excises. The following is the official statistics figures (see [5], [6]).

	1992	1993	1994	1995	1996	1997
Payments of the Pension Fund, % GDP	6,3	5,9	5,9	4,7	5,2	5,8
VAT and excise collection, % GDP	11,1	6,9	5,9	5,5	-	6,6
Corporate tax collection, % GDP	8,9	11,5	7,8	7,5	-	1,3
Profit tax collection, % GDP	2,39	3	3	2,2	-	0,1

Figures on pay-roll tax collection are not available directly and one can judge about the weight of pay-roll taxes in tax revenues of the government in the following way.

If we assume that payments <u>of</u> the Pension Fund are approximately equal to payments <u>to</u> the Pension Fund and note that the former's rate is more than a half of pay-roll tax rate, we will see that the latter payments are quite noticeable.

From now on we denote taxes as follows (I -investments, p -price, $F(K,L)$ - output as a function of capital K and labor L):

v - Value-added tax (VAT): $$R_{VAT} = \frac{v}{1+v} pF(K,L)$$

γ - Corporate tax: $$R_{CT} = \gamma(pF(K,L) - wL - I)$$

s_I -Investment subsidy (if any; this subsidy may be present as a credit rather than a direct payment):

$$R^I_{sub} = -s_I I$$

τ_{WF} -Charges on wage fund (pay-roll taxes): $$R_{WF} = \tau_{WF} wL$$

e' -Excise: $$R_e = pF(K,L)\frac{e'}{1-e'} = e \bullet pF(K,L)$$

Thus, the profit of a representative producer becomes:

$$\pi = (\frac{1}{1+v} - \gamma - e)\{pF(K,L) - (1+\tau_L)wL - (1+\tau_I)I\},$$

where

$$\tau_L = \frac{\tau_{WF} + \frac{v}{1+v} + \gamma + e}{\frac{1}{1+v} - \gamma - e}$$

$$\tau_I = \frac{\frac{v}{1+v} + \gamma + e - s_I}{\frac{1}{1+v} - \gamma - e}$$

$$R_{Total} = R_{VAT} + R_{CT} + R_{WF} + R^e + R^I{}_{sub}$$

Note, that although there is no direct taxation of investment into production, the existence of VAT, excise and corporate taxes gives rise to effective indirect taxation of investment. Thus, the tax code can equivalently be represented by a set of effective profit tax and excise and taxes on labor and investment.

Section 3.2. Description of the model.

The Dutch Disease is modelled within the framework of a three-sector endogenously growing economy with a tax system. Two of these sectors produce tradeable goods whereas the other- a non-tradeable good. To introduce a certain interpretation to the model, these sectors are referred to as: raw materials sector (energy or simply E-sector), traditional manufacturing sector (M-sector) and services-producing sector (S-sector). All prices are measured in terms of M-sector goods. The output of E-sector is priced at a worldly set level, whereas S-sector production price is ruled by domestic supply and demand alignment.

The output of energy sector is entirely exported and the revenue is spent, also completely, on imports of manufacturing goods.

The economy is inhibited by identical consumers, represented by aggregated preferences over manufactures and service goods, producers in each sector and the government that charges taxes on producers.

Let us denote:

<u>Indice</u>:

M stands for manufacturing sector,

S- services' sector

E- energy, or resource, sector.

Production factors:

L- labor (for example, L_S stands for labor, employed in the service sector).

K- physical capital,

H- human capital,

I- investments.

Production functions:

$F_M = A_M K_M^{\alpha_M} (HL_M)^{1-\alpha_M}$ in manufacturing sector

$F_S = A_S (HL_S)^{\beta_S}$ in service sector

$F_E = A_E K_E^{\alpha_E}$ in energy sector

Tax rates:

e_E - excise

τ_L^M - effective labor tax rate in M-sector,

$$\tau_L^M = \frac{\tau_{WF} + \frac{v}{1+v} + \gamma}{\frac{1}{1+v} - \gamma}$$

τ_I^M - effective investment tax rate in M-sector,

$$\tau_I^M = \frac{\frac{v}{1+v} + \gamma - s_I}{\frac{1}{1+v} - \gamma}$$

τ_L^S - labor tax rate in S-sector, $\tau_L^S = \dfrac{\tau_{WF} + \frac{v}{1+v} + \gamma}{\frac{1}{1+v} - \gamma}$

τ_I^E - effective investment tax rate in E-sector,

$$\tau_I^E = \frac{\frac{v}{1+v} + \gamma + e_E}{\frac{1}{1+v} - \gamma - e_E}$$

Prices:

p_S, p_E - prices of services and resource goods correspondingly after VAT (in terms of manufactures).

ω - wage rate in the economy; the same for the entire economy due to perfect labor mobility.

r - exogenous international interest rate.

Agents in the economy:

The problem of the manufacturing producer:

$$\int_0^{\infty} (F_M - w(1+\tau_L^M)L_M - (1+\tau_I^M)I_M)e^{-rt}dt \longrightarrow \max_{I_M, L_M}$$

FOC

$$F'_K = r(1+\tau_I^M)$$
$$F'_L = w(1+\tau_L^M)$$

The problem of the service producer:

$$\int_0^{\infty} (p_S F_S - w(1+\tau_L^S)L_S)e^{-rt}dt \longrightarrow \max_{L_S}$$

FOC

$$p_S F'_L = w(1+\tau_L^S)$$

$L_M + L_S = L$ - labor constraint.

The problem of the resource producer:

$$\int_0^{\infty} (p_E F_E - (1+\tau_I^E)I_E)e^{-rt}dt \longrightarrow \max_{I_E}$$

FOC

$p_E F_K' = r(1+\tau_I^E)$

The problem of the consumer:

$$PVU = \int U e^{-rt} dt = \int_0^{\infty} M^a S^b e^{-rt} dt \longrightarrow \max_{M,S},$$

s.t. $$p_S S + M = (1-g)(F_M + p_E F_E + p_S F_S - I_E - I_M) \qquad (1')$$

M, S –consumption of services and manufactures correspondingly, U is the consumer's utility function (consumption is divided between consumers and the government in shares of $(1-g):g$).

$$S = F_S \qquad (2')$$

as services are non-tradeable.

FOC

$$M = \frac{a}{b} p_S S$$

FOC, (1') and (2') give:

$$p_S S = \frac{1-g}{\frac{a}{b}+g}(F_M + p_E F_E - I_M - I_E)$$

$$M = \frac{a}{b}\frac{1-g}{\frac{a}{b}+g}(F_M + p_E F_E - I_M - I_E)$$

The problem of the government:

$\sum TR$ -total government's tax revenue

$Y_{consumption} = F_M + p_E F_E + p_S F_S - I_E - I_M$ -output used for consumption

It is assumed that government has fixed-percentage-of-consumption expenditures:

$$G = gY_{consumption}$$

$$PVU \longrightarrow \max_{Some\ \ taxes}$$

s.t. $\sum TR = G$,

where

$$\sum TR = (\frac{1}{1+v} - \gamma)\left(F_M + p_S F_S + (\tau_L^M L_M + \tau_L^{\prime S} L_S)w + \tau_I^M I_M\right)$$

$$G = g(F_M + p_E F_E + p_S F_S - I_E - I_M)$$

Human capital accumulation:

$$\dot{H} = A_H K_M^{\alpha_H} (L_M H)^{1-\alpha_H}$$

Section 3.3. Solution.

After some manipulation, the following system of differential equations may be derived:

$$\begin{cases} \dot{K}_M = a_1 K_M - a_2 H + d \\ \dot{H} = b_1 K_M \end{cases} \qquad (3')$$

$$a_1 = \frac{r(1+\tau_I^M)}{\alpha_M} \left(1 + \frac{\frac{a}{b} + g}{1-g} \cdot \frac{1+\tau_L^S}{1+\tau_L^M} \cdot \frac{1-\alpha_M}{\beta_S} \right)$$

$$a_2 = \frac{\frac{a}{b} + g}{1-g} \cdot \frac{1+\tau_L^S}{1+\tau_L^M} \cdot \frac{1-\alpha_M}{\beta_S} A_M \left(\frac{\alpha_M A_M}{r} \right)^{\frac{\alpha_M}{1-\alpha_M}} L$$

$$b_1 = A_H \left(\frac{r(1+\tau_I^M)}{(1-\alpha_M) A_M} \right)^{\frac{1-\alpha_H}{1-\alpha_M}}$$

$$d = (p_E A_E)^{\frac{1}{1-\alpha_E}} \left(\frac{\alpha_E}{r(1+\tau_I^E)} \right)^{\frac{\alpha_E}{1-\alpha_E}}$$

System of differential equations (3') has the following solution:

$$\begin{cases} K_M = C_1 \eta e^{\eta t} + C_2 \mu e^{\mu t} \\ H = b_1 (C_1 e^{\eta t} + C_2 e^{\mu t}) + \dfrac{d}{a_2} \end{cases} \tag{1}$$

where

$$\eta = \frac{a_1}{2} + \sqrt{\frac{(a_1)^2}{4} - b_1 a_2}\,, \qquad \mu = \frac{a_1}{2} - \sqrt{\frac{(a_1)^2}{4} - b_1 a_2}$$

From economics it follows that root $\eta = \frac{a_1}{2} + \sqrt{\frac{(a_1)^2}{4} - b_1 a_2}$ is inappropriate (or technically, TVC does not hold). The selection of the root can be explained as follows. As it is implied by system (3’), the change in human capital is increasing in b_1, no matter what initial conditions are valid for a particular economy. But root η contradicts to this fact as it allows for the case when human capital decreases in b_1(for example, $C_1 = 1,\ C_2 = 0$) and thus it should be excluded. Therefore, the solution of the system of differential equations becomes:

$$\begin{cases} K_M = C \mu e^{\mu \cdot t} \\ H = b_1 C e^{\mu \cdot t} + \dfrac{d}{a_2}\,, \end{cases} \tag{2}$$

where $Cb_1 = H(0) - \dfrac{d}{a_2}$

Using functions in system (2), employment of production factors, investments and levels of production in three sectors of the economy can be determined.

