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Transition and the Output Fall

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TRANSITION AND THE OUTPUT FALL

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ABSTRACT.

We present a model to explain why in transition economies of Central and Eastern Europe an important output fall has been associated to price liberalization. Its key ingredients are search frictions and Williamsonian relation-specific investment implying that new investments are made only after having found a new long term partner. When all firms search for new partners, output may fall because of three effects: a) disruption of previous production links, b) a fall in investment, c) capital depreciation due to the absence of replacement investment. We show that forms of gradual liberalization like the Chinese "dual-track" price liberalization may avoid or reduce the transitory output fall.

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I. INTRODUCTION

One of the most striking stylized facts about transition in Central and Eastern Europe is the important output fall that took place at the beginning of transition. There are important disagreements on the exact numbers involved but few disagree that this fall has been large.² Early debates on the causes of the output fall have focused on the relative role of aggregate demand (stabilization) vs aggregate supply (see e.g. Bruno (1992), Bhaduri et al (1993), Berg and Blanchard (1994), Rosati (1994)). It would seem however very difficult to explain such an important output fall with standard macroeconomic analysis only. For example, blaming stabilization policies alone cannot provide a satisfactory explanation. Indeed, the experience of developing and developed countries shows that stabilization policies do not lead to such important output falls and may in some cases lead to increases in output (Kiguel and Liviatan (1990)). Moreover, it is difficult to claim that Russia experienced excess stabilization in 1992, the year of the biggest output decline. On the other hand, explanations focusing on aggregate supply cannot be convincing without serious microeconomic underpinnings, related to the insitutional context of transition.

From that point of view, it is quite striking to observe that the output fall was contemporaneous with price and trade liberalization. Table 1 gives figures for real GDP growth in Central and Eastern European countries between 1989 and 1994. Even though most countries have experienced a decline in output for several years in a row, it is interesting to observe that the biggest decline usually takes place the year a country experiences liberalization: 1990 for Poland, 1991 for Czech republic and Slovakia, 1992 for Russia, 1994 for the Ukraine. Countries which were more gradualist in liberalization like Hungary experienced their biggest output fall the year of CMEA breakdown, i.e. the year of trade liberalization at the level of the region. Rodrik (1992) estimates that most of the output fall in Hungary can be attributed to the CMEA breakdown, contrary to the case of Poland. Because of the coincidence of a sharp output fall with liberalization, when searching for

² Some authors emphasize that an important part of the output fall is mainly a statistical exaggeration due either to underreporting of the private sector (Berg and Sachs, 1992) or overreporting of the state sector under socialism (Winiecki, 1991, Aslund, 1994). The latter explanation can however not be valid for those countries as Poland or Hungary where mandatory planning (with its incentive system based on output targets) had been abolished many years earlier.

microeconomic foundations of the explanation for the output fall, one must ask: why may a sharp output fall be associated with or even generated by liberalization? An associated question is whether the speed of liberalization has an effect on output dynamics in transition.

INSERT TABLE 1

Gomulka (1992) and Kornai (1993) have provided non formal explanations of the output fall as related to price liberalization. The main idea is that the output contraction in sectors experiencing a decline in relative prices is not compensated by an output increase - which takes more time - in sectors where relative prices go up. Formal analysis is however needed to be more precise about the mechanisms leading to output contraction.

Among formal models, a first explanation is the credit crunch hypothesis put forward by Calvo and Coricelli (1992). When stabilization policies were put in place in Poland in 1990 and high real interest rates were imposed on enterprises together with an announcement of hard budget constraints, enterprises strongly reduced their demand for credit, thereby reducing their output levels. Even though this explanation seems important and even if in Poland bank credits became very expensive early 1990, it cannot be the whole story. One has indeed also seen simultaneously an increase of inter-entreprise arrears. Evidence from Central Europe seems to indicate that budget constraints were hardening only gradually over time. It is thus a bit difficult to believe in an explanation based on a strong credit crunch in the early liberalization phase.

Other explanations are based on models with labor market frictions due to sectoral shifts taking place (Atkeson and Kehoe (1995)). Such sectoral shifts however take place in other economies and do not usually lead to such strong output falls. Moreover, the evidence does not point toward strong sectorial shifts taking place directly after liberalization (Fingleton et al. 1996). Moreover, unemployment has generally increased ~~after~~ the output fall, thus casting doubt on explanations based on labour market frictions. *→ partly made later*

Sussman and Zeira (1994) emphasize the role of network externalities in explaining the output fall in a model where a new technology (or language) must replace the old one. Because of network externalities associated to a "language", complete adoption of the new language may be associated with a transitory fall of output in the economy. While this model is interesting and may play a role in explaining more long term phenomena, it is difficult to have a concrete interpretation of what the adoption of a new language precisely means in the

context of transition economies and why output fall should be contemporaneous to liberalization.

Another possible explanation for the output fall is based on monopoly behavior by enterprises after liberalization. Wei Li (1994) and Blanchard (1996) have put forward a double marginalization argument: the central planners behaved like a single vertically integrated monopoly whereas liberalization led to multiple monopolies charging monopoly prices to downstream monopolies. Such an argument may be valid in a closed economy but is less convincing when trade liberalization creates import competition.

In this paper, we assume that markets do not yet exist when prices are liberalized. We put forward an explanation of the output fall based on a search model. Liberalization means the freedom for enterprises to search for new clients and suppliers. More efficient opportunities become available to all enterprises but the search process generated involves externalities as search by many bad clients may reduce the quality of the overall matches. Unlike in job search models, when enterprises are searching, they can maintain their existing production links with suppliers and clients, as long as the latter have not found new matches. However, the important assumption we make is that there are relation specific (in the Williamsonian sense) investments that take place only after a new long-term partner is found. If many enterprises prefer to keep on searching at least one more period, they will not invest while searching. Aggregate output may thus fall after liberalization due to the failure of enterprises to replace obsolete capital and due to a fall in investment demand. The advantage of this explanation is that it provides realistic micro foundations for understanding why liberalization may lead to a short-term macroeconomic contraction. Our explanation does not require capital market imperfections even though such imperfections will strongly reinforce the effects of our model.

Recent research by Caballero and Hammour (1996) has started investigating the role of asset-specificity in macroeconomics. This paper emphasizes that specificity may be a key determinant in explaining the output fall in transitional economies.

The closest paper to ours is that by Blanchard and Kremer (1996) which also takes the disorganization of existing production links as starting point for explaining the output fall. In their paper, liberalization leads to disruption because of information asymmetries on the outside options of suppliers. As firms cannot find out the price that alternative buyers are ready to pay, they are unwilling to offer to their suppliers a price that will prevent them from

moving to a new client because of the too high rents the suppliers would derive from such prices. In their model however, firms cannot elicit information about outside options from suppliers, even when it would be efficient to do so. Moreover, the outside options are modelled by an exogenous parameter and the dynamics of transition are described by an exogenous shift of this parameter. In our paper, we do not rely on inefficiencies in bargaining between existing partners but emphasize the role of search frictions: desired new partners, i.e. better matches after price liberalization, cannot necessarily be found immediately.³ In that sense, our analysis is quite robust. We also fully endogenize the outside option of producers as our model is one of two-sided search and matching. This allows us to derive endogenously the time path of transition, with output contraction always followed by output expansion and a higher post-transition output compared to the pre-transition level.

