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By: Maxim Bouev

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Maxim Bouev
St.Antony's College
Oxford OX2 6JF
UK
maxim.bouev@sant.ox.ac.uk

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Abstract

This work suggests a development of the seminal model of transition from plan to market economy by Aghion and Blanchard (1994). We introduce an informal sector to show that its presence can generate qualitatively different steady states, to which the economy converges in the end of transition. Two types of transitional dynamics are considered, and it is argued that they can help explain differences in evolution of formal and informal output exhibited, on the one hand, by East European countries and, on the other hand, by the former Soviet Union republics such as Russia or Ukraine.

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1 Introduction

It is been about 15 years since Central and East European countries (CEEC) as well as the former Soviet Union republics (FSU) embarked on a process of structural reforms to abolish the former system of central planning and establish economies based on market principles. It already becomes popular to talk about the end of transition (for some discussion see, e.g., Svejnar, 2002) as many CEE countries have joined the European Union. On the theoretical front, however, the creation of a coherent model of transition is still open to dispute.

The transition in CEE countries has led to a U-shaped response of output (Blanchard, 1997). That is, a sharp recession, that all the countries started to experience right after the beginning of reforms, was followed by a recovery. However, many countries – members of the Commonwealth of the Independent States (CIS, the successor of the FSU) – are still close to the bottom of the U-curve.

It is widely held that the principal driving force of the economies, capable of pulling them out of the downside of the U, is the private sector that emerged at the beginning of transition. Before that the private initiative was tolerated almost exclusively in agriculture while non-agricultural self-employment was either non-existent or confined to the shadow economy (Boeri and Terrell, 2002). The idea of a buoyant private sector proved so attractive that it was absorbed by many economists studying the transition. A lot of theoretical work was put forward, in which transformation was modelled as a process of a more or less gradual fade-out of the state sector and the flowering of the private firms. This view had an important implication for studies of labour markets of transition economies.

In a number of papers (Burda, 1993; Aghion and Blanchard, 1994; Rodrik, 1995; Blanchard, 1997; etc.) processes taking place in transitional labour markets were represented as shifts of labour from the shrinking state (traditionally called "old") sector to emerging private firms (the "new" sector). However, those shifts were not usually seen as a direct movement of labour from one sector to the other: periods of employment were separated by unemployment spells. In a nutshell, the simple but very appealing mechanism can be described as follows. Workers, fired from state enterprises during their restructuring, become unemployed and start to search for a job in the growing private sector. After some time more workers are hired in private firms than are laid off in the old sector, which leads to a decrease in unemployment.

These studies have become known as the OST (for Optimal Speed of Transition) literature, since many of them try to figure out what speed of labour reallocation would be optimal for the economies. Usually, such work draws upon ideas put forward by the Harris and Todaro (1970) two-sector migration model adapted to a transitional setting.

However, quite recently attention has been drawn (Boeri, 1999, 2000a,b) to the fact that this literature does not provide a satisfactory explanation of output trends in many transition economies nor does it explain a number of stylised facts concerning labour markets. The flowering of the informal economies (Johnson et al., 1997; Schneider and Enste, 2000), and a decrease in participation rates have been widely observed in Eastern Europe (Boeri et al., 1998), and, particularly, in Russia (Standing, 1998), but were ignored by the majority of OST studies. Little attention was given to labour supply (Boeri, 1999, is among rare exceptions). On the policy prescription front, the OST models have not gone further than pointing to the speed of scrapping of the inefficient sector, the level of unemployment benefits and minimum wages, as crucial in leading to the success in transformation. However, recent empirical investigations (Jurajda and Terrell, 2002, 2003) find a striking similarity in the patterns of old-to-new reallocation across countries that pursued different

approaches to the reform of the old sector and established varied labour market institutions. They stress that it appears as if the influence in macroeconomic policies was mainly manifested in the aggregate level of unemployment and wages, but not in the composition of the new sector. Other models (such as Caballero and Hammour,1996, 2000a,b), developing the Schumpeterian idea of "creative destruction", similar in spirit to the OST models, but still not directly applicable to the transitional setting, are now about to be called into play to fill in the gaps left by the OST literature. In particular, it is suggested that it is the importance of the right policy environment for promoting new start-up firms that matters after all.