$$I_E = 0$$

$$I_M = \frac{dK_M}{dt} = C\mu^2 e^{\mu \cdot t} \tag{3}$$

$$L_M = \left[\frac{r(1+\tau_I^M)}{\alpha_M A_M}\right]^{\frac{1}{1-\alpha_M}} \frac{C\mu e^{\mu \cdot t}}{Cb_1 e^{\mu \cdot t} + \frac{d}{a_2}} \tag{4}$$

$$F_M = C\mu e^{\mu \cdot t} \frac{r(1+\tau_I^M)}{\alpha_M} \tag{5}$$

$$\omega = \left(Cb_1 e^{\mu \cdot t} + \frac{d}{a_2}\right) \frac{1-g}{\frac{a}{b}+g} \frac{\beta_S a_2}{L(1+\tau_L^S)} \tag{6}$$

$$L_S = L - L_M = L - \left[\frac{r(1+\tau_I^M)}{\alpha_M A_M}\right]^{\frac{1}{1-\alpha_M}} \frac{C\mu e^{\mu \cdot t}}{Cb_1 e^{\mu \cdot t} + \frac{d}{a_2}} \tag{7}$$

$$p_S = \frac{A_M (1-\alpha_M)(1+\tau_L^S)}{A_S \beta_S (1+\tau_L^M)} \left[\frac{\alpha_M A_M}{r(1+\tau_I^M)}\right]^{\frac{\alpha_M}{1-\alpha_M}} \left[\frac{L}{a_2}\left(C\mu e^{\mu \cdot t}\left[\frac{r(1+\tau_I^M)}{\alpha_M} - \mu\right] + d\right)\right]^{1-\beta_S} \tag{8}$$

$$p_S F_S = \frac{1-g}{\frac{a}{b}+g}\left[C\mu e^{\mu \cdot t}\left(\frac{r(1+\tau_I^M)}{\alpha_M} + \mu\right) + d\right] \tag{9}$$

$$K_E = \frac{\alpha_E}{r(1+\tau_I^E)} d \tag{10}$$

$$p_E F_E = \frac{r(1+\tau_I^E)}{\alpha_E}\left[\frac{p_E \alpha_E A_E}{r(1+\tau_I^E)}\right]^{\frac{1}{1-\alpha_E}} = d \tag{11}$$

As the energy sector does not use human capital and does not enjoy investments, its production does not rise with time, while the manufacturing and service outputs increase exponentially.

It is useful to note that

$$\frac{I_M}{F_M} = \mu \frac{\alpha_M}{r(1+\tau_I^M)} \quad \text{and thus} \quad \mu = \frac{I_M(t)}{F_M(t)} \frac{r(1+\tau_I^M)}{\alpha_M} \tag{12}$$

The government's objective function (which is equilibrium derived utility function of consumers in the economy) $U = M^a S^b$ can be obtained from expressions (4)-(11):

$$U = \left(\frac{a}{b} \frac{1-g}{\frac{a}{b}+g} \right)^{a+b} \left[\left(\frac{a_2}{L} \right)^{1-\beta_S} \frac{A_S \beta_S (1+\tau_L^M)}{A_M (1-\alpha_M)(1+\tau_L^S)} \left(\frac{r(1+\tau_I^M)}{\alpha_M A_M} \right)^{\frac{\alpha_M}{1-\alpha_M}} \right]^b \bullet \tag{13}$$

$$\bullet \left[C\mu e^{\mu \cdot t} \left(\frac{r(1+\tau_I^M)}{\alpha_M} - \mu \right) + d \right]^{a+b\beta_S} \xrightarrow[taxes]{} \max$$

Denoting

$$\overline{U} = \left(\frac{a}{b} \frac{1-g}{\frac{a}{b}+g} \right)^{a+b} \tag{14}$$

$$\left[\left(\frac{a}{b} \frac{1-g}{\frac{a}{b}+g} \frac{1+\tau_L^S}{1+\tau_L^M} \frac{1-\alpha_M}{\beta_S} A_M \right)^{1-\beta_S} \left(\frac{r}{\alpha_M A_M} \right)^{\beta_S b \frac{\alpha_M}{1-\alpha_M}} \frac{A_S \beta_S (1+\tau_L^M)}{A_M (1-\alpha_M)(1+\tau_L^S)} \left(\frac{r(1+\tau_I^M)}{\alpha_M A_M} \right)^{\frac{\alpha_M}{1-\alpha_M}} \right]^b$$

we can rewrite the complicated expression for the utility function above as follows

$$U = \overline{U} \cdot \left[C\mu e^{\mu \cdot t} \left(\frac{r(1+\tau_I^M)}{\alpha_M} - \mu \right) + d \right]^{a+b\beta_S} (1+\tau_I^M)^{\beta_S b \frac{\alpha_M}{1-\alpha_M}}, \tag{15}$$

where $\overline{U}$ does not depend on excise in energy sector and investment tax in manufacturing sector.

The government budget constraint is a complicated expression. We postpone the determination of the budget constraint till PART 5.

Subject to the postponed constraint, the government maximizes the integral:

$$PVU = \int_0^\infty \overline{U} \bullet \left[C\mu e^{\mu \cdot t} \left(\frac{r(1+\tau_I^M)}{\alpha_M} - \mu \right) + d \right]^{a+b\beta_S} (1+\tau_I^M)^{\beta_S b \frac{\alpha_M}{1-\alpha_M}} e^{-r \cdot t} dt \tag{16}$$

Necessary and sufficient convergency condition for this integral is

$$\mu(a + b\beta_S) - r < 0 \quad (17)$$

Denoting $\Delta = a + b\beta_S$ we rewrite it as $\mu\Delta - r < 0$ (18)

PART4. Estimation of key parameters on the basis of the Russian statistic figures.

1.) Elasticities of labor in M- and S-sectors and utility function elasticity.

These values were determined in Master Thesis by Natalia Cybuleva, NES graduate 1998. She found that

$1 - \alpha_M = 0.25$ in M-sector

$\beta_S = 0.30$ in S-sector.

$\frac{a}{b} \approx 0.9$ It is assumed further that $a + b = 1$, so $a \approx 0.47$, $b \approx 0.53$

The author could not find the value of α_H (elasticity of $\dot{H}$ with respect to K_M) for the Russian economy so that the value of this parameter for the US economy has been used.

As it is suggested in Jones, Manuelli and Rossi (1993), $\alpha_H \approx 0.36$.

2.) Taxes.

Tax rates are set up by the Federal government and currently have the following values (this data was obtained from Milyakov (1998)):

Corporate profit tax 35%: $\gamma = 0.35$

Value-added tax 20%: $v = 0.2$

Payroll tax 38%: $\tau_{WF} = 0.38$

Excise rates:

Gas 30%:

Oil 20 ECU per 1 tonn

Excise on oil should thus be recalculated in an equivalent percentage rate. For this to exert one should know values of world oil prices and exchange rates of ECU versus US dollar. In the model it was accepted that in 1997

1 ECU~1.1 US dollar

$\Pr ice_{OIL} \approx \$14 / barr = \$100 / tonn$

$\Pr ice_{GAS} \approx \$22 / tonn$

Thus, equivalent percentage excise on oil is

$100 \dfrac{e}{100 - e} = 22$, and $\qquad e = 18\%$

Now, the calculation of aggregate excise on oil and gas, with the use of oil and gas export data, can be provided.

$Export_{OIL} = \$13 \quad billion$

$Export_{GAS} = \$10,7 \quad billion$

$$(13,0 + 10,7) \frac{e_E}{100 - e_E} = 13,0 \frac{e_{OIL}}{100 - e_{OIL}} + 10,7 \frac{e_{GAS}}{100 - e_{GAS}}$$

$e_E = 24\%$, or in decimals, $e_E = 0.24$

It is feasible now to find effective tax rates (using formulae of Sections 3.1 and 3.2):

$\tau_L^M = 1,85$

$\tau_L^S = 1,85$

$\tau_I^M = 1,07$

$\tau_I^E = 3,10$

$e \quad = 0.32$

3.) Rate of manufacturing sector growth.

From formula (12) it can be seen that $\mu = \frac{I_M(t)}{F_M(t)} \frac{r(1+\tau_I^M)}{\alpha_M}$, where I_M is investments in M-sector and F_M is production in M-sector. Thus, one can determine rate of manufacturing sector growth. According to 1997 investments data,

$$I_M = I_{TOTAL} - I_E - I_S = Rb(408{,}8 - 52{,}7 - 163{,}5) billion \quad Roubles$$

$$I_M = 192{,}3 \quad billion \quad Roubles$$

$$F_M = 1456 \quad billion \quad Roubles$$

Thus,

$$\mu = 0.36 \cdot r$$

It is also useful to calculate parameter a_1:

$$a_1 = \frac{r(1+\tau_I^M)}{\alpha_M} \left(1 + \frac{\frac{a}{b} + g}{1-g} \cdot \frac{1+\tau_L^S}{1+\tau_L^M} \cdot \frac{1-\alpha_M}{\beta_S} \right) = 3.05 r(1+\tau_I^M) = 6.31r$$

4.) Parameters in $\frac{\partial PVU}{\partial d}$ (for use in Section6.1.)