A natural question that arises from the type of framework we use is whether the speed of liberalization has an impact on the extent of the output fall and on output dynamics in transition. We use the model to show that big bang liberalization can be dominated by gradual liberalization in the style of Chinese price liberalization with the use of the dual price system (Byrd, 1987, McMillan and Naughton, 1992). Under the dual price system, *all* prices were liberalized at the margin but enterprises were forced to maintain production links for given production quotas at non liberalized prices (on the inefficiencies of liberalizing part of the prices see e.g. Murphy et al. 1992 or Gates et al. 1992). Such a form of gradual liberalization may not have been an option in those countries where state structures collapsed and where it became impossible to enforce such quotas. We show however that a case can be made for Chinese style gradual liberalization in circumstances where some form of state control is maintained at the beginning of the liberalization period. Indeed, such gradual liberalization may avoid the output disruption and temporary fall in investment generated by a big bang policy.

Section 2 presents the basic model in a two period search framework and describes the economy before liberalization. Section 3 analyzes the impact of liberalization and analyzes aggregate output dynamics under an all search equilibrium. Section 4 analyzes a

³ The importance of search frictions in the transition context has been recently reinforced by empirical analysis of Haggard, McMillan and Woodruff (1996) applied to the Vietnamese private sector.

scenario of Chinese style gradual liberalization. Section 5 extends the model to an infinite horizon framework. Section 6 concludes.

II. THE MODEL.

We assume an economy with two sectors, a consumption goods sector and an investment goods sector. In the consumption goods sector, output depends on the quality of the match between producers. This match can be seen as a supplier-client relationship or as any form of joint relationship in production. The net present value of a match is given by $V_{ij} = f(h_i, h_j)$ where h_i and h_j are a measure of the productivity of partners i and j . Each partner can be one of two types H (high productivity) or L (low productivity). We thus have $h^L < h^H$. In what follows, we assume that $f(h_i, h_j) = h_i h_j$ and that $h^L = 1$ and $h^H = h > 1$. What matters for our reasoning is that $f(h_i, h_j)$ be convex so that it is more efficient to have H match with H types and L with L types rather than have H match with L types as in the Kremer-Maskin (1996) model of wage inequality.

We denote by m_1^H and m_1^L the proportion of H and L among all consumption good producers at time 1 so that $m_1^H + m_1^L = 1$. The number of producers is normalized to 1.

We assume that socialism was characterized by inefficient matches due to distorted prices. Specifically, we assume that under the socialist economy the sector was characterized by m_1^H HL pairs and thus $1/2 - m_1^H$ LL pairs.

Given our assumptions, the value of consumption good matches under socialism is:

$$V_S = m_1^H h + 1/2 - m_1^H$$

Efficient matching requires $1/2 m_1^H$ HH pairs and thus $1/2 m_1^L = 1/2 - m_1^H/2$ LL pairs. The value of efficient matches is then:

$$V_C = 1/2 m_1^H (h^2 - 1) + 1/2$$

The gain from efficient matching is thus

$$V_C - V_S = 1/2 m_1^H (h-1)^2 \text{ and } V_C > V_S \iff h > 1.$$

The output flow of a match during period t is

$$\theta_t \frac{1-\delta}{1-\delta^T} h_i h_j \tag{1}$$

where we assume $\Theta_t = 1$, for $t = 1, \dots, T$ and $= 0$ for $t > T$. T is thus the length of physical

life of capital. This particular time profile of capital depreciation is made solely to simplify the model.

Let us first define steady state output under socialism, just before transition. Each year, $1/T$ of total capital stock was replaced. Call p the unit investment cost per pair. Total annual investment outlays were thus equal to $p/2T$. We assume no "time to build" lag so that aggregate output of the consumption goods sector is equal to the output flow of each pair. Total aggregate GNP under socialism is:

$$\frac{1-\delta}{1-\delta^T} [m_1^H h + (\frac{1}{2} - m_1^H)] + \frac{p}{2T} \quad (2)$$

III. LIBERALIZATION AND OUTPUT DYNAMICS.

Liberalization is defined by the freedom to set prices and to contract. It gives producers the possibility of searching for new and more efficient partners. We will thus analyze search equilibria. The following two assumptions are driving our results. First, we assume that the probability of finding a type H in period t is equal to the proportion of type H who are searching in period t . This assumption reflects the fact that markets and their informational networks do not yet exist at the time of liberalization. It thus takes time for producers to find appropriate matches. Otherwise, efficient matches are reached within one period and no output fall is possible. The second important assumption we make is that investments are relation-specific in the Williamsonian sense so that an investment valid for an existing match loses its value if taken into a new match. For this assumption to "bite", we assume that an investment is not profitable if it lasts only one period, i.e. the output flow of the most productive type of pair (the HH pairs) is lower than the investment cost p . Moreover, we assume investment to be profitable in all pairs, including the least productive LL pairs. These two assumptions are reflected in the two following inequalities:

$$\frac{(1-\delta)h^2}{(1-\delta^T)} < p < 1 \quad (3)$$

We assume the investment sector is competitive with perfectly elastic supply at price p and

zero supply at prices below p . This also simplifies the analysis since p remains constant.

We also assume, in this first model, that the search for new partners lasts only 2 periods. We denote respectively by α and by β the proportion of LH and LL pairs with $\Theta = 1$ at the beginning of the first period. In a first natural interpretation, these different parameters reflect different investment durations for different pairs under socialism. In that case, consistency with our assumption about investment under socialism requires that α and β must be such that:

$$(1-\alpha)m_1^H + (1-\beta)\left(\frac{1}{2} - m_1^H\right) = \frac{1}{2T} \quad (4)$$

Another, maybe more realistic interpretation concerning α and β is the idea that they represent the fraction of firms which, after economic liberalization, have some type of capital able to produce goods adapted to the new markets conditions. In that case one need not impose a constraint like (4).