In this work we argue that the critique of earlier OST models (such as, e.g., Aghion and Blanchard, 1994) is correct only in pointing to the fact that those studies do not account for a number of labour market flows observed in reality, but still they offer a general picture of transition that was hardly significantly modified in more recent and more elaborate work, allowing for better treatment of job-to-job movements and job search intensity (Brixiova, 1997), productivity shocks affecting the old sector (Garibaldi and Brixiova, 1998), labour supply (Boeri, 1999), capital relocation (Castanheira and Roland, 2000), moonlighting (Bouev, 2001), etc. However, still the substantial deficiency of the OST models is inability to account for the informal labour market, the underground economy, which presence may suggest a significantly different dynamics of output in transition.

Further, we contend that the rent appropriability problem, embedded in the Caballero and Hammour (1996) set-up and crucial for policy implications underscoring the importance of creating vigorous incentives in the expanding sector, is effectively present in the seminal Aghion and Blanchard (1994) work. At the same time, the more recent strand of the OST studies (*inter alia* Brixiova, 1997; Garibaldi and Brixiova, 1998; Boeri, 1999, 2000b) misses out on this aspect because of slightly different assumptions regarding functioning of markets and matching between firms and workers.

The goal of this paper is to provide an example of a simple model, an extension of the work by Aghion and Blanchard (1994), that is not only able to generate the type of dynamics suggested by the previous OST studies, but also shows that qualitatively different equilibria are possible for various sets of policy parameters in the presence of the informal sector. We suggest that while a choice of the pace of transition (a principal instrument in determining the success of transformation in preceding OST studies) is important for the total welfare of the economy, it is the policies towards the emerging new firms and informal sector that define the eventual outcome of transition. In particular, we stress the importance of certain labour market conditions (such as wage mark-ups in the emerging new and informal sectors) as well as of a broader effect of various institutions on the comparative profitability of new formal and informal firms. The numerical simulations indicate that the dynamics of a sustained L-type experienced by Russia and other former USSR countries during the 90s may be explained by the convergence to a steady state qualitatively different from the one likely pursued by the East European transition economies.

The work is organised as follows. The next section is devoted to the critical review of OST literature. Section 3 presents a simple model of transition in the presence of the informal sector, derives main theoretical results, considers numerical simulation, interpretation of dynamics and explains main findings. Section 4 concludes.

2 Background

2.1 Optimal Speed of Transition Literature

2.1.1 Theoretical Models: The Picture of Transition

The experience of Central and Eastern Europe in the early 90s was that of the output decline at the start of the process of economic transformation, when state inefficient enterprises began to restructure or close down, unemployment grew as capital and labour were reallocated across sectors, while the new private firms came forth. A number of scholars (to name just a few - Burda,1993; Aghion and Blanchard,1994; Rodrik, 1995; Atkeson and Kehoe, 1996; Commander and Tolstopiatenko, 1996; Gavin,1996, Ruggerone, 1996; etc.) took up the issue of explaining the transitional output fall and unemployment theoretically and initiated a strand of the literature later called the Optimal Speed of Transition (OST) work. The name comes after the attempts of many authors to look into the problem of finding the speed of resource relocation that would be socially optimal. The issue was especially relevant in the light of the ongoing debate about gradualist versus shock therapy approaches to reforms in the region (e.g. Roland, 1996).

As Boeri (1999) argues all such OST studies can be seen as developing the ideas of Harris and Todaro (1970) migration model in the transitional backdrop. The host of models is normally of search in the labour market type, applying the matching function (Pissarides, 2000) and the labour market flow approach (Blanchard and Diamond, 1992). The two main exceptions, Castanheira and Roland (2000) and Castanheira (2003), use the Ramsey growth model as a framework. All the OST models can also be split into two main categories: partial equilibrium (Aghion and Blanchard, 1994; Ruggerone, 1996; Brixiova, 1997; Shimer, 1997; Garibaldi and Brixiova, 1998; Boeri, 2000b, etc.) and general equilibrium models (Atkeson and Kehoe, 1996; Castanheira and Roland, 2000; and Castanheira, 2003). The general equilibrium models as a rule devote less attention to labour markets but provide a very good set-up for the analysis of various economy-wide policies. The partial equilibrium models focus narrowly on labour market flows and policies, but their numerical simulations still are broadly consistent with those of the general equilibrium models and the main stylised facts. In particular, all the models feature a declining old sector, a growing new sector, inverted U- or L-shaped development of unemployment. Job creation comes from the new firms, while the old sector is responsible for most of the job destruction. Reallocation of workers is driven by job destruction and creation. At the beginning of transition job destruction dominates over job creation, but in a later stage they come into balance (see Haltiwanger et al., 2003, for discussion of main stylised facts).