From export statistics for 1997 it can be found that:

$$p_E F_E = Export_{OIL} + Export_{GAS} = \$23{,}7 \quad billion \approx 120 \quad billion \quad Roubles$$

$$k_1 = \frac{p_E F_E(0)}{F_M(0) - I_M(0)} = 0.095$$

$$k_2 = \frac{F_M(0) - I_M(0)}{F_M(0) \left(1 + \frac{\frac{a}{b} + g}{1-g} \frac{1+\tau_L^S}{1+\tau_L^M} \frac{1-\alpha_M}{\beta_S} \right) - I_M(0)} = 0.405$$

5.) Convergency of integrals $PVU \quad and \quad \frac{\partial PVU}{\partial d}$

$\Delta = a + b\beta_S = 0.63$

Convergency condition reads: $\Delta\mu - r < 0$.

In case of Russia ($0.63 \cdot 0.36 \cdot r - r < 0$) this condition holds.

PART 5. Estimation of welfare effects from the price shock and government policy.

Before proceeding to calculations, several remarks are worth making.

The effect from a price shock is found from the determination of derivative's sign $\mathrm{sgn}(\frac{\partial PVU}{\partial d})$ (d stays for the resource extracting sector output, PVU - for present value of utility), on the plane $[\frac{\mu}{r}, k_1]$, where $\frac{\mu}{r}$ - is the rate of growth of manufacturing sector in units of interest rate, (0.36 for Russia), k_1 - initial ratio of extracting sector output to manufacturing sector output.

In the paper, the set of possible government policies is restricted to the policy of subsidizing the manufacturing sector at the expense of taxing all the other industries of the economy. Moreover, the government can alter only two tax rates of many introduced by the government in these industries: the rate of investment subsidy in the manufacturing sector and the rate of excise in the resource extracting sector. All the other tax rates are suggested constant and equal to those in use in Russia.

The choice of capital as a factor to subsidize stems from the following speculation.

First, it should be noted that the assumed assymetry between capital and labor, namely, potentially boundless amount of the former and scarcity of the latter, dissappears when the associated production costs are considered: constrained labor is hired at the expense of exponentially rising wages while increasing amount of capital is rented at internationally fixed interest rates, so that the capital-to-labor cost ratio remains nearly constant, and it makes no difference for the government which factor to support, as far as the order of magnitude of the help package is concerned.

Second, numerical simplification is not available for the case of labor subsidization, because one needs to know the relative productivities of manufacturing and service sectors A_M and A_S. These figures are difficult to obtain from official statistic reference editions and determination of them requires a separate investigation.

In the study of subsidy s_I^M effect on PVU, the link between s_I^M and effective excise rate e (via government's budget constraint) and dependency of $\frac{\mu}{r}$ on s_I^M should be taken into account. In subsections 5.1 and 5.2 below, the necessary calculations are provided to determine the regions in the plane $[\frac{\mu}{r}, k_1]$, where the derivative $\frac{\partial \ PVU}{\partial \ d}$ keeps its sign, and to find out the behavior of PVU as a function of s_I^M.

Section 5.1. Price shock.

The question of whether present value of utility falls or rises when prices for oil increase (d rises) is now explored.

For this purpose, it is convenient to look at the derivative of PVU with respect to value of raw material production d.

According to conducted calculations,

$$\frac{\partial PVU}{\partial d} = (a + b\beta_S)\overline{U}\left[C\mu\left(\frac{r(1+\tau_I^M)}{\alpha_M} - \mu\right)\right]^{a+b\beta_S-1}(1+\tau_I^M)^{\beta_S b\frac{\alpha_M}{1-\alpha_M}} \bullet$$

$$\bullet \int_0^\infty \left(e^{\mu\cdot t} + k_1\right)^{a+b\beta_S-1}\left(1 - k_2 e^{\mu\cdot t}\right)e^{-r\cdot t}dt \quad , \tag{19}$$

where

$$k_1 = \frac{d}{C\mu\left[\frac{r(1+\tau_I^M)}{\alpha_M} - \mu\right]} \tag{20}$$

$$k_2 = \frac{C\mu\left[\frac{r(1+\tau_I^M)}{\alpha_M} - \mu\right]}{C\mu\frac{r(1+\tau_I^M)}{\alpha_M}\left(1 + \frac{\frac{a}{b}+g}{1-g}\frac{1+\tau_L^S}{1+\tau_L^M}\frac{1-\alpha_M}{\beta_S}\right) - \mu} \tag{21}$$

(20) and (21) may be rewritten as

$$k_1 = \frac{p_E F_E}{F_M(0) - I_M(0)} \tag{22}$$

$$k_2 = \frac{F_M(0) - I_M(0)}{F_M(0)\left(1 + \frac{\frac{a}{b}+g}{1-g}\frac{1+\tau_L^S}{1+\tau_L^M}\frac{1-\alpha_M}{\beta_S}\right) - I_M(0)} \tag{23}$$

Equivalently, using (12) to express I_M yields for k_2 k

$$k_2 = \frac{F_M(0) - F_M(0)\frac{\mu}{r}\frac{\alpha_M}{1+\tau_I^M}}{F_M(0)\left(1 + \frac{\frac{a}{b}+g}{1-g}\frac{1+\tau_L^S}{1+\tau_L^M}\frac{1-\alpha_M}{\beta_S}\right) - F_M(0)\frac{\mu}{r}\frac{\alpha_M}{1+\tau_I^M}} \tag{24}$$

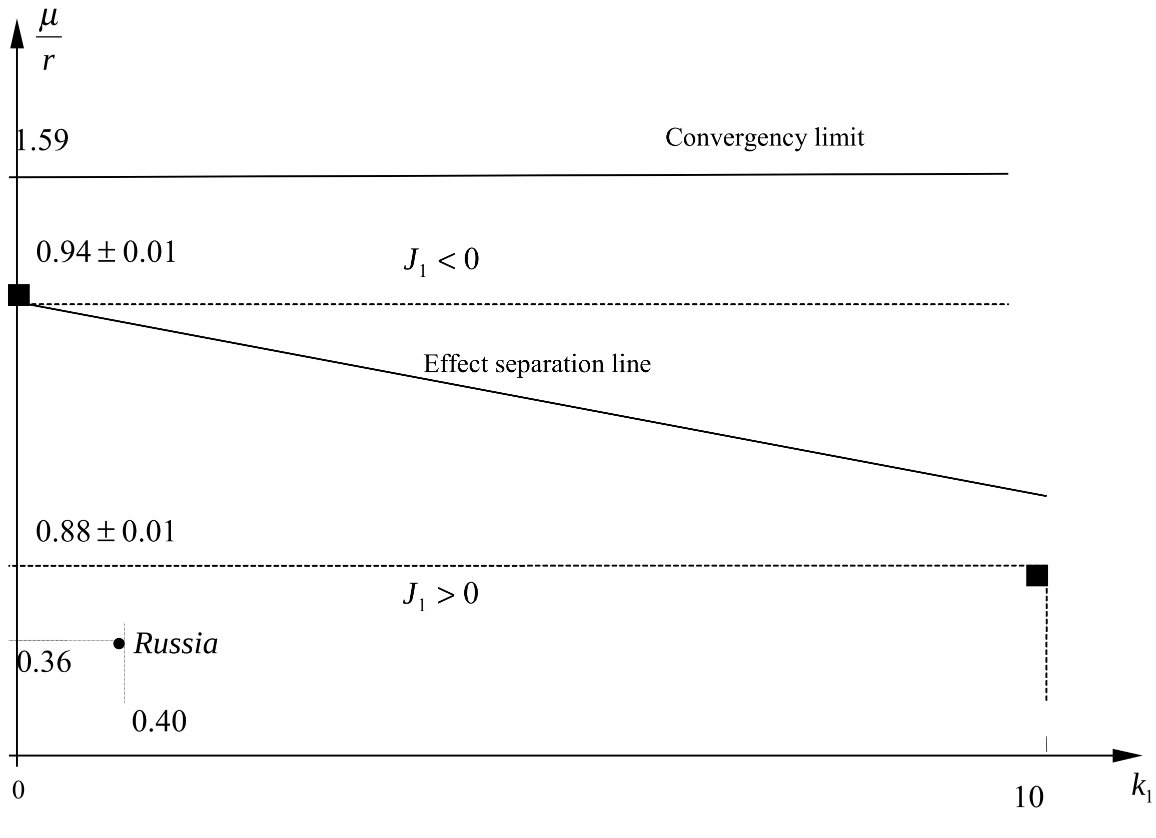
Integral in (19)

$$J_1 = \int_0^\infty \left(e^{\mu\cdot t} + k_1\right)^{a+b\beta_S-1}\left(1 - k_2 e^{\mu\cdot t}\right)\cdot e^{-r\cdot t}dt \tag{25}$$

with the use of variable substitution $x = e^t$ and expression for k_2(24), can be transformed into form:

$$J_1 = \int_1^{\infty} \left(x^{\frac{\mu}{r}} + k_1 \right)^{a+b\beta_S-1} \left(1 - \frac{1 - \frac{\mu}{r}\frac{\alpha_M}{1+\tau_I^M}}{\left(1 + \frac{a}{b} \frac{\frac{a}{b}+g}{1-g} \frac{1+\tau_L^S}{1+\tau_L^M} \frac{1-\alpha_M}{\beta_S} \right) - \frac{\mu}{r}\frac{\alpha_M}{1+\tau_I^M}} x^{\frac{\mu}{r}} \right) \frac{dx}{x^2} \qquad (26)$$

The following result is obtained for the sign of J_1:



Next section represents the techniques and results of estimating the effect on PVU from investment subsidy.

Section 5.2. Investment subsidy.