Given our simplified two-period set-up, we now ask what are the conditions for generating different search equilibria. This is done by backward induction. We assume that when producers settle with a match, they share equally the surplus generated as well as the investment cost. Denote by q_2^H the probability of finding a H type when searching in period 2. Since the search process finishes at the end of period 2, producers must then match with the partner they found. The value of searching in period 2 for type H and type L is then given by:

$$V_2^H = q_2^H \frac{h^2 - p}{2} + (1 - q_2^H) \frac{h - p}{2} \quad (5)$$

$$V_2^L = q_2^H \frac{h - p}{2} + (1 - q_2^H) \frac{1 - p}{2} \quad (6)$$

Let us define an "all search" equilibrium as a Nash equilibrium of the search game where all producers search in period 1 and where all decide to search in period 2 except for H types who have found a H partner in period 1. Under an all search equilibrium, the proportions of H and L searching in period 2 will be given by:

$$m_2^H = m_1^H(1 - m_1^H), \quad m_2^L = m_1^L \Rightarrow q_2^H = \frac{m_1^H}{m_1^H + 1} \quad (7)$$

Let us first ask what happens in this model if investment specificity plays no role. To do this, let us assume that no investment is necessary for production to take place. In other words, $p=0$, $\alpha=\beta=1$. This would be the case in a search model of pure exchange. The answer to this question is expressed in proposition 1.

Proposition 1: Without investment specificity, there always exists an all search equilibrium if $h \geq 1$. Output then never falls but increases monotonically during the transition period with

$$\Delta Q = q_i^H \left(\frac{h^2}{2} - h + \frac{1}{2} \right) \quad (8)$$

Proposition 1 is easy to understand. Searching is always a weakly dominant strategy, and a strictly dominant one as soon as others search, since one loses nothing from searching. It is thus always possible to produce with the match of the current period without committing to any long term relation with that match. Searching has thus no cost, in terms of current output.

This will not be the case in the presence of relation-specific investments where there is a clear choice between deciding to search tomorrow and investing in a long term relationship today. We now ask what are the conditions for an "all search" equilibrium in the presence of investment specificity. The answer to this question is expressed in lemma 1 and proposition 2.

Lemma 1: *A necessary and sufficient condition for an "all search equilibrium" is:*

$$\delta \frac{(m_1^H h + 1)}{m_1^H + 1} \frac{1+h}{2} \geq h - p(1 - \delta) \quad (9)$$

Proof: see the appendix.

Lemma 1 reduces to one inequality the condition to have an "all search" equilibrium. On the basis of lemma 1, one would think that an all search equilibrium will exist if h and m_1^H are high enough. Proposition 2 establishes conditions of existence:

Proposition 2: *There exists $h^* > 2$ such that:*

a) *for $h < h^*$, there is no "all search equilibrium".*

b) *for $h > h^*$, there exists $m^\circ(h) < 1/2$ such that: An "all search equilibrium" exists if and only if $m^\circ(h) < m_1^H \leq 1/2$.*

Proof: see the appendix.

Since this is a coordination game, there are of course other equilibria, including equilibria where nobody searches. One may wonder to what extent our assumption that the surplus is shared equally between partners of a pair is important for our results. In order to prevent a H from searching further, a L would have to concede him a transfer t such that $t \geq \delta V_2^H$. On the other hand, the transfer must not be too big so as to make the HL match unattractive compared to a LL match so that $t \leq (h-p) + \delta V_2^L$. These two constraints imply $\delta(V_2^H + V_2^L) \leq (h-p)$. If this inequality is violated, then it is impossible to prevent search through transfers from L to H. But violation of this inequality implies exactly the inequality of lemma 1. The existence of an all search equilibrium is therefore robust to variations in the bargaining power between H and L types.

Let us now look at the output dynamics under an all search equilibrium. Output will consist of the new HH pairs which were matched in period 1 directly and of the remaining HL and LL pairs whose capital has not become obsolete. Recall that under an all search equilibrium, it is not worthwhile undertaking an investment that lasts only one period. Therefore, the only new investments that will take place are those for successful matches, i.e. the new HH pairs. Denoting m_1^H by m , the variation of output is then given by:

$$\Delta Q = \left[\frac{m^2}{2} h^2 + m(1-m)\alpha h + \left(\frac{1}{2} - m\right)\beta \right] - \left[mh + \left(\frac{1}{2} - m\right) \right] \quad (10)$$

Period 1 output is given by the first expression in brackets. Out of m H types, m^2 have found a H type. There are thus $m^2/2$ successful HH pairs producing h^2 . Since all other agents

decide to search, this also means that there are $m^2 L$ type agents without a partner. There are then $m(1-m)$ HL pairs, of which α have $\Theta = 1$ and $(1/2 - m)$ LL pairs of which β have $\Theta = 1$. This expression can be rewritten to see better the output dynamics

$$\Delta Q = \left[\frac{m^2}{2} (h^2 - h) - \frac{m^2}{2} h - m(1-m)(1-\alpha)h \right] - \left(\frac{1}{2} - m \right) (1-\beta) \quad (11)$$

The first expression between brackets shows the variation for the HL pairs that existed under socialism: the first term is the efficiency gain from the new HH pairs that have been formed, the second term is the disruption effect for the $m^2 L$ types who have lost their H partner and the third term is the capital depreciation for the remaining HL pairs. The second expression under brackets shows the output loss due to depreciation for the LL pairs. The depreciation effect for the HL and LL pairs is potentially important. Indeed, agents do not undertake any replacement investment if they intend to search in the next period. The whole expression must be < 0 in order to have an output fall in the consumption goods sector. This will not necessarily be the case for all values of parameters m , h , α and β . For example, if there were no capital depreciation and $\alpha = \beta = 1$, there will be an output fall only if $h < 2$. However, we know from proposition 2 that h must be > 2 to have an all search equilibrium.

The condition for an output fall is defined by the following function of those parameters:

$$\phi(m, h, \alpha, \beta) = m^2 \left(\frac{h^2}{2} - \alpha h \right) + m(1-\beta - (1-\alpha)h) - \frac{1-\beta}{2} < 0 \quad (12)$$

This defines implicitly a function $m^-(h, \alpha, \beta)$

$$m < m^-(h, \alpha, \beta) \leq \frac{1}{2} \quad (13)$$

We then have:

Proposition 3: *The conditions for an "all search equilibrium" with output fall are defined by a (m, h) space such that:*

$$m^\circ(h, \delta, p) \leq m \leq m^-(h, \alpha, \beta) \text{ and } h \geq h^*$$

This space is non-empty as long as $h^ < 2(2-\alpha)$.*

Proof: see the appendix.

For an output fall to occur, m and h must be big enough so as to generate an all search equilibrium. However, m and h cannot be too big. Otherwise, no output fall will be generated. Indeed, a high m and a high h will generate a high efficiency gain from the successful matches and this may more than compensate the output fall due to the absence of capital replacement and the disorganization of the LH matches which have dissolved. The higher the h , the lower the m consistent with an output fall. The space of (m, h) parameters consistent with an output fall is the shaded area in figure 1.

INSERT FIGURE 1

Corollary: *The space of (m, h) values generating an output fall is larger when α and β are low and when δ is close to 1.*

Proof: see the appendix.