2.1.2 Speed of Transition Matters

In addition to be in seemingly good accordance with the early evidence, the OST models suggested their own vision on the gradualism versus big bang debate. They addressed the issue by showing that too slow or too high a speed of transition (in their context a speed of scrapping of old sector employment) can have an adverse effect on the outcome of transformation. Thus, on the one hand, Aghion and Blanchard (1994) and Chadha and Coricelli (1994) paid close attention to explicitly introduced fiscal externalities. In the economy where unemployment acts as a disciplining device (Shapiro and Stiglitz, 1984) in lowering pressure on wages in the emerging sector, the government may be tempted to go for excessive scaling down of old enterprises. This, however, will lead to an increasing tax burden on new sector firms as the growing number of

unemployment benefit claimants calls for raising tax rates in the emerging sector while the old sector tax base is eroding. Transition may be brought to a halt because of the adverse effect of taxation. At the same time, too slow a speed of transition can be detrimental as well: low unemployment can squeeze new sector profits by driving up wages. On the other hand, Castanheira and Roland (2000) suggested another transmission mechanism, namely savings. For example, if the speed of transition is too high, a high unemployment rate means lower savings, and hence investment, that eventually leads to depression of output. The optimal speed should level off various counterbalancing effects and maximise the economy's net output (Burda, 199; Aghion and Blanchard, 1994; Brixiova, 1997) or life-time utility of consumers (Castanheira and Roland, 2000; Castanheira, 2003). What is the optimal speed in practice? The question was left down to empirical research.

2.1.3 Are the OST studies any good?

More recent OST studies have confronted their predecessors with the data more thoroughly and argued that they fail to incorporate several features of the transitional labour markets that are very important in reality. In particular, it is claimed that the incorporation of job-to-job movements and the heterogeneous labour force (Boeri, 1999, 2000a,b) may help refine the implications for the optimal speed and, in addition, explain such stylised facts as, for example, stagnant unemployment pools or a drop in labour force participation in East European countries. Brixiova (1997) introduces job-to-job movements and shows that the duration of unemployment rises, while the optimal speed lowers as the jobless need to compete for new matches with workers searching on-the-job. Boeri (1999, 2000b) goes further and points out that heterogeneous opportunities for working in the subsistence sector may explain the drop in participation rates and the stagnancy of non-employment pool in the presence of high non-employment benefits.

Despite this success the recent OST models still turn out to be less good at explaining the behaviour of old and new sector wages as well as the behaviour of transition probabilities out of unemployment. The main stylised facts in this respect are that the average wages fell at the start of transition, but started to recover soon after (Basu et al, 2000; Jurajda and Terrell, 2002), while the new/old sector wage differentials were very significant at the start of reforms but remarkably reduced afterwards (see, e.g. Basu et al., 2000; Jurajda and Terrell, 2003); at the same time transition probabilities out of unemployment have decreased over the course in transition in many countries (see a summarising table in Bouev, 2004).

Why is the recent OST literature weak on this conformity to the evidence? On the one hand, in their work Castanheira and Roland (2000) make an impromptu simplifying assumption of free movement of labour between sectors so that there is no intersector wage differential over the course of transition. Later Castanheira (2003) corroborates it by the evidence on the declining new/sector wage differentials. On the other hand, Brixiova (1997), Garibaldi and Brixiova (1998) and Boeri (1999, 2000b) extended a one sector model by Pissarides (2000) to depict the transition as essentially an equilibrium phenomenon in the absence of entry barriers, when wages, as well as labour market transition probabilities, are constant throughout the process of transformation. Still, even in this set-up, Garibaldi and Brixiova (1998) show that the average real wages fall and then recover in the course of transition by means of introducing different productivity states in the old sector, each with a fixed wage. As the number of jobs with different productivity varies in the old sector the average wage in the economy changes as well.