In its regulation of excise and subsidy rates the government is restricted by the budget constraint ($\sum tax\ revenues = total\ \exp enditure$):

$$R_E + R_M + R_S = G \qquad (27),$$

where

$$R_E = \frac{v}{1+v} p_E F_E + \gamma\left(p_E F_E\right) + e p_E F_E = \left(\frac{v}{1+v} + \gamma + e\right) p_E F_E \qquad (28)$$

$$R_M = \frac{v}{1+v} F_M + \gamma\left(F_M - wL_M - I_M\right) + \tau_{WF} wL_M - s_I^M I_M = \frac{v}{1+v} F_M + \tau_{WF} wL_M - s_I^M I_M \qquad (29)$$

$$R_S = \frac{v}{1+v} F_S + \gamma\left(p_S F_S - wL_S\right) + \tau_{WF} wL_S \qquad (30)$$

$$G = g(F_M + p_E F_E + p_S F_S - I_M)$$

The substitution of corresponding functions of time for the expressions in the right parts of (28)-(30) yields for (27):

$$f_1 d + ed + \left[f_2(1+\tau_I^M)r - f_3\mu\right] C\mu \cdot e^{\mu \cdot t} = 0 \qquad (31)$$

$$f_1 = \frac{v}{1+v}\frac{1}{a} + \gamma\frac{1-b\beta}{a} + \frac{bA}{a}\frac{\beta_S}{1+\tau_L^S}\tau_{WF} - \frac{g}{a} = 0.461$$

$$f_2 = \frac{bA}{a}\frac{\beta_S}{1+\tau_L^S}\tau_{WF}\frac{1}{\alpha_M}\left(1 + \frac{a}{bA}\frac{1+\tau_L^S}{1+\tau_L^M}\frac{1-\alpha_M}{\beta}\right) + \frac{v}{1+v}\frac{1}{a\alpha_M} + \gamma(1-\beta)\frac{b}{a\alpha_M} - \frac{g}{a\alpha_M} = 0.137$$

$$f_3 = \frac{bA}{a}\frac{\beta_S}{1+\tau_L^S}\tau_{WF} + \frac{b}{a}\frac{v}{1+v} + \gamma(1-\beta_S)\frac{b}{a} - g\frac{b}{a} = 0.275, \text{ where } A \equiv \frac{\frac{a}{b}+g}{1-g}.$$

Having the freedom to alter the rates of excise e and investment subsidy s_I^M, the government may betake to the following policies:

1. e=const, s_I^M changes with time;
2. e changes with time, s_I^M=const;
3. both e and s_I^M change with time.

Case 3 corresponds to the problem of maximizing PVU over the set of time-depending e(t) and s_I^M(t). This problem is too complicated for the present paper and is not considered here.

Of cases 1 and 2 the latter is more convenient for computations as μ, which depends on s_I^M and enters the budget constraint in the power of the exponent, turns then constant. It is the case that is studied in the paper.

The solution of system (3') was facilitated by the assumption of constant resource extracting sector output. But this assumption stops to be valid as long as the excise rate is variable (as it is dictated by the choice of case 2. above). Then all the obtained expressions for outputs in sectors of the economy, capital and labor employment in these sectors and tax revenues turn incorrect, and the problem of determination of tax influence on PVU turns depending on agents' expectations of government's tax policy.

To settle this difficulty it is sufficient to assume that agents in the economy have simple expectations. In case of Russia it seems well justified that the agents at any moment in time do not even attempt to foresee the policy dynamics and consider its current characteristics as valid once-and-forever. Then, the expressions just mentioned still remain valid.

5.2.1 Dependency of C on subsidy s, initial size of resource extracting sector k_1 and initial rate of growth of manufacturing sector $\left(\frac{\mu}{r}\right)_0$.

The value of C, entering budget constraint (31), depends on initial excise rate and investment subsidy rate. It is assumed that at «zero» moment of time the government's budget can be not balanced and initial excise and subsidy rates are equal to rates accepted in Russia. Next year, the budget balance is established and the excise rate is computed in accordance with (31). From these assumptions it follows that C can be found as follows.

$$C(s_M^I = 0) \equiv \frac{H_0}{b_1(s_M^I = 0)} - \frac{d\left(e = e_{t=0}\right)}{b_1 a_2 (s_M^I = 0)}. \tag{32}$$

This expression allows to determine H_0, which depends neither on s_M^I, nor on e(t=0):

$$H_0 = b_1(s_M^I = 0)\left(C(s_M^I = 0) + \frac{d(e = e_{t=0})}{a_2 b_1 (s_M^I = 0)} \right) \tag{33}$$

$b_1 a_2 \equiv \mu(a_1 - \mu)$, by definition of μ. Taking an advantage of this circumstance as well as of expression (33), one can rewrite (32) as follows:

$$C(s_M^I = s) = \frac{b_1(s_M^I = 0)}{b\ (s_M^I = s)}\left(C(s_M^I = 0) \cdot + \frac{d(e = e_{t=0})}{\mu(s_M^I = 0)\left(a_1 - \mu(s_M^I = 0)\right)} \right) - \frac{d(e = e_t)}{\mu(s_M^I = s)\left(a_1 - \mu(s_M^I = s)\right)}$$

The other step necessary to find the dependency C(s) is computing $\mu(s_M^I = s)$. By definition,

$$\mu = \frac{a_1}{2} - \sqrt{\left(\frac{a_1}{2}\right)^2 - b_1 a_2}\ . \tag{34}$$

Substituting in (34) expressions for a_1, a_2 and b_1, in which the dependencies on s_M^I are highlighted, yields ($s_M^I = s$):

$$\frac{\mu}{r} = \frac{w_1(1-s)}{2} - \sqrt{\left(\frac{w_1}{2}\right)^2 (1-s)^2 - w_2 (1-s)^{\frac{1-\alpha_H-\alpha_M}{1-\alpha_M}}}\ , \tag{35}$$

where

$$w_1 = \frac{1}{\alpha_M\left(\frac{1}{1+v} - \gamma\right)}\left(1 + \frac{\frac{a}{b} + g}{1-g}\,\frac{1-\alpha_M}{\beta_S} \right) = 6.7,$$

$$w_2 = \frac{\frac{a}{b} - g}{1-g}\,\frac{1+\tau_L^S}{1+\tau_L^M}\,\frac{1-\alpha_M}{\beta_S \cdot r^2} A_M A_H \left(\frac{\alpha_M^{\alpha_M} \cdot A_M^{\alpha_M+\alpha_H-1}}{(1-\alpha_M)^{(1-\alpha_M)} r^{\alpha_M+\alpha_H-1}} \right)^{\frac{1}{1-\alpha_M}} \cdot L$$

Because of date insufficiency, it seems not unfeasible to compute w_2 numerically (A_H is not available), that is why (35) can be used in an indirect manner:

$$\frac{\mu}{r}-\frac{w_1(1-s)}{2}=-\sqrt{\left(\frac{w_1}{2}\right)^2(1-s)^2-w_2(1-s)^{\frac{1-\alpha_H-\alpha_M}{1-\alpha_M}}}$$

$$\left(\frac{\mu}{r}-\frac{w_1(1-s)}{2}\right)^2=\left(\frac{w_1}{2}\right)^2(1-s)^2-w_2(1-s)^{\frac{1-\alpha_H-\alpha_M}{1-\alpha_M}}$$

$$\left(\frac{\mu}{r}-\frac{w_1(1-s)}{2}\right)^2-\left(\frac{w_1}{2}\right)^2(1-s)^2=-w_2(1-s)^{\frac{1-\alpha_H-\alpha_M}{1-\alpha_M}}$$

$$\frac{\left(\frac{\mu}{r}-\frac{w_1(1-s)}{2}\right)^2-\left(\frac{w_1}{2}\right)^2(1-s)^2}{(1-s)^{\frac{1-\alpha_H-\alpha_M}{1-\alpha_M}}}=-w_2 \qquad (36)$$

(36) is valid for any pair of $\frac{\mu}{r},s$, corresponding to each other, and w_2 is a constant:

$$\frac{\left(\frac{\mu}{r}-\frac{w_1(1-s)}{2}\right)^2-\left(\frac{w_1}{2}\right)^2(1-s\ )^2}{(1-s\ )^{\frac{1-\alpha_H-\alpha_M}{1-\alpha_M}}}\equiv -w_2\equiv\frac{\left(\left(\frac{\mu}{r}\right)_0-\frac{w_1(1-s_0)}{2}\right)^2-\left(\frac{w_1}{2}\right)^2(1-s_0)^2}{(1-s_0)^{\frac{1-\alpha_H-\alpha_M}{1-\alpha_M}}}$$

Assuming that $\frac{\mu}{r}(s_M^I=0)=\left(\frac{\mu}{r}\right)_0$, the solution of this quadratic equation above yields ($s_0=0$):

$$\frac{\mu}{r}(s)=\frac{1-s}{2}\left(6.7\pm\sqrt{44.89+4\cdot(1-s)^{-2.44}\left[\left(\frac{\mu}{r}\right)_0^2(1-s)^{0.44}-6.7\cdot\left(\frac{\mu}{r}\right)_0(1-s)^{1.44}\right]}\right)$$

The logic, used in root selection while solving system (3’), dictates that the «+» root should be omitted:

$$\frac{\mu}{r}(s)=\frac{1-s}{2}\left(6.7-\sqrt{44.89+4\cdot(1-s)^{-2.44}\left[\left(\frac{\mu}{r}\right)_0^2(1-s)^{0.44}-6.7\cdot\left(\frac{\mu}{r}\right)_0(1-s)^{1.44}\right]}\right) \tag{37}$$