To give an example: if we take $\alpha = \beta = 0.5$, $m_1^H = 0.33$, $\delta = 0.98$, $p = 0.9$ and $h = 3.21$, then we have $\Delta Q/Q = -18.6\%$ with a potential efficiency gain of 65% with perfect matching. These are admittedly somewhat extreme figures for capital depreciation⁴ but if we take $\alpha = \beta = 0.66$, $m_1^H = 0.33$, $\delta = 0.98$, $p = 0.9$ and $h = 3.27$, then we have $\Delta Q/Q = -6.9\%$ in the consumption goods sector alone.

The output recovery in period 2 is then given by:

$$Q_2 = \frac{(m_1^H)^2}{2} h^2 + \frac{(m_2^H)^2}{2} h^2 + m_2^H (1 - m_2^H) h + \frac{m_1^L - m_2^H (1 - m_2^H)}{2} \quad (15)$$

It is important to observe the variation of investment in period 1:

There will thus be a fall of investment if $m_1^H < 1/T^{1/2}$, which will generally be the case for the parameters considered.

⁴This is so if one considers that α and β reflect pure capital depreciation. On the other hand, if one keeps in mind that a significant amount of the socialist capital was obsolete because one could not produce with it goods suited to the needs of new market conditions, then such values of α and β are not necessarily too extreme.

$$\Delta I = \frac{(m_1^H)^2}{2} p - \frac{p}{2T} \quad (16)$$

The total output fall is given by output variation in the consumption goods and investment sector. Table 2 shows results of simulations with different parameters for m , h , α, β , δ and p . The first three rows show that depreciation has potentially a big effect on the output fall via the depreciation effect and the investment fall effect. In the current set-up of the model, the investment fall is the main determinant of the output fall. This leads to strong falls in investment rates. Also the magnitude of m_1^H plays an important role for our results as can be seen from table 2. The three lower rows show that the sign of output variation can be reversed if the proportion of H types goes up to .5.

INSERT TABLE 2

It should be noted at this point that more realistic calibrations could be obtained by introducing multiplier effects of fall in aggregate demand on the consumption goods sector. The disruption effect would also be much stronger if, instead of assuming production pairs, we had production teams with more than 2 partners. The formal analysis of such a case would however also be more complex, especially the derivation of the conditions for an "all search" equilibrium.

Another situation which would also increase the likelihood of instantaneous output fall for given structural parameters is the situation where domestic agents expect some foreign investment liberalization in the future. To see that, suppose as seems natural that foreign investors are of the H type and that they are expected to enter into the domestic economy in period 2. Assume also that their expected number in this period is X . Then it is quite immediate to see that the conditions for an "all search" equilibrium are more likely to be satisfied, the greater is X . On the other hand, X does not affect the condition for a fall of output in the first period. Hence output fall becomes more likely the larger is X . The intuition is quite clear: if domestic agents anticipate that they may be able to make a good match with foreigners in the next future, their option value to wait increases and they are more ready to reject a first period bad match and delay investment.

IV. OUTPUT DYNAMICS UNDER GRADUAL LIBERALIZATION.

In this section, we want to compare the output dynamics under a policy of gradual liberalization. There are many forms of gradual liberalization which have the potential of being economically more harmful than full liberalization. This will be the case for example if only a subset of prices are liberalized (see e.g. Murphy et al. 1992 or Gates et al. 1994 for such models). It is however not true that all forms of gradual liberalization yield a worse outcome. The converse may actually be true. Here, we look at a special form of liberalization which is close to the Chinese dual track liberalization (Byrd, 1987; McMillan and Naughton, 1992) where all prices were liberalized at the margin. Enterprises were allowed to trade only a small part of their output at liberalized prices and had to maintain planned deliveries at planned prices for most of their output. This form of gradual liberalization allows to reap the informational benefits from price liberalization while avoiding the disruption associated to the potential breakdown of the planning system. Lau et al. (1996) have shown that such a form of gradual liberalization has big political advantages since it allows to implement pareto-improving reforms. Here, we show that such a form of gradual liberalization has the effect of smoothing output dynamics and reducing, or even eliminating, the initial output fall after liberalization. We model this type of dual track liberalization by assuming that only HL pairs are allowed to search. For this to make sense, productivity under socialism must be observable, which seems a reasonable assumption. Even if productivity is not perfectly observable, screening away part or all of the LL pairs in the search process has the effect of increasing q_1^H up to $1/2$. The following proposition is then easy to derive.

Proposition 4: *Gradual liberalization relaxes the conditions for an "all search" equilibrium for agents allowed to search while increasing ΔQ_1 and preventing an output fall if $h > 2(4m_1^H - \alpha)$.*

Proof: see the appendix.

The reasons for the results are quite intuitive. This form of gradual liberalization improves the pool of those who search which increases both the incentives to search and the number of successful HH matches in the first period.

V. THE INFINITE HORIZON MODEL

In the previous sections, we had imposed that search could take place at most during two periods. In this section, we extend our two-period framework to an infinite horizon. The purpose is to test the robustness of the analysis of the previous sections by endogenizing the terminal date of search. In order to perform this analysis, we need to make some simplifying assumptions. Specifically, we will assume $\alpha = \beta = 0$. This would correspond to the case of a socialist economy with investment cycles and where liberalization takes place just at the beginning of a new investment cycle. Former socialist production links cannot perform if there is no specific investment in the relationship.

Again, as in the two-period setting, there are multiple search equilibria. In particular, given that there is still search in $t-1$, there is always the possibility that the search process stops at period t : if each individual expects nobody to search in period t , then search effectively stops in that period. Here we are looking for "search equilibria" with the maximal search length. Let us first write the conditions for an "all search equilibrium" at period t (given that search occurs for all periods $t' < t$):

$$\delta V_{t+1}^H \geq \frac{h-p}{2} + \delta \frac{V_{t+1}^H - V_{t+1}^L}{2} \quad (17)$$

$$\delta V_{t+1}^L \geq \frac{1-p}{2} \quad (18)$$

$$V_t^H = q_t^H \frac{h^2-p}{2} + (1-q_t^H) \delta V_{t+1}^H \quad (19)$$

$$V_t^L = \delta V_{t+1}^L \quad (20)$$

where V_t^H , V_t^L , q_t^H are respectively the value function of a H type, a L type and the proportion of H type in the population searching at time t . Equation (17) is the condition for H type agents to refuse a match with a L type agent. Similarly (18) reflects the condition for L type agents to keep on waiting without making the specific investment until the next period

$t+1$. Equations (19) and (20) show the evolution of the value functions of both types from period t to period $t+1$ given that H type and L type agents reject a match with a L type agent in period t . The evolution of the number of remaining H type and L type agents searching in the next period is given by; $m_{t+1}^H = m_t^H (1-q_t^H)$ and $m_{t+1}^L = m_0^L$. Hence the fraction q_t^H changes according to:

$$q_{t+1}^H = \frac{q_t^H}{1+q_t^H} < q_t^H \quad (21)$$

Then we have the first following straightforward lemma:

Lemma 2: *There cannot exist a never ending "all search" equilibrium.*

In a never ending "all search" equilibrium, L type individuals end up with a zero value because

$$V_t^L = \delta^{T-t} V_T^L \quad (22)$$

and because of the transversality condition $\lim \delta^T V_T = 0$. Hence condition (18) cannot be satisfied and there cannot be an equilibrium with L type and H type agents searching permanently. This discussion leads to consider equilibria where type H agents always reject type L agents while type L agents accept after a given t_F a match with another type L; or equilibria where type H agents accept, after a given t_F' , a match with type L agents and the whole search process stops at that date.