Another weak spot of the recent OST models, in our opinion, is that although they incorporate more

labour market flows into the benchmark of Aghion and Blanchard (1994) and allow for the better treatment of labour market institutions, the numerical simulations of those models still are remarkably similar to those implied by the original. This is explained by that what is important in the end is not incorporation of on-the-job search, etc., but the relation between the exit rate from unemployment to employment and the wage in the new sector. This relation is essentially the same in all the models, including the most recent. The bells and whistles of the latter are undoubtedly useful policywise but they are not changing qualitatively the predictions of the backbone model: in transition the economy converges at a faster or lower speed to a steady state with the dominating new sector, unemployment follows an inverted U or L-shaped (if layoffs in the new sector are allowed) trajectory, until flows in and out of the pool of job-seekers are balanced. This qualitative consistence of the OST studies with stock adjustment in CEEC is acknowledged in Boeri and Terrell (2002).

2.1.4 Why do CEEC and the CIS differ?

There is one more important question not successfully challenged by the OST literature, namely the diverging paths of CEE and the CIS. The two regions started the transition in broadly similar initial conditions, however, the structural change has proceeded at a faster pace in CEEC than in the CIS, the development of the private sector and of non-agricultural self-employment has been much faster in the former than in the latter, unemployment reached the peak much earlier in CEEC than in the CIS and is more stagnant in the Central and Eastern Europe (Boeri and Terrell, 2002; Bouev, 2004). Over the 90s the evolution of output and employment in the CIS has resembled more a L-shaped trend, while CEEC enjoyed U-shaped patterns both in employment and output. Boeri and Terrell (2002) argue that there are at least two different labour market adjustment trajectories in the transitional arena: the one followed by CEEC experiencing significant employment adjustment, fast structural change, and high unemployment (most of which long term), and the other one pursued by the FSU (except for the Baltic states) with low responsiveness of employment to output changes, strong and persistent wage declines, slower structural change and a more gradual build-up of unemployment, which is also characterised by a relatively large turnover rate.

A possible explanation of the differences could be in the notorious speed of transition chosen: how fast the old sector has been scrapped. A different pace of old sector downsizing leads the economy to different equilibria. From the Aghion and Blanchard (1994) work it follows that these equilibria differ only in the resulting level of unemployment and wages. Indeed this can explain why unemployment in CEEC was quicker to reach the peak than in the CIS. However, the divide between the two regions seems to have had other qualitative differences. Boeri and Terrell (2002) point out that Russia and Ukraine adopted much more aggressive privatisation strategies than Poland or Slovenia and yet output and employment growth in the former two have been inferior compared to the latter two. So, the authors conclude that the differences have little to do with the alternative between rapid and gradual transition.

An attempt to explain the divergence in the behaviour of real wages and unemployment in CEEC and the CIS has been made in Garibaldi and Brixiova (1998). The authors argued that differences in such labour market institutions as minimum wages and unemployment benefits should be analysed together with differences in the labour market dynamics. Boeri and Terrell (2002) have agreed on this point and stressed that the institutional side of the labour markets, namely the design of social benefit systems, minimum wages and adjustment of wages in general, and in the old sector in particular, at least in part explains the CEE

and CIS paths. They point out that "the policy trade-offs embedded in the OST literature relate mainly to the alternative between a big-bang strategy and a gradual transition process...the OST theory cannot frame the trade-off between employment and wage adjustment in the old sector."

2.1.5 Shifting Away From the OST

It seems that what the OST models have so far excessively focused on is the policy towards the inefficient old sector (for the most recent example see Castanheira, 2003, who studies at more length subsidisation of state firms), in particular, the speed of its closure, as well as the difference in social models adopted in different countries.

However, the evidence suggests that this is not enough for satisfactory explanation of differences in experience of countries within CEE, and, in particular, between CEEC and the CIS. So, EBRD (2000) writes that "It has become increasingly clear that the distinction between fast and slow speeds of reform camouflages many important similarities and provides limited guidance on the policies that need to be taken" (p.97). Moreover, the recent empirical evidence (Jurajda and Terrell, 2002, 2003) finds a striking similarity in the patterns of old-to-new reallocation across two CEE countries that pursued different approaches to the reform of the old sector and established varied labour market institutions. They point out that it appears as if the influence in macroeconomic policies is mainly manifested in the aggregate level of unemployment and wages, but not in the composition of the new sector. As regards the CIS versus CEEC experience - the low unemployment benefits and minimum wages could indeed facilitate the drop in wages and support the employment in the old sector - the argument of Garibaldi and Brixiova (1998) and Boeri and Terrell (2002), but, at the same time, following the logic of the OST theory, while often acting as wage floors (Boeri, 2000), they should have reduced wage pressure and increased profit margins in the new sector to lead to its faster development. However, it has never happened.