Thus, the dependency C(s) is now determined:

$$C(s)=\frac{b_1(0)}{b_1(s)}\left(C(0)+\frac{d(e_{t=0})}{\mu(0)\left(a_1-\mu(0)\right)}\right)-\frac{d(e_{t=0})}{\mu(s)\left(a_1-\mu(s)\right)}$$

$$C(s)=\frac{1}{(1-s)^{\frac{1-\alpha_H}{1-\alpha_M}}}\left(C(0)+\frac{d(e_{t=0})}{\mu(0)\left(a_1-\mu(0)\right)}\right)-\frac{d(e_{t=0})}{\mu(s)\left(a_1-\mu(s)\right)} \tag{38}$$

Everywhere C enters the formulae only in combination $C\mu^2(s)$:

$$C(s)\mu^2(s)=\frac{\mu^2(s)}{\mu^2(0)}\frac{1}{(1-s)^{\frac{1-\alpha_H}{1-\alpha_M}}}\left(C(0)\mu^2(0)+\frac{d(e_{t=0})\mu^2(0)}{\mu(0)\left(a_1-\mu(0)\right)}\right)-\frac{d(e_{t=0})\mu^2(s)}{\mu(s)\left(a_1-\mu(s)\right)} \tag{39}$$

The latter expression, together with (37)

$$\frac{\mu}{r}(s)=\frac{1-s}{2}\left(6.7-\sqrt{44.89+4\cdot(1-s)^{-2.44}\left[\left(\frac{\mu}{r}\right)_0^2(1-s)^{0.44}-6.7\cdot\left(\frac{\mu}{r}\right)_0(1-s)^{1.44}\right]}\right),$$

allows finding C for different growth rates $\left(\frac{\mu}{r}\right)_0$ and subsidies s.

Below, the investment subsidy influence on PVU will be studied for several different pairs of parameters $k_1=\frac{d(t=0)}{C\mu\left[\frac{r(1+\tau_M^I)}{\alpha_M}-\mu\right]_{S=0}}$ (i.e. initial relative size of resource extracting sector) and $\left(\frac{\mu}{r}\right)_0$ (initial growth rate of manufacturing sector).

5.2.2 Excise dynamics determination under the condition of balanced budget.

Now that the functions $\frac{\mu}{r}\left[s,\left(\frac{\mu}{r}\right)_0\right]$ and $C\left[s,\left(\frac{\mu}{r}\right)_0,k_1\right]$ are found, it is possible to solve equation (31) with respect to excise rate. Preliminarily, it is convenient to transform the equation as follows:

$$f_1 d + ed + \left[f_2(1+\tau_I^M)r - f_3\mu\right]C\mu\cdot e^{\mu\cdot t} = 0$$

$$f_1 d + \left(\frac{1}{1+v}-\gamma\right)d - \left(\frac{1}{1+v}-\gamma\right)d + ed + \left[f_2(1+\tau_I^M)r - f_3\mu\right]C\mu\cdot e^{\mu\cdot t} = 0$$

$$\left(f_1 + \left(\frac{1}{1+v}-\gamma\right)\right)d - \left(\frac{1}{1+v}-\gamma-e\right)d + \left[f_2(1+\tau_I^M)r - f_3\mu\right]C\mu\cdot e^{\mu\cdot t} = 0 \tag{40}$$

By definition of d,

$$d = \left(p_E A_E\right)^{\frac{1}{1-\alpha_E}}\left(\frac{\alpha_E}{r}\right)^{\frac{\alpha_E}{1-\alpha_E}}\left(\frac{1}{1+\tau_E^I}\right)^{\frac{\alpha_E}{1-\alpha_E}}.$$

$d \equiv \bar{d}\cdot\left(\frac{1}{1+v}-\gamma-e(t)\right)^{\frac{\alpha_E}{1-\alpha_E}}$, where $\bar{d} \equiv \left(p_E A_E\right)^{\frac{1}{1-\alpha_E}}\left(\frac{\alpha_E}{r}\right)^{\frac{\alpha_E}{1-\alpha_E}}$. Then (40) turns into

$$\left(f_1 + \left(\frac{1}{1+v}-\gamma\right)\right)\bar{d}\left(\frac{1}{1+v}-\gamma-e(t)\right)^{\frac{\alpha_E}{1-\alpha_E}} - \left(\frac{1}{1+v}-\gamma-e(t)\right)\bar{d}\left(\frac{1}{1+v}-\gamma-e(t)\right)^{\frac{\alpha_E}{1-\alpha_E}} +$$
$$+\left[f_2(1+\tau_I^M)r - f_3\mu\right]C\mu\cdot e^{\mu\cdot t} = 0$$

$$\left(f_1 + \left(\frac{1}{1+v}-\gamma\right)\right)\bar{d}\left(\frac{1}{1+v}-\gamma-e(t)\right)^{\frac{\alpha_E}{1-\alpha_E}} - \bar{d}\left(\frac{1}{1+v}-\gamma-e(t)\right)^{\frac{1}{1-\alpha_E}} + \left[f_2(1+\tau_I^M)r - f_3\mu\right]C\mu\cdot e^{\mu\cdot t} = 0$$

$$\left(f_1 + \left(\frac{1}{1+v}-\gamma\right)\right)d(0)\left(\frac{\frac{1}{1+v}-\gamma-e}{\frac{1}{1+v}-\gamma}\right)^{\frac{\alpha_E}{1-\alpha_E}} - d(0)\left(\frac{\frac{1}{1+v}-\gamma-e}{\frac{1}{1+v}-\gamma}\right)^{\frac{1}{1-\alpha_E}} +$$
$$+\left[f_2(1+\tau_I^M)r - f_3\mu\right]C\mu\cdot e^{\mu\cdot t} = 0$$

Highlighting k_1 yields

$$d(0)\left\{\left(f_1+\left(\frac{1}{1+v}-\gamma\right)\right)\left(\frac{\frac{1}{1+v}-\gamma-e}{\frac{1}{1+v}-\gamma}\right)^{\frac{\alpha_E}{1-\alpha_E}}-\left(\frac{\frac{1}{1+v}-\gamma-e}{\frac{1}{1+v}-\gamma}\right)^{\frac{1}{1-\alpha_E}}\right\}+$$

$$+\left[f_2(1+\tau_I^M)r-f_3\mu\right]C\mu\cdot e^{\mu\cdot t}=0$$

$$\frac{d(0)}{C\mu^2\left[\frac{r(1+\tau_M^I)}{\mu\cdot\alpha_M}-1\right]}\left\{\left(f_1+\left(\frac{1}{1+v}-\gamma\right)\right)\left(\frac{\frac{1}{1+v}-\gamma-e}{\frac{1}{1+v}-\gamma}\right)^{\frac{\alpha_E}{1-\alpha_E}}-\left(\frac{\frac{1}{1+v}-\gamma-e}{\frac{1}{1+v}-\gamma}\right)^{\frac{1}{1-\alpha_E}}\right\}+$$

$$+\frac{1}{\frac{r(1+\tau_M^I)}{\mu\cdot\alpha_M}-1}\left[f_2(1+\tau_I^M)\frac{r}{\mu}-f_3\right]\cdot e^{\mu\cdot t}=0$$

$$k_1\frac{C(0)\mu^2(0)}{C(s)\mu^2(s)}\frac{\left[\frac{r(1+\tau_M^I)}{\mu(0)\cdot\alpha_M}-1\right]}{\left[\frac{r(1+\tau_M^I)}{\mu(s)\cdot\alpha_M}-1\right]}\left\{\left(f_1+\left(\frac{1}{1+v}-\gamma\right)\right)\left(\frac{\frac{1}{1+v}-\gamma-e}{\frac{1}{1+v}-\gamma}\right)^{\frac{\alpha_E}{1-\alpha_E}}-\left(\frac{\frac{1}{1+v}-\gamma-e}{\frac{1}{1+v}-\gamma}\right)^{\frac{1}{1-\alpha_E}}\right\}+$$

$+\frac{1}{\frac{r(1+\tau_M^I)}{\mu(s)\cdot\alpha_M}-1}\left[f_2(1+\tau_I^M)\frac{r}{\mu}-f_3\right]\cdot e^{\mu\cdot t}=0$. Here $1+\tau_E^I=\frac{1}{\frac{1}{1+v}-\gamma-e}$, and that is why

$$k_1 \frac{C(0)\mu^2(0)}{C(s)\mu^2(s)} \frac{\left[\dfrac{\dfrac{r}{\mu(0)}(1-s)}{\alpha_M\left(\dfrac{1}{1+v}-\gamma\right)}-1\right]}{\left[\dfrac{\dfrac{r}{\mu(s)}(1-s)}{\alpha_M\left(\dfrac{1}{1+v}-\gamma\right)}-1\right]} \left\{\left(f_1+\left(\frac{1}{1+v}-\gamma\right)\right)\left(\frac{\dfrac{1}{1+v}-\gamma-e(t)}{\dfrac{1}{1+v}-\gamma}\right)^{\frac{\alpha_E}{1-\alpha_E}} - \left(\frac{\dfrac{1}{1+v}-\gamma-e(t)}{\dfrac{1}{1+v}-\gamma}\right)^{\frac{1}{1-\alpha_E}}\right\}+$$

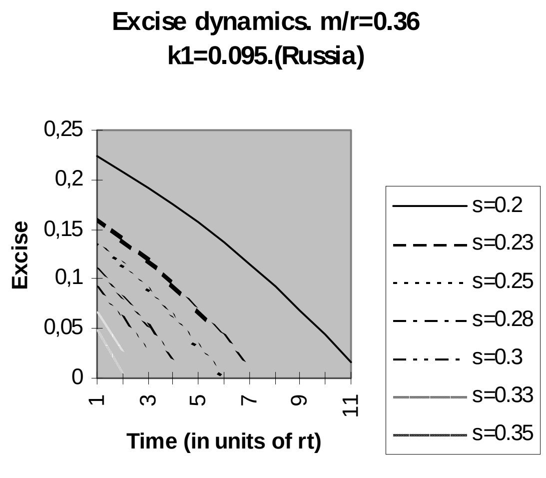
$$+\frac{1}{\dfrac{\dfrac{r}{\mu(s)}(1-s)}{\alpha_M\left(\dfrac{1}{1+v}-\gamma\right)}-1}\left[f_2 \frac{1-s}{\dfrac{1}{1+v}-\gamma}\frac{r}{\mu}-f_3\right]\cdot e^{\mu\cdot t}=0 \qquad (41)$$