Proposition 5: *Assume that:*

$$[(1-p) + (h^2 - p)] \delta > 2(h-p)(2-\delta) \quad (23)$$

then there exists a stationary equilibrium with H types rejecting permanently L types and L types accepting immediately L types. Moreover $q_t^H = 1/2$ for all t .

Proof: See the appendix.

Proposition 5 states that, under condition (23), there is a "search equilibrium" which lasts permanently. In that equilibrium, former pairs of LL individuals do not search and start to invest and produce immediately. Only HL socialist production links break down; H type agents search for another H type agent and the remaining L type agents are "forced" to search for another L type individual. The searching type L agents invest then as they get matched with another type L while type H invest only with other type H individuals.

When (23) is not satisfied, then this equilibrium cannot exist and only "all search" equilibria with a bounded number of periods can prevail. The following proposition then characterizes the maximum number of search periods in a finite "all search" equilibrium given the initial condition m_1^H .

Proposition 6: *Assume that:*

$$[(1-p) + (h^2 - p)] \delta < 2(h-p)(2-\delta) \quad (24)$$

then only "all search" equilibria prevail and the maximal time of search is such that:

$$T \leq E\left[\frac{1}{m^o(h,\delta,p)} - \frac{1}{m_1^H}\right] + 1 \quad (25)$$

where $E(x)$ is the largest integer smaller than x .

Proof: See the appendix.

A special case of proposition 6 gives the configuration of parameters where the two period set-up occurs in the infinite horizon model:

$$\frac{m_1^H}{1+m_1^H} < m^o(h,\delta,p) \leq m_1^H \quad (26)$$

The first inequality ensures that the search process stops at most in two periods. The second inequality is no more than a restatement of proposition 1 for the "all search" equilibrium to exist in a two period setting.

Looking at the conditions of proposition 5 and 6, one sees that the former will occur if h and δ are sufficiently high. Intuitively, if h is sufficiently high and if H type agents are sufficiently patient, they will always prefer to continue searching and to wait to invest because of the high returns when matching with another H type.

Consider now the dynamics of output and investment. Let us first concentrate on the stationary equilibrium described in proposition 5. Output and investment in period 1 are given by:

$$Q_1 = \left(\frac{1}{2} - m_1^H\right) + \frac{m_1^H}{4} h^2 + \frac{m_1^H}{4} \quad \text{and} \quad I_1 = p\left(\frac{1}{2} - m_1^H\right) + p\frac{m_1^H}{4} + p\frac{m_1^H}{4} \quad (27)$$

Just after price liberalization, only the m_1^H HL production links break down. The $1/2 - m_1^H$ LL pairs start immediately to invest and produce. At the same time, out of the m_1^H former HL links, only $m_1^H/2$ type H individuals (type L individuals) get matched with a type H (type L) agent. Hence $m_1^H/4$ new pairs of HH and LL form with corresponding investment and production. Compared to initial former socialist output Q_0 , there is an initial fall of output if and only if:

$$Q_1 - Q_0 = \frac{m_1^H}{4} h^2 + \frac{m_1^H}{4} - m_1^H h < 0 \quad (28)$$

which is satisfied if and only if $1 < h < h^{**} = 1 + \sqrt{3}$. Note that investment is unambiguously lower than the average investment level under socialism (recall that investment is cyclical since we assume that $\alpha = \beta = 0$) if capital duration exceeds $1/(1 - m_1^H)$ periods.

Output and investment after time 1 increases monotonically as more HH and LL pairs get formed. Given that $q_t^H = 1/2$ for all t , the growth of output is given by:

$$Q_t - Q_{t-1} = \frac{m_{t-1}^H}{4} (h^2 + 1) = \frac{1}{2^{t+1}} m_1^H (h^2 + 1) \quad (29)$$

The time path of output in the stationary equilibrium can then be represented as in figure 2 depending on h larger or smaller than h^{**} .

-INSERT FIGURE 2-

In figure 2a) output initially falls and then monotonically increases, converging to a higher

steady state value Q_∞ than former socialist output Q_0 as:

$$Q_\infty = \left(\frac{1}{2} - m_1^H\right) + \frac{m_1^H}{2}(h^2 + 1) > Q_0 \quad (30)$$

In figure 2b) productivity is high enough that there is no initial output fall but an initial jump in output in period 1, after which there is again a monotonic convergence towards the higher level Q_∞ .

Consider now the case of the "all search equilibria" in finite time t_F , the case of proposition 6. In the initial period, the analysis is exactly the one of section III with $\alpha = \beta = 0$ and proposition 2 gives us the conditions on m_1^H , h , δ and p to have an initial fall of output. In later periods and until t_F , as new HH relationships get formed, output and investment increase monotonically until we get to period t_F where the search process stops and all matches are accepted. In this last period, the increase in output and investment is larger than in the preceding period as more matches are achieved.

VI. Concluding remarks.

Our model is only a first step in trying to rigorously understand the microeconomic reasons leading to the macroeconomic output contraction in transitional economies in the beginning of transition. Most of the "action" is taken by the fall in investment during the search process taking place in the aftermath of liberalization. In its current version, the model lacks multiplier effects of aggregate demand contraction which would feed back from the investment goods to the consumption goods sector. This can be added to the existing model. In the current state of knowledge, we think it is however important to generate a class of models giving explanations for the output fall which rely on features specific to the transition process. In our case, the presence of search frictions plays that role. The role of asset specificity is certainly not restricted to economies in transition but it probably plays a more important role in those economies for two reasons: first, the extent of liberalization is much larger and so the search process generated by liberalization has an unusually big magnitude; second, because of the extent of the distortions and the obsolescence of the existing capital stock, the new business links that must be created are also much more

important.