Weaknesses of the OST theory have resulted in that it has become increasingly popular to invoke other models to expound the transition in Eastern Europe. In particular, a strand of the developing economy literature, building upon the Schumpeterian idea of "creative destruction" (in particular, Caballero and Hammour,1996, 2000a,b), has been called into play, although, some assumptions (e.g. profit maximisation in the inefficient sector) do not make it directly applicable to the transitional setting. The literature shares a great deal of similarities with the OST theory, but it also pays some special attention to the inefficiencies in the job creation process. In particular, it stresses that if investment (in its broad sense) in the expanding sector is specific, the generated quasi-rents may be appropriable by workers/unions/government, etc., increase investment costs to firms and slow down the adjustment process. This takes the debate on gradualism to its new level: it is not only the speed of destruction that matters, but boosting job creation through eliminating inefficiencies which is immensely important too. Caballero and Hammour (1996) argue that policy analysis must go beyond gradualism versus cold turkey debate, and examine the managed adjustment policies needed in the face of unbalanced restructuring. The economy's ills are ultimately institutional in nature. An appropriate macroeconomic policy should create favourable climate to job creation in the expanding sectors and support employment in the contracting sectors.

2.1.6 Specific Assumptions

This part of the argument is well understood by many scholars contributed to the development of the OST theory. In general, many agree that the superior growth performance of new private firms in transition seems to raise important policy questions regarding the development of an economic and legal environment which is conducive to start-ups (Jurajda and Terrell, 2000; Haltiwanger et al., 2003). Boeri and Terrell (2002) note that the CIS, for instance, is known for significant entry barriers associated with mafia and smuggling that slow down the take-off of the new sector. Johnson et al. (2000b) provide evidence supporting Johnson et al. (1997) that Eastern Europe and the FSU are diverging largely because of differences in the protection of property rights. They note that efforts should be made to stabilise the country's regulatory environment and to develop market-supporting infrastructure. Haltiwanger et al. (2003) stress that this point ties in with the widely held view (see e.g. EBRD, 2000) that it is the differences in legal infrastructure that mainly explain the diverging paths of CEE and CIS transition countries.

In order to effectively address this side to the transition at a theoretical level, one should scrutinise creation of job places in the new sector. However, it is difficult, if at all possible, to do with the help of the recent OST studies because job creation is modelled there in a specific way. In particular, it is assumed that in the absence of entry barriers, and while capital markets are perfect and workers and firms have perfect foresight, the value of created vacancy in the new sector is constant in and out of the steady state of a system of differential equations describing dynamics of the economy. Then, given the assumption of constant returns in the matching function, vacancy creation always has to respond proportionally to the size of the pool of job-seekers, as if firms were able to close or open up vacancies instantaneously, or, in other words, enter or leave the market unimpeded. Thus, vacancy creation turns out to be a jump-variable so that it keeps the economy on the equilibrium transition path along which the market tightness is constant, which drastically simplifies the analytical complexity of such models. Then the economy always resides in a steady state of a system of Bellman differential equations, while the transition reallocation is essentially an equilibrium phenomenon. Such modelling of the job creation process, while being a fair theoretical exercise, assumes no inefficiencies and defies analysis of many possibilities that could slow down the development of the new sector. Not surprisingly the attention of students of transition has started to shift away from the OST theory.