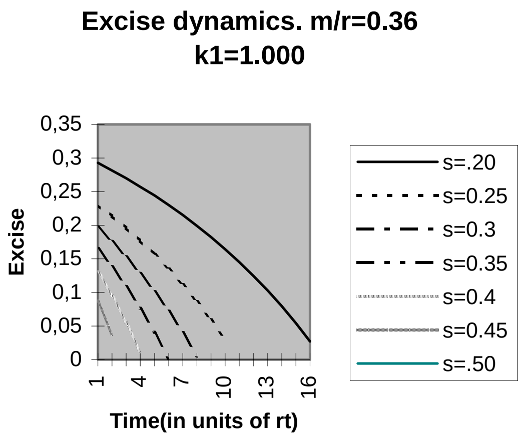
Together with already usual add-on (37)

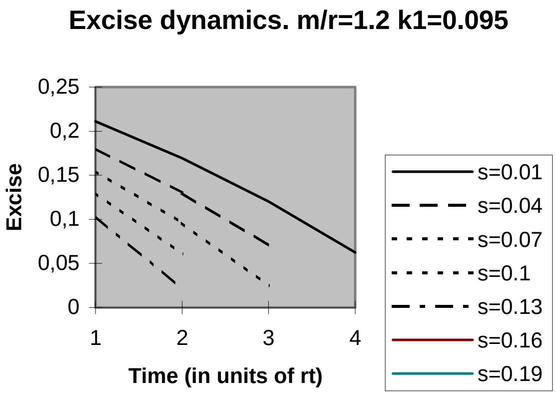
$$\frac{\mu}{r}(s)=\frac{1-s}{2}\left(6.7-\sqrt{44.89+4\cdot(1-s)^{-2.44}\left[\left(\frac{\mu}{r}\right)_0^2(1-s)^{0.44}-6.7\cdot\left(\frac{\mu}{r}\right)_0(1-s)^{1.44}\right]}\right)$$

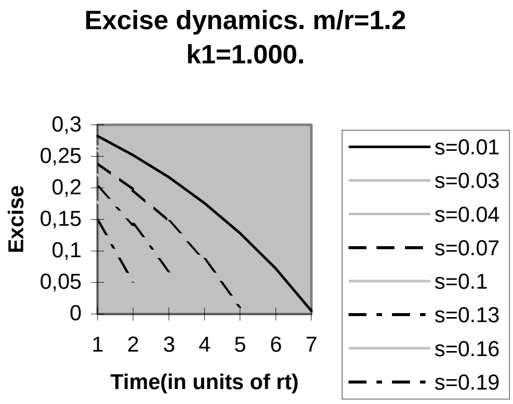
equation (41) allows finding functions $e(t,s)$.

For the four pairs of $\left[\frac{\mu}{r},k_1\right]$ ($\frac{\mu}{r}=0.36,1.20$ и $k_1=0.095,1.000$)б the following excise profiles were obtained (the profiles correspond to different constant subsidy rates):

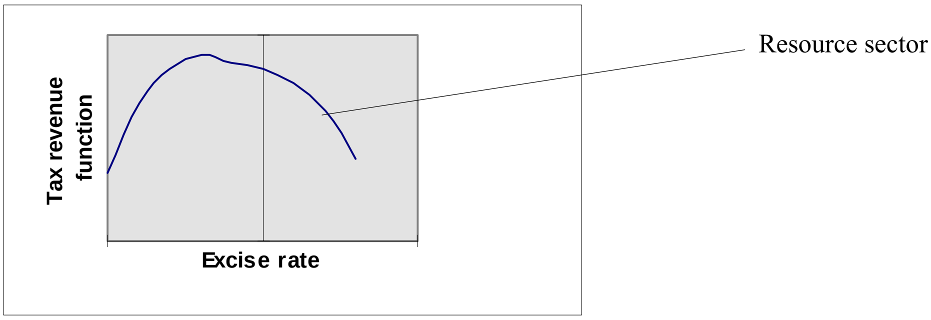






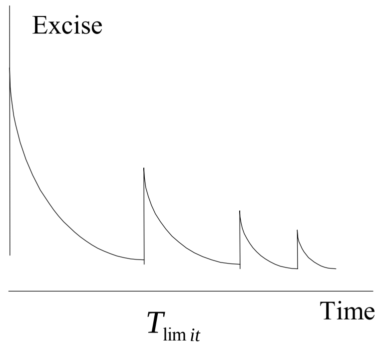


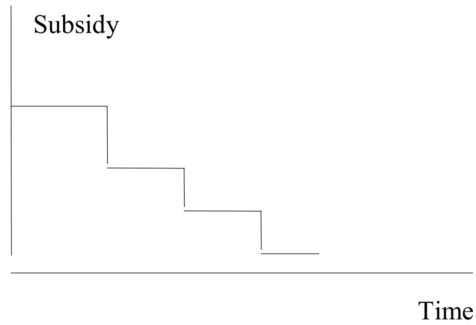
In all cases, the rise in subsidy rate causes the excise profile to move down and the time, when the budget may remain balanced, to shrink. This behavior is explained by the tax structure in Russia. The tax revenue, obtained from the extracting sector, is a non-monotonic function of excise rate that has a point of maximum. This point (the excise rate corresponding to tax revenue maximum), as computations reveal, is negative. So, the positive initial excise rate assumed in computations of excise profiles predetermines that the rise in subsidy rate will cause the downward slopes and shifts of the profiles.



Section 5.2 continued. Investment subsidy.

The budget balance is feasible for a chosen investment subsidy rate only until the moment when the excise rate reaches zero. Then, the government has to change the subsidy rate. This happens jumplike (the data used for modelling require that the subsidy rate can only diminish). Then, the situation reduplicates, infinitely in general. The problem of determining the optimal subsidy rates sequence, depending on the subsidy rate in the first period, may be set. The corresponding «optimal» excise profile then looks swallow-like while the subsidies sequence resembles a set of descending staircases.





Yet the paper considers only a part of the whole problem, the part that concerns the optimal choice of investment subsidy over the first period of planning the subsidy policy. Because the unit of time in the computations of excise profile is a unitless combination of rt, and a change in this combination by 1 corresponds to a real-time change by ~30 years (given the typical value of $r \approx 0.03$ per year), the times of excise diminishing to zero, which fall into interval from 3 to 10 on average over the permissible ranges of s_M^I, in terms of real time amount to 90-300 years. Thus solving the partial problem may turn useful not only in theoretical sense, as a stage of solving the whole problem of finding the optimal subsidy sequence, but also in practical sense, as 90-300 years may be well-justly considered infinite for any ruling government, or ministries' planners, or even political parties in Russia.

So, the subsidy effect determination is held only within the first period of planning.

$$PVU = \int_0^\infty \overline{U} \bullet \left[C\mu e^{\mu \cdot t}\left(\frac{r(1+\tau_I^M)}{\alpha_M} - \mu\right) + d \right]^{a+b\beta_S} (1+\tau_I^M)^{\beta_S b \frac{\alpha_M}{1-\alpha_M}} e^{-r\cdot t} dt$$

$$J_2 = \int_0^{T_{\lim it}} \left[C\mu^2 \cdot e^{\mu \cdot t} \left(\frac{r}{\mu} \frac{(1-s)}{\alpha_M \left(\frac{1}{1+v} - \gamma \right)} - 1 \right) + d(0) \left(\frac{\frac{1}{1+v} - \gamma - e(t)}{\frac{1}{1+v} - \gamma} \right)^{\frac{\alpha_E}{1-\alpha_E}} \right]^{a+b\beta_S} (1-s)^{\beta_S b \frac{\alpha_M}{1-\alpha_M}} \cdot e^{-rt} dt$$

Substituting $e^{r \cdot t} = x$,

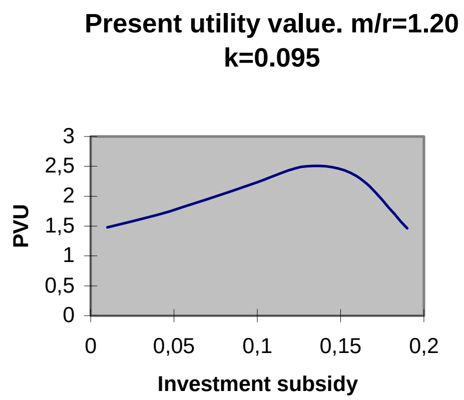
$$J_2 = \int_1^{X_{\lim it}} \left[C\mu^2(s) \cdot x^{\frac{\mu}{r}(s)} \left(\frac{r}{\mu}(s) \frac{(1-s)}{\alpha_M \left(\frac{1}{1+v} - \gamma \right)} - 1 \right) + d(0) \left(\frac{\frac{1}{1+v} - \gamma - e(t)}{\frac{1}{1+v} - \gamma} \right)^{\frac{\alpha_E}{1-\alpha_E}} \right]^{a+b\beta_S} (1-s)^{\beta_S b \frac{\alpha_M}{1-\alpha_M}} \cdot \frac{dx}{x^2}$$