APPENDIX

Proof of proposition 1: Note first that, whatever they do in the first period, a H type who has not found a H type in the first period cannot commit not to search in period 2 since $V_2^H > h/2$ as soon as $q_2^H > 0$. Similarly, for a L type who has not matched with a L type in period 1, we have: $V_2^L > 1/2$. In period 1, a H type is always better off searching as soon as $q_1^H > 0$ since

$$q_1^H \frac{h^2}{2} + (1 - q_1^H) \left(\frac{h(1-\delta)}{2} + \delta V_2^H \right) > \frac{h(1-\delta)}{2} + \delta V_2^H$$

A L Type is indifferent in period 1 between searching or not but is intertemporally better off if all L types search in period 1 since then q_2^H is maximal. An all search equilibrium thus exists if $h > 1$. The variation in output in period i is given by

$$\Delta Q = q_i^H \left(\frac{h^2}{2} - h + \frac{1}{2} \right)$$

QED

Proof of lemma 1: We first look at the conditions under which a H type will choose to reject a L type in period 1. Take first the case of a H type whose capital has become obsolete and thus has $\Theta = 0$:

$$0 + \delta V_2^H \geq \frac{h-p}{2} + \delta \frac{V_2^H - V_2^L}{2} \tag{33}$$

The left hand side measures the payoff from searching in period 2: a zero output flow today given that $\Theta = 0$ and the discounted value of searching in period 2. The right hand side indicates the payoff from settling with a L partner in period 1, i.e. half of the NPV of the match minus the investment plus half of the additional gain H would have over L by continuing to search. For a H type for who $\Theta = 1$, the left hand side includes the current output flow from the existing partnership:

Similarly, we find the conditions for a L type to reject a match with a L type in period 1,

$$\frac{h}{2} \frac{1-\delta}{1-\delta^T} + \delta V_2^H \geq \frac{h-p}{2} + \delta \frac{V_2^H - V_2^L}{2} \quad (34)$$

again for $\Theta = 0$ or 1:

$$0 + \delta V_2^L \geq \frac{1-p}{2} \quad (35)$$

$$\frac{h}{2} \frac{1-\delta}{1-\delta^T} + \delta V_2^L \geq \frac{1-p}{2} \quad (36)$$

To generate an all search equilibrium, the binding conditions are those for the H and L types with $\Theta = 0$. Using the definitions of V_2^H and V_2^L , the relevant conditions thus boil down to:

$$\text{Htype: } \delta [q_2^H h + (1-q_2^H)] \frac{1+h}{2} \geq h-p(1-\delta) \quad (37)$$

$$\text{Ltype: } \delta [q_2^H h + (1-q_2^H)] \geq 1-p(1-\delta) \quad (38)$$

Inspection of these two equations shows that because $h > 1$, when the former inequality holds, the latter automatically holds. The former is thus binding. Replacing q_2^H by its expression in terms of m_1^H then yields the condition.

QED

Proof of proposition 2: Using equation (7) of lemma 1, we have:

$$(m_1^H h + 1) \geq \left[\frac{2}{1+h} \frac{h-p(1-\delta)}{\delta} \right] (1+m_1^H) \quad (39)$$

Call $A(h)$ the expression within brackets in the right-hand side of the inequality. $A(h)$ is such that:

$$A(1) = \frac{1-p(1-\delta)}{\delta} > 1 \quad \text{and} \quad A(\infty) = \frac{2}{\delta} \quad (40)$$

and

We thus get:

$$A'(h) = \frac{2}{\delta} \frac{1+p(1-\delta)}{(h+1)^2} > 0 \quad \text{and} \quad A''(h) = \frac{-4(1+p(1-\delta))}{\delta^2(h+1)^3} < 0 \quad (41)$$

$$m_1^H \geq m^\circ(h) = \frac{A(h)-1}{h-A(h)} \quad (42)$$

However, to be consistent with our assumptions, $m^\circ(h)$ must be $< 1/2$. This implies that:

$$h \geq h^* \text{ such that } A(h^*) = \frac{h^*}{3} + \frac{2}{3} \quad (43)$$

Because $A(h)$ is concave, to have an "all search" equilibrium, we must have:

$$A(h) \leq \frac{h}{3} + \frac{2}{3} \quad (44)$$

Note further that $m^\circ(h)$ declines with δ and p . Indeed,

$$\frac{\partial m^\circ(h)}{\partial \delta} = \frac{2(h-1)(p-h)}{(1+h)[\delta(h-A(h))]^2} < 0$$

$$\frac{\partial m^\circ(h)}{\partial p} = \frac{-(1-\delta)2(h-1)}{\delta(1+h)[h-A(h)]^2} < 0$$

By setting δ to 1, we thus have a lower bound to h^* . This lower bound is the lowest value of h satisfying $h^2 - 3h + 2 \geq 0$. The highest root of $h^2 - 3h + 2$ is 2. We must thus have $h^* > 2$.

QED

Proof of proposition 3: All we need to prove is that the (m, h) space of output fall under an "all search" equilibrium is non empty when $h^* < 2(2-\alpha)$. Recall from proposition 1 that h^* defined the lower bound on h to have an "all search" equilibrium when $m = 1/2$. The function $m^\circ(h)$ is a negative function of h . Indeed, $m^\circ(h)$ is the solution of:

$$A(h) = \frac{m}{1+m} h + \frac{1}{1+m} \quad (47)$$

by varying m . If m declines below $1/2$, the slope declines but the intercept increases.

However, for all values of m , the right hand side of this equation is equal to 1 for $h=1$. A decrease in m thus decreases the right hand-side of the above equation for values of h above 1, and thus increases h^* .

Note further that, at $m = 1/2$, $\phi(m,h,\alpha,\beta) \leq 0$ iff

$$\left(\frac{h^2}{2} - \alpha h\right)\frac{1}{4} + \frac{1}{2}(1 - \beta - (1 - \alpha)h) - \frac{1 - \beta}{2} \leq 0 \quad (48)$$

iff $h \leq 2(2 - \alpha)$. If $h^* < 2(2 - \alpha)$, then for $m = 1/2$, there will be an interval of h from h^* to $2(2 - \alpha)$ for which there will be an output fall with an all search equilibrium. By continuity, for lower values of m slightly above $m^\circ(h)$, the same will be true.

QED

Proof of the corollary to proposition 3:

We have shown in the proof of proposition 1 that $m^\circ(h,\delta,p)$ declines with δ . One checks that:

$$\frac{\partial \phi}{\partial \beta} = -m + \frac{1}{2} > 0, \quad \frac{\partial \phi}{\partial \alpha} = mh(1 - m) > 0 \quad (49)$$

Therefore, a lowering of α and β will increase the space over which $\phi(h,\alpha,\beta) \leq 0$.

QED

Proof of proposition 4: An increase in m_1^H increases the LHS of inequality (7) in lemma 1 as soon as $h > 1$, therefore relaxing the conditions for an all search equilibrium. Moreover, the effect on output variation in the consumption goods sector can be seen by deriving the first expression between brackets in equation (8) with respect to m_1^H which yields $mh^2 + (1 - 2m)\alpha h - \beta$ which is > 0 if $m_1^H = 1/2$. Investment unambiguously increases with m_1^H . The rest of the proof is computed immediately from the expressions from the variation of output in the consumption goods sector (by replacing in the expression in the first bracket of equation 8 m by $1/2$) and in the investment sector.