However, it turns out that the backbone model by Aghion and Blanchard (1994) still has something to offer. In contrast to more recent studies it does not assume that transition occurs in perfect circumstances, where firms can immediately inundate the market with vacancies if need be. Instead, vacancy creation becomes proportional to the pool of job seekers only in a steady state. Out of it the economy develops under the specific assumption that new sector firms do not face matching problems - still a realistic hypothesis in the presence of high transitional (often involuntary) unemployment and some entry barriers. This particular type of matching allows the authors to simplify the algebra. In such a set-up vacancy creation becomes more explicit, and allows closer examination. In particular, it is assumed that vacancy and, hence, job creation is a function of profits, which are not driven to nil by firms freely flooding the market. Thus the vacancy rate no longer jumps to keep the market tightness constant, so that one can address explicitly the question of influence of various factors on the ability of existing firms in the new sector to expand. This suggests that a parallel to Caballero and Hammour (1996, 2000a,b) approach may be drawn. In order to facilitate solution of a system of Bellman differential equations out of steady state, Aghion and Blanchard

(1994) make a simplifying assumption of a wage mark-up in the new sector, interpreting it by efficiency wage considerations. However, it can readily be shown that it is also, in fact, one of the ways to represent the rent appropriability problem in the spirit of Caballero and Hammour (1996). We shall return to this point later in section 3.7.

2.1.7 Summary

So, where do things stand? In this section we have seen that all the OST models provide a similar picture of transition despite a variety of their modifications put forward. On the policy front the literature emphasises the importance of proper engineering of the job destruction in the old inefficient sector, and a reasonable choice of social support programmes (unemployment compensation and minimum wages). The job creation part of the transition process has received little or no attention in the theory, apart from the benchmark model. Other literature from the development economics realm was enlisted to fill in this gap and to provide a better guidance in policy-making. The major question is still to be answered is why the CEEC and CIS experience has been so different. Thus far, no theoretical model has been satisfactory in giving a clue.

In the next subsection we review some more stylised facts that were missed out on by the OST studies. Then we go further to suggest our own modification of the theory.

2.2 Expanding the seminal model

2.2.1 Facts to be explained

In his impugning the OST literature Boeri (1999, 2000a,b) points out that the drop in participation rates is what the theory should *inter alia* incorporate to provide a better account of reality. Boeri and Bruno (1997), Boeri (1999), and Bouev (2004) find that flows into inactivity are widely observed in both Eastern Europe and the CIS and take place mainly through unemployment. This drop in formal labour market activity is likely to be connected with a rise in the share of the informal sector (Schneider and Enste, 2000). For instance, EBRD (2000) refers to the importance of new private sector activity in the informal economy.

The striking stylised fact is that while the informal sector was expanding in many transitional economies in the beginning of the 90-s (e.g., see the data provided by Johnson et al., 1997; Lackó, 2000; Feige and Urban, 2003), it has been especially notable in the FSU countries such as Russia or Ukraine. Even in such a rapidly and successfully reformed economy as Estonian at the beginning of transition hiring and creation disproportionately occurred for workers with informal or temporary contracts (Haltiwanger and Vodopivec, 2002). In the CIS the irregular activities are still likely to keep on mounting. EBRD (2000) reports that employment in the CIS has a higher informal share than in CEE.

These facts suggest that flows to inactivity and informal employment have been important in labour force reallocation in transition. The way economies develop cannot be completely described by ignoring such phenomena. The truth, however, is that these facts were passed over by the majority of the OST studies.

2.2.2 Moving to Modelling

Not all the OST studies have ignored the role of the informal sector in adjustment of transitional labour markets. So, in their contribution to the OST thought Commander and Tolstopiatenko (1997) have modelled the new sector as representing the informal economy. Boeri (1999, 2000b) has focused on the role of the

subsistence sector in affecting labour reallocation. Both models are essentially of two-sector type, and either look at transitions between formal and informal parts of the economy (Commander and Tolstopiatenko, 1997), or assess the reallocation between the old and new sectors when implicit outside opportunities are present (Boeri, 1999, 2000b). Technically their results are hardly different from the rest of the OST literature - the labour moves between two destinations in the presence of non-employment (either active or passive in the case of Boeri's models). However, in these models the presence of the informal sector in the course of transition does not generate any adverse externalities on the rise of the new formal sector, in which development the ultimate objective of transformation is contained. Meanwhile, Caballero and Hammour (1996) has pointed to the existence of such externalities. In particular, they argue that many crisis situations are characterised by quick destruction of jobs in one sector and sluggish creation of jobs in another sector, so that an employment problem develops. Many workers who lose their jobs in the contracting sectors find themselves either in the overt unemployment, if some form of unemployment compensation is available, or being forced to take on employment in the informal sector. The authors show that the presence of the informal sector can slow down the adjustment process. This happens, for example, when its productivity rises, so that the possibility of engaging in informal sector activity strengthens workers' threat point in wage negotiations with the formal expanding sector. Obviously it squeezes profits and hampers job creation process, especially in the presence of specific investment that can be held up by workers.