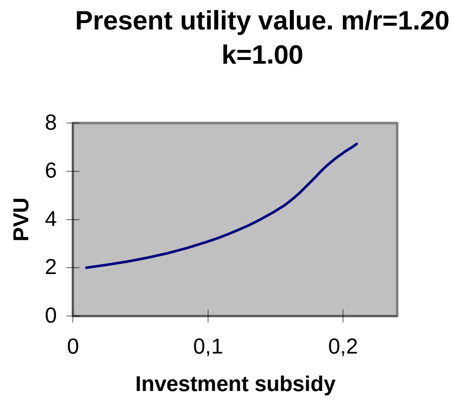
Highlighting parameter k_1 yields (42):

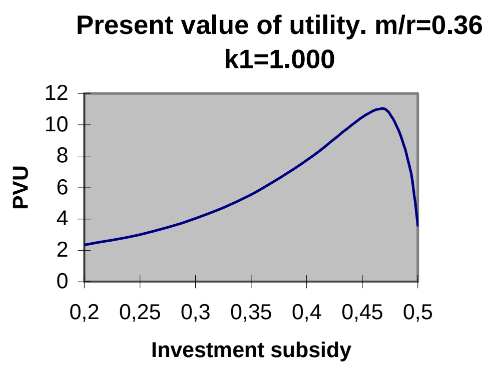
$$J_2 \propto \int_1^{X_{\lim it}} \left[\frac{C\mu^2(s)}{C\mu^2(0)} \cdot x^{\frac{\mu}{r}(s)} \left(\frac{\frac{r}{\mu}(s) \frac{(1-s)}{\alpha_M \left(\frac{1}{1+v} - \gamma \right)} - 1}{\frac{r}{\mu}(0) \frac{1}{\alpha_M \left(\frac{1}{1+v} - \gamma \right)} - 1} \right) + k_1 \left(\frac{\frac{1}{1+v} - \gamma - e(t)}{\frac{1}{1+v} - \gamma} \right)^{\frac{\alpha_E}{1-\alpha_E}} \right]^{a+b\beta_S} (1-s)^{\beta_S b \frac{\alpha_M}{1-\alpha_M}} \cdot \frac{dx}{x^2}$$

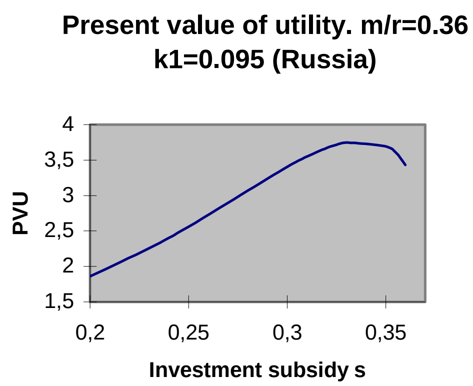
It was assumed that the change in k_1 is not accompanied by a change in manufacturing sector output.

Computation of this integral for all four pairs of parameter values $\left[\frac{\mu}{r}(0), k_1 \right]$ for a range of investment subsidy rates s_I^M yields ($\frac{\mu}{r}(0)$ is represented by m/r sign in the graphs' legends):





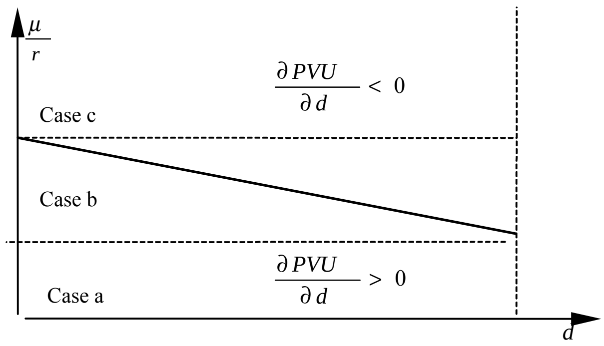




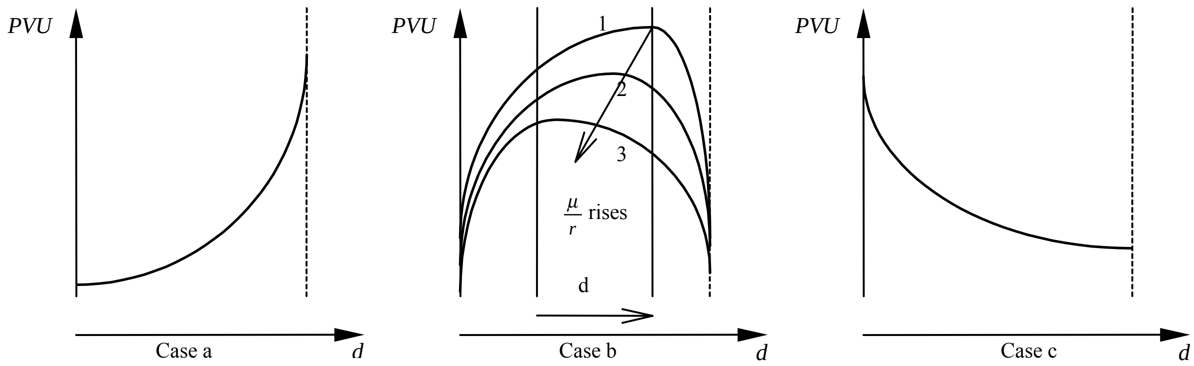
PART 6. Discussion.

Section 6.1. Reaction on the price shock

In introduction to the diploma it was argued that the size of the raw material price shock might be large enough to compensate for the welfare losses from slowing down the rates of economic development. From the result in Section6.1 it follows that this is not quite correct. It should have been said that the shock might be fairly small to bring gains, not losses.



Indeed, let us consider following representation of the result.



Case a) states that the price jump leads to country's enrichment. This is true for economies with relatively low ratio $\frac{\mu}{r}$, what corresponds to economic intuition: the less is the rate of development μ or greater the discount rate (so that $\frac{\mu}{r}$ is low), the less valuable is the future prosperity and the more appreciable is the present rise of welfare.

Case b) describes the situation of the «Dutch Disease». It may or may not happen, and whether it does depends on the size of the shock. A country experiencing the rise in raw material exports may:

1. Remain on the in creasing part of the curve and thus gain from the shock.
2. Find itself in the decreasing branch of the curve but have final value of PVU greater than initial value.
3. Find itself in the decreasing branch of the curve and have a lower final value.

All three case are depicted by curves numbered «1», «2» and «3», according to proposed classification.

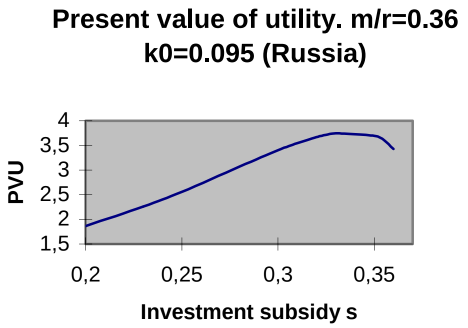
In the latter case (case b.3) the country suffers the «Dutch Disease». The extent of the present utility losses is crucially dependent on the value of μ-to-r ratio. Facing one and the same price shock, a country, whose ratio is high, is more likely to bear costs from the price increase, than a country whose ratio is low.

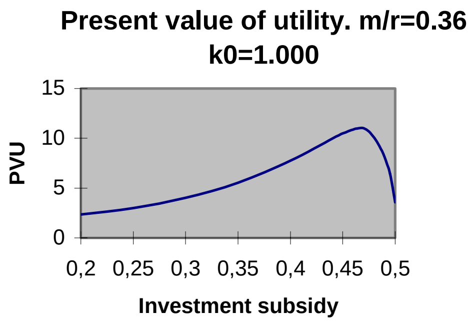
The result that countries with higher $\frac{\mu}{r}$ are more sensitive to, or, that is to say, less resisted against the «Dutch Disease», seems reasonable. The result means that the greater are the benefits from large growth pace of the country or patience of its inhabitants, the less easy is the country's reaction to the raw material sector expansion.

Case c) suggests that the shock inevitably worsens the well-being of the nation, the greater is the shock the worse is the damage. This rule applies to the countries with quite high growth-to-discount-rate ratio.

Section 6.2. A change in subsidy rate.

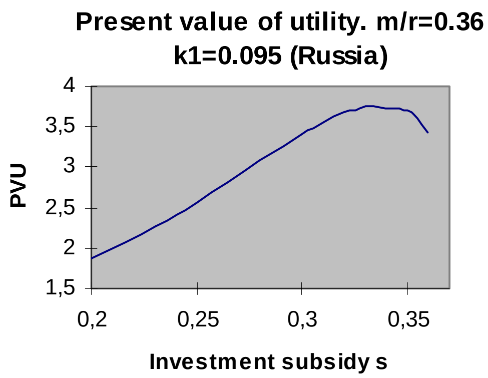
In subsection 5.2 it was obtained for the effect from subsidy rate change given that the values of parameters are $\frac{\mu}{r} = 0.36$ and $k_1 = 0.095{,}1.000$:

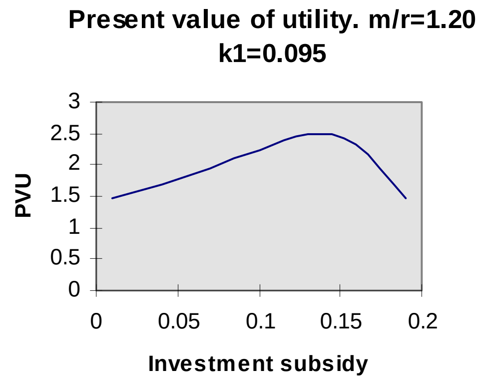




If the rate of growth $\frac{\mu}{r}$ does not change while k_1 rises then PVU shifts upward. This is not astonishing and is a straightforward consequence of used computational techniques that assumed that the initial output of manufacturing sector does not change either. A nontrivial though easily explicable result here is that in both cases of k_1 values the function of PVU has a distinct maximum; another result is the shift of subsidy rate, that delivers this maximum to PVU, rightward in respond to increase in k_1. The maximum appear due to simultaneous presence of two counteracting factors: the acceleration in the rate of economic growth, stimulated by investment subsidy, and the shrinkage of the period of time when this subsidy can be maintained at the expense of taxing the resource extracting sector.