QED

Proof of proposition 5: i) Consider that after time T , all type L agents accept matching with another type L agent while H type agents permanently reject a type L match. The time evolution of m_t^H and m_t^L after T is then given by:

$$\begin{aligned}
m_{T+k}^H &= m_{T+k-1}^H (1 - q_{T+k-1}^H) \\
m_{T+k}^L &= m_{T+k-1}^L - m_{T+k-1}^L (1 - q_{T+k-1}^H)
\end{aligned} \tag{50}$$

only type H agents who get matched with another H type agent exit the searching pool. Similarly only type L agents who get matched with another type L agent do exit the searching pool. hence it is straightforward to see that in such a situation, the fraction q_t^H of type H agents in the searching pool from T on is a constant and equal to 1/2:

$$q_{T+k}^H = \frac{m_{T+k}^L}{m_{T+k}^H + m_{T+k}^L} = \frac{1}{2} \quad \forall k \geq 0 \tag{51}$$

The value functions V_{T+k}^H and V_{T+k}^L of type H and L agents are then given by:

$$V_{T+k}^H = \frac{1}{2} \frac{h^2 - p}{2} + \frac{1}{2} \delta V_{T+k+1}^H \tag{52}$$

$$V_{T+k}^L = \frac{1}{2} \frac{1-p}{2} + \frac{1}{2} \delta V_{T+k+1}^L \tag{53}$$

Given that, in the long run the value functions have to remain bounded, the solutions of (46) and (47), from T on, are necessarily the stationary values:

$$V_\infty^H = \frac{h^2 - p}{2(2-\delta)} \quad \text{and} \quad V_\infty^L = \frac{1-p}{2(2-\delta)} \tag{54}$$

ii) Conditions to have type L agents accepting type L and type H accepting only type H are given by:

$$\delta V_{T+k+1}^H \geq \frac{h-p}{2} + \delta \frac{V_{T+k+1}^H - V_{T+k+1}^L}{2} \quad \forall k \geq 0 \tag{55}$$

$$\delta V_{T+k+1}^L < \frac{1-p}{2} \quad \forall k \geq 0 \tag{56}$$

Substituting the stationary values of V_∞^H and V_∞^L , it is straightforward to see that (50) is always satisfied as $\delta < 1$ and that (49) is satisfied if and only if:

(57)

$$[(1-p) + (h^2 - p)] \delta > 2(h-p)(2-\delta)$$

iii) Assuming that we have such an equilibrium, T is necessarily equal to one. Suppose the contrary, then $T > 1$ which means that at $T-1 \leq 1$, agents of type L do not accept matches of type L. this implies that:

$$\delta V_T^L > \frac{1-p}{2} \quad (58)$$

but $V_T^L = V_\alpha^L$ which is always smaller than $(1-p)/2$. Hence agents at time $T-1$ do accept matches with other type L agents. Hence a Contradiction. Thus, in such an equilibrium, agents of type L accept from the beginning a match with other type L agents. Collecting i) ,ii) and iii) we get proposition 3.

QED.

Proof of proposition 6: i) Because of (), there cannot a stationary equilibrium where H type agents search permanently. Hence only equilibria with agents of type H (and therefore agents of type L) searching in finite time is possible.

ii) Consider then that search by agents of type H lasts at most T periods. The conditions for "all search" in $T-1$ given there was an "all search" process until $T-1$ are given by:

$$0 + \delta V_T^H \geq \frac{h-p}{2} + \delta \frac{V_T^H - V_T^L}{2} \quad (59)$$

$$0 + \delta V_T^L \geq \frac{1-p}{2} \quad (60)$$

with:

$$V_T^H = q_T^H \frac{h^2-p}{2} + (1-q_T^H) \frac{h-p}{2} \quad (61)$$

$$V_T^L = q_T^H \frac{h-p}{2} + (1-q_T^H) \frac{1-p}{2} \quad (62)$$

As is clear from (60),(61),(62), (63), the problem is exactly the same as the one solved in

the two period setting except that one starts from T-1 with initial condition q_{T-1}^H . From this, we conclude that "all search" does not stop in T-1 when it is expected to stop at most in T if:

$$q_T^H \geq m^\circ(h, \delta, p) \quad (63)$$

When the inequality does not hold on the other hand, there is no rejection of L type individuals by H type agents in T-1 and therefore the search process stops at T-1 given that there was "all search" until T-1 and that the search process is expected to last at most T periods.

iii) By recurrence one can then renew the analysis for T-1 and find a similar condition on q_{T-2}^H for the rejection of L types matches by H type agents in T-2. More generally the condition for rejection by H types of L type matches in period t knowing that search at most lasts t+1 periods is given by:

$$q_t^H \geq m^\circ(h, \delta, p) \quad (64)$$

From the previous discussion, one can characterize the maximal number of periods T for which a H type agent rejects a match with a L type agent (and therefore a L type agent does the same). This number T should be such that:

$$q_T^H < m^\circ(h, \delta, p) \leq q_{T-1}^H \quad (65)$$

In such an equilibrium the time evolution of q_t^H is given by:

$$q_t^H = \frac{q_{t-1}^H}{1 + q_{t-1}^H} = \frac{q_1^H}{1 + (t-1)q_1^H} \quad \forall t, 1 < t \leq T \quad (66)$$

Substitution of (67) in (66) gives the maximal number of periods for a "finite time all search" equilibrium. Recollecting i),ii) and iii), one gets proposition 4.

QED.

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TABLE 1

Real GDP growth in Central and Eastern Europe (% change)

	1989	1990	1991	1992	1993	1994
Poland	0.2	-11.6	-7.6	2.6	3.8	5.0
Hungary	0.7	-3.5	-11.9	-3.0	-0.9	2
Czech Republic	1.4	-0.4	-14.2	-6.4	-0.9	2.6
Slovakia	1.4	-0.4	-14.5	-7.0	-4.1	4.8
Russia	n.a.	n.a.	-13	-19	-12	-15
Ukraine	4	-3	-12	-17	-17	-23
Bulgaria	0.5	-9.1	-11.7	-7.3	-2.4	1.4
Romania	-5.8	-5.6	-12.9	-10.0	1.3	3.4

Source: EBRD.

TABLE 2. SIMULATIONS ($p=.99, \delta=.97$).