Keeping in mind a differing experience of CEEC and the CIS as far as the development of the informal sector is concerned, one can ask a question: Is it possible that the diverging paths of the two regions in general are explained by such an interplay of the new formal and informal sectors in the presence of inefficiencies similar in spirit to ones described by Caballero and Hammour (1996, 2000a,b) and, perhaps, some other factors?

In the next section we offer our own vision of what has been going on in CEEC and the CIS. We suggest a very simple development of the Aghion and Blanchard (1994) model to incorporate an informal sector. We then show that this addition generates qualitatively different equilibria from those present in the OST literature. In particular, the economy does not necessarily always converge to a steady state where the new sector prevails in the end of transition. In some cases the informal sector wins. We believe that existence of such equilibria may explain the divergence of the course of CEE and the CIS countries, such as Russia or Ukraine, in the 90s. We illustrate how important the interplay of the formal new and informal sector can be, and that it is the policy towards the new formal sector that matters after all for the eventual success of transformation. A direct parallel to arguments by the Caballero and Hammour models can clearly be seen.

3 A Dynamic Model of Transition with an Informal Sector

In this section we present an OST-type dynamic model of labour force reallocation in transition in the presence of an underground sector.

The model suggests that depending on different combinations of policy parameters as well as other factors conducive to more or less effective job creation in the new sector relative to the informal sector, the economy ends up either in the steady state without the underground economy, or in the steady state where it is present. For a range of parameter values the informal sector completely crowds out the new formal sector in

the steady state, which thus effectively implies a complete failure of transformation. Numerical simulations of the model show that irrespective of the type of the steady state, the drop in participation rate (observed in many transition economies over the 90s) can be an inherent part of transition.

We describe main assumptions and the idea of the model in the next subsection.

3.1 Main Assumptions

Consider an economy consisting of three sectors: two official sectors - old and new, and one informal sector.

By the old sector we understand all those state enterprises that are not efficient, possess large stocks of obsolete capital and are expected to be liquidated during the transition. Here we do not model the restructuring process of old enterprises[1]: we simply assume that the reforms initiated in the economy inevitably lead to the reduction in *old* sector employment, happening at some rate γ, - a parameter, which can in principle be affected by the government. Following Commander and Tolstopiatenko (1996), we assume that these firms do not invest. This could happen because either insiders have enough power to extract all surplus or some part of revenue is defalcated or wasted.[2] Old enterprises do not hire in our economy, they just shed labour.[3] Workers in the old enterprises earn some fixed wage w_o in general equal to their product in the sector.

By the new sector we understand *de novo* (newly established) private enterprises and successfully restructured former state enterprises that have productivity $y > w_o$ and offer a flexible wage. These firms invest their profits causing the economy to grow. We abstract from accumulation of physical or human capital in this model. All investments in fact go into new job creation.

The informal sector is understood as a whole range of activities including subsistence activities, home production (e.g. work on worker's own land plot), informal entrepreneurship, unregistered activities of formal firms. We will think of firms in this sector as entities essentially similar to their new sector counterparts, i.e. having the same productivity level, y, setting a flexible wage according to the same general bargaining rules, and investing their profits in job creation. The difference between the two sectors is that the government levies taxes on the new firms, while the informal firms evade taxation. Also, as we shall see later, the ability of government to monitor the informal economy implies a higher death rate of informal firms as opposed to new firms, and, as a result, a higher turnover of labour force in the sector.

We assume that both new sector and informal firms hire from the pool of non-employed workers. Direct shifts between employment in one sector and employment in another are excluded.[4]

[1] Aghion and Blanchard (1994) consider a variant of their model where a part of old enterprises is being restructured rather than simply closed.

[2] Boeri and Terrell (2002) note that in some CEEC (e.g., Poland, Hungary and Slovenia) and in Russia the so-called worker councils or collectives had some control over the appointment of managers, wage setting and the allocation of profits, which generally went to workers.