It seems natural that the mightier is the energy sector, the longer can the chosen subsidy rate and the greater subsidy rate be sustained (see the corresponding profiles in the two diagrams just below) That is why the shift of $Arg \max_{s} PVU$ is not bizarre.

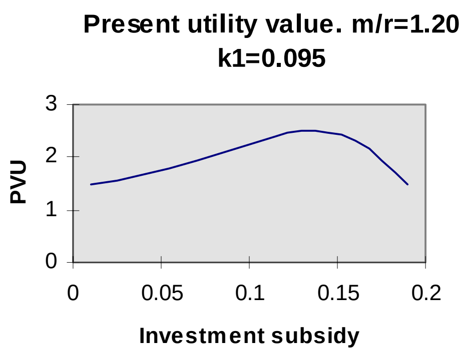


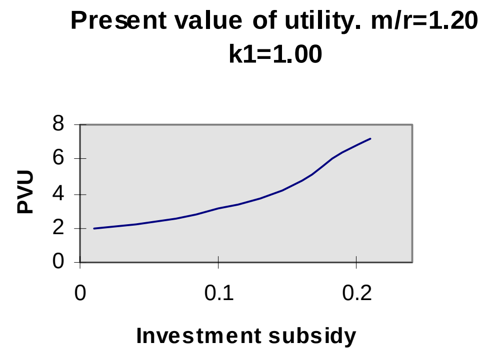


The lengths of periods during which the optimal programs of investment subsidization can be pursued are almost the same in the economies with different sizes of extracting sectors (precisely, this period is a little bit greater for a country with a larger energy sector).

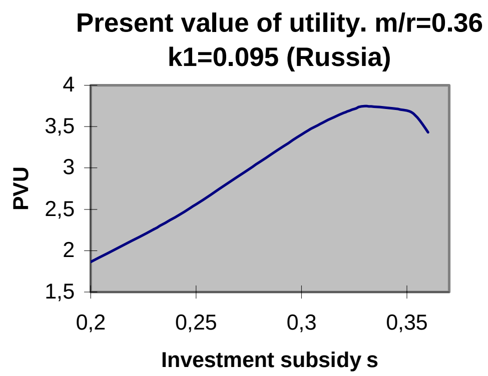
High growth rate ($\frac{\mu}{r}=1.2$) can eliminate the maximum of PVU (given that $k_1 = 0.095, 1.000$):

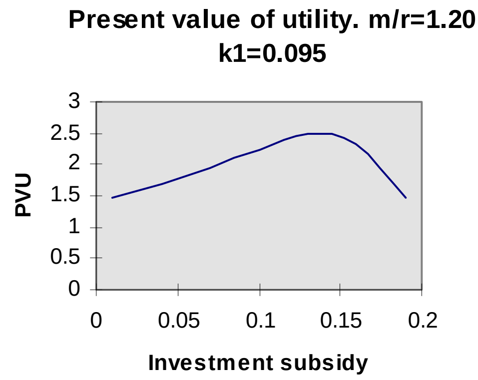
$\frac{\mu}{r} = 1.2 \quad k_1 = 0.095, 1.000$

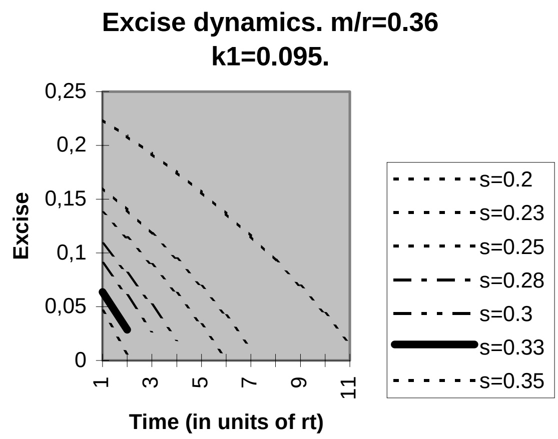


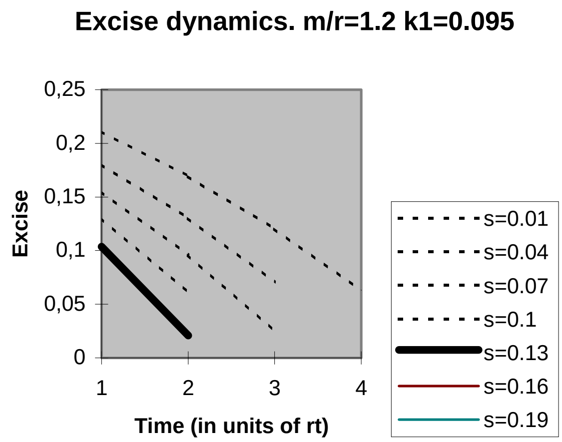


The larger initial growth rate allows to set smaller optimal subsidy rates (~ 33% versus 14%):









But, as the bottom pair of diagrams shows, a less subsidy rate (the bold line in the right diagram) does not give an opportunity to use the policy longer: the resource sector can sponsor the policy in course of 2 units of "time" rt when the subsidy is a modest 14% investment help and nearly the time (in fact, a little bit longer) when this rate is 30%.

The obtained results can briefly be resumed as follows. Of two countries with equal growth rates the country with the greater resource-extracting sector can afford greater subsidies in course of longer periods of time. Of two countries with equal extracting sectors the country with higher growth rate requires the less subsidy rates than does the other country, and during almost the same but a little bit shorter period. Economies with the high rate of growth of the manufacturing sectors and considerable resource extracting sectors seemingly do not face any difficulties: the governments should simply set as high subsidies as the stable paths of growth of their countries can only allow, and their resource sectors will be able to provide these subsidizations during the longest periods of time.

In the context of the "Dutch Disease" this result implies that after a shock, when economy's parameters $\frac{\mu}{r}$ and k_1 change and the former government's tax policy is no longer optimal, the subsidy rate should be adjusted in accordance with the obtained graphs to maximize PVU again.

PART 7 CONCLUSION.

The study revealed that there are several possible reactions of an economy on the price shocks and investment subsidization policy change. The price shock can lead the economy to three final states of PVU (relative to initial PVU value). The subsidy change can generally be chosen so that PVU become maximal again.

In the model many assumptions were made to simplify the proceedings:

a three-sectored structure of the economy,

production functions of Cobb-Douglas type,

a very special form of technical progress,

very simple agents' expectations of the government's tax policy,

several others.

Some necessary data proved unavailable and the needed values were chosen deliberately in accordance with "common sense". Besides, the problem itself was set as limitedly optimal: the maximization was held over extremely restricted set of possible state policies. In view of all these shortcomings the obtained results can hardly be thought of as a serious recipe to apply. However the solved problem makes sense as a basis to model the real economic activity and ways to govern this activity; but if the paper turns to be of more practical value than it has been just offered than the authors will only be glad.

References

1. Chamney, Christophe 1989 «The Welfare Cost of Capital Income Taxation in a Growing Economy» Journal of Political Economy, June 81, 468-91
2. Cybuleva Natalia 1998 « The Dutch Disease and Restructuring in the Russian Economy» Master Thesis, NES.
3. Bergloff and Neven «The integration of Russia into the world economy» Draft paper prepared for the Ministry of foreign Economic Relations, Moscow, October 1997
4. King, Robert G and Rebelo, Sergio 1990 «Public Policy and Economic Growth: Developing Neoclassical Implications», Journal of Political Economy 98, N5, part2 (October): S126-S150
5. Larry Jones, Rodolfo E. Manuelli, Peter Rossi »Optimal Taxation in models of Endogenous Growth» Journal of Political Economy 1993 N3 pp 415-518.
6. Aarestad J., 1979 «Resourse Extraction, Financial Transactions and Consumption in an Open Economy», Scandinavian Journal of Economics, vol.81, 552-565.
7. Dasgupta P., R. Eastwood, G. Heal, 1978, «Resource Management in a Trading Economy», Scandinavian Journal of Economics,vol., 297-306.
8. Siebert H., 1985 «The Economics of the Resource-Exporting Country», JAI Press Inc.
9. Sachs, J and A Warner, 1995 «Natural Resource Abundance and Economic Growth», NBER, working paper 5398

10. Lucas R, 1988 «On the mechanics of Economic Development», Journal of Monetary Economics, vol. 22 3-42
11. Romer Paul M, 1986, «Increasing Returns and Long-Run Growth», Journal of Political Economy 94, 1002-1037
12. Eismont, O. and Kuralbareva, K. ,«Depletion of Natural Resources and Long-term Perspectives of the Russian Economy »(1998), GET Conference Papers, NES 1998
13. Enders, Klaus and Herberg, Horst, «The Dutch Disease: Causes, Consequences, Cures and Calmatives» (1983), Weltwirtxhaftliches Archiv, 1983, 119
14. Kaldor, Nicolas, 1981, «The energy Issues» In: Terry Barker and Vladimir Braiilovsky (Eds.), Oil or Industry?, London, pp.3-9
15. Ellman, Michael, 1981, «Natural Gas Restructuring and Re-Industrialization: the Dutch Experience of Economic Policy», In: Tery Barker and Vladimir Brailovsky (Eds.) Oil or Industry?, London, pp 149-166.
16. Milyakov, 1999 ”Nalogi i Nalogooblozhenie”, Moscow, Infra-M.