α	β	m	h	T	GNP growth (in %)	efficiency gain	disruption effect	depreciation effect	investment fall effect
0.500	0.500	0.300	3.700	2	-33.7	25.0	-9.3	-27.2	-22.2
0.75	0.75	0.3	3.7	4	-14.8	25.2	-9.3	-13.7	-17.0
0.85	0.85	0.3	3.7	6.67	-2.6	25.5	-9.4	-8.3	-10.3
0.500	0.500	0.500	3.700	2	3.4	53.4	-19.8	-19.8	-10.4
0.75	0.75	0.5	3.7	4	23.9	53.8	-19.9	-10.0	0.0
0.85	0.85	0.5	3.7	6.67	41.2	54.2	-20.1	-6.0	13.2

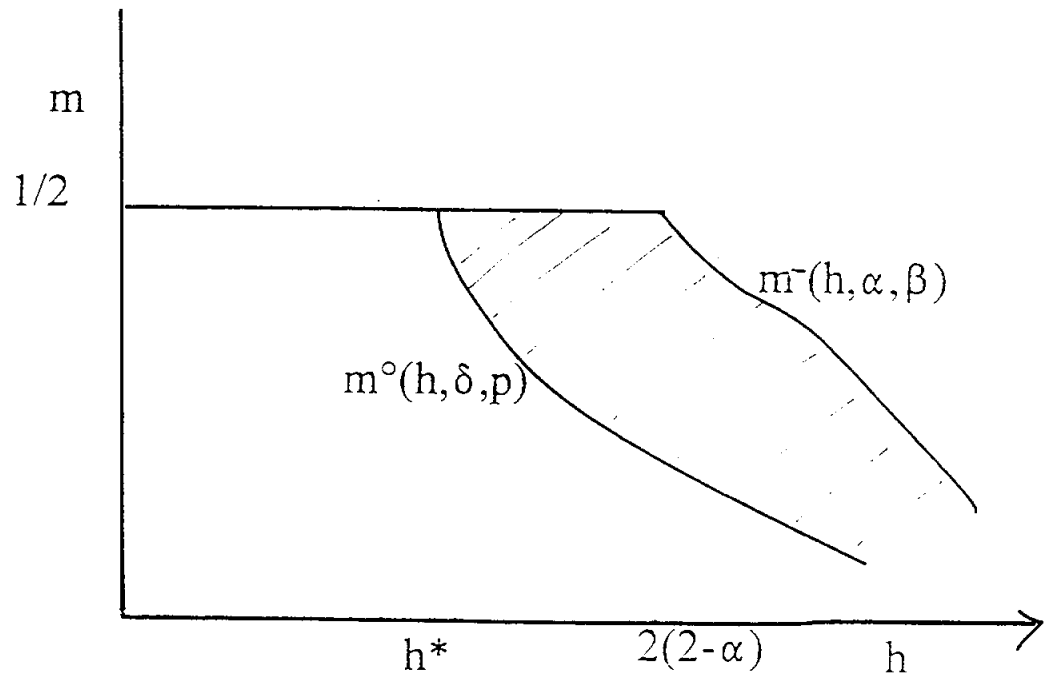


Figure 1

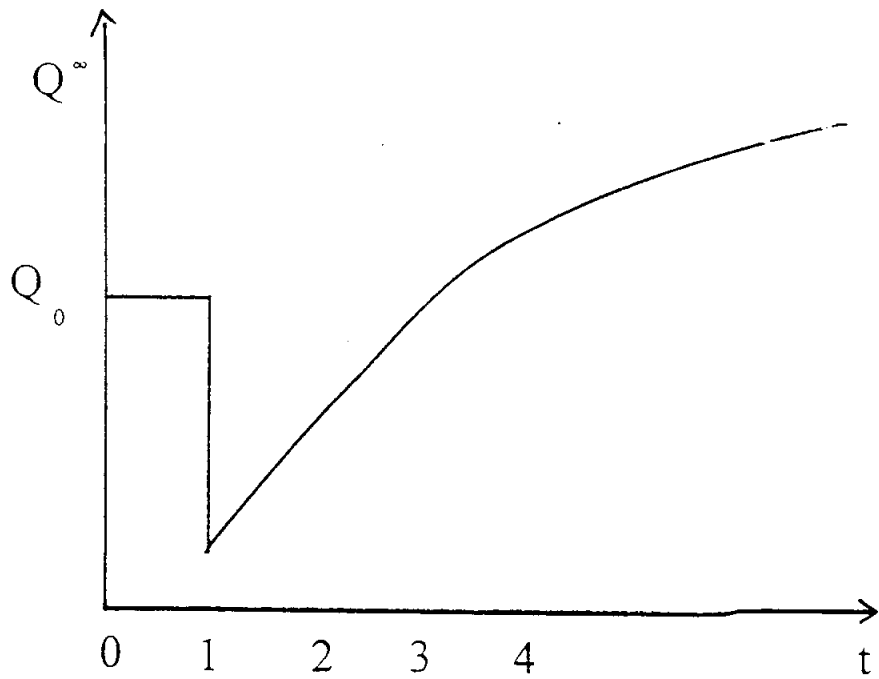


Figure 2a)

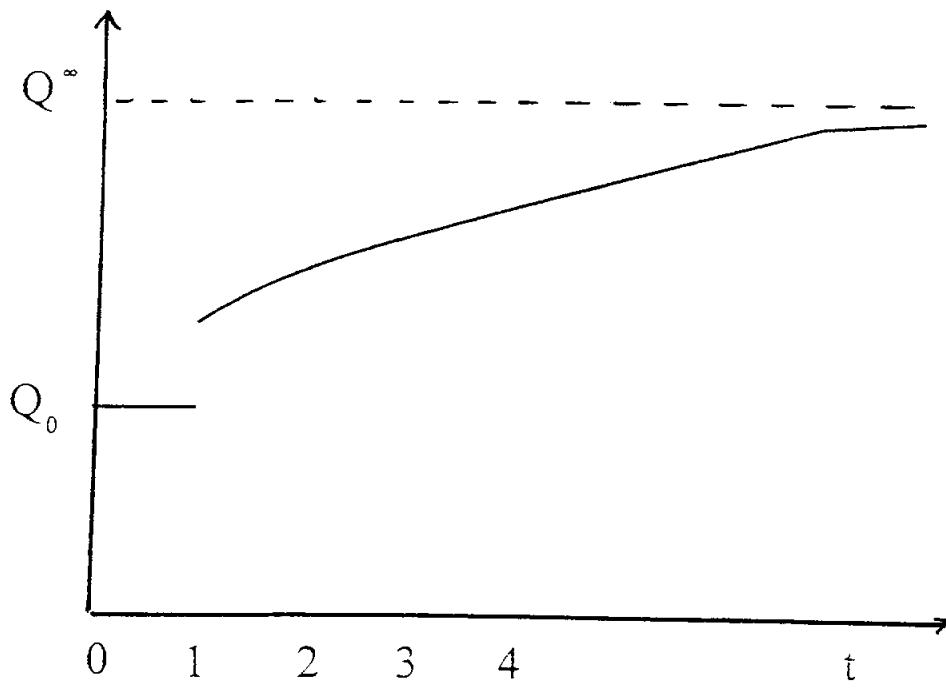


Figure 2b)