[3] Layard and Richter (1995) note, that in Russia, for example, most of the unemployed are eventually rehired in old state enterprises rather than in the new private sector. However, according to Clarke (1999) this happens mainly due to churning (i.e. the worker movement between exhisting workplaces, which is left out of our model), but not due to creation of new jobs. Clearly, in exacerbating conditions of economic slump creation of new job places requires at least some degree of restructuring, which within the limit of our model would imply that such enterprises already belong to the new sector. Generally speaking, what essential for our analysis is not the fact of hirings (or their absence) in the old sector, but is that the size of the old sector itself shrinks in the course of transition, thus providing labour resources for the new sector and informal economy.

[4] The assumption of reallocation through the unemployment pool, made also in many other OST studies, is countered by Brixiova (1997) and Boeri (2000), who argue that the reallocation of labour in the transition between the old and new sectors has not only been through the unemployment pool but often through a mechanism of direct job-to-job shifts.

Still, this assumption can be justified on several grounds. First and foremost, one can think of the non-employment pool in

Workers in the economy can find themselves in four possible states: old sector employment, new sector employment, informal employment and non-employment. Moonlighting (i.e. simultaneous job holding in two sectors at a time) and on-the-job search are not possible. Workers involved in informal businesses drop out of participation in the formal part of the economy and can be considered inactive.

The transition is viewed as reallocation of labour from old sector enterprises to more efficient firms in the new sector or/and informal economy. At the beginning of transition the economy is dominated by old sector firms. Ultimately, the basic mechanism implied by the model is as follows.

The old sector is shrinking because of job break-ups. The new sector and the informal sector both create new vacancies and start growing. Thus, workers getting unemployed in the old sector can find a job either in the new sector or in the informal economy. In the latter case they drop out of participation. While in the new or informal sector workers can be fired and become non-employed. If a worker loses her job in the informal sector, joins the ranks of non-employed and starts searching for a new job, she effectively comes back into participation (the reallocation flows and transition probabilities are shown in Fig.1).

The level of wages in the old sector is given. Firms both in the new and informal sector negotiate wages with workers through a process of Nash bargaining. It is assumed that firms do not face matching problems, but make some "specific" investment when they create a job. This presents an inefficiency, such as a rent-appropriability problem in the spirit of Caballero and Hammour (1996), that allows workers to extract some additional surplus from the match so that the value of being employed either in the new or informal sector turns out to be always higher than the value of being non-employed. Thus, employment is more attractive to workers than non-employment.

The wage rates in the new and informal sectors determine their profit rates, on which basis firms in these sectors can work out a number of job vacancies to create. The latter impacts on the exit rate from non-employment, and drives the dynamic process which describes how the economy evolves over time.

Now we can get round to considering the model in more detail.

3.2 Workers

It is assumed that the overall number of workers (working age population) available in the economy as a whole is constant and normalised to 1. This implies that the size of the labour force (labour supply in the formal economy) may vary depending on the size of the informal sector.

Workers can either be employed in only one of three sectors at a time or search for jobs while non-employed. It is assumed that if employed they never leave employment voluntarily to start looking for another job. This assumption is implicit for old sector employment, that workers may value more than unemployment because of some additional characteristics (e.g. non-pecuniary benefits) that are not specified in the analysis

a broader sense, for example as consisting both of unemployed workers and so-called concealed unemployed. The latter group may include workers in the old enterprises compulsorily sent on an "administrative leave" (as was all too often happening in, e.g., Russia), employees put on short-time due to absence of work for them, workers with partial payment or even without pay (but still preserving access to some non-wage benefits), etc. (Clarke, 1999). Such workers can and do in fact often spend their additional free time looking for other jobs in formal or informal sectors. When they find a job and are hired - a direct job-to-job shift is registered in reality. Within the limits of our model this is captured by the transition from non-employment to employment. Secondly, and importantly for the purpose of our study, we have argued in the background section that while inclusion of job-to-job transitions provides a useful set-up for analysing certain labour market policies, it still does not change the qualitative dynamics of the system. As we concentrate our efforts not on taking into account as many of labour flows as possible but rather on analysing in general the dynamics and the eventual outcome of transformation of an economy with the informal sector, the assumption of hirings solely from non-employment holds out well. Finally, as has also been mentioned above, flows into inactivity (which also include outflows into the informal economy) take place mainly through unemployment.

that follows. However, we shall see later that predilection for employment over non-employment in emerging sectors is guaranteed by inefficiencies in the job creation process that feeds through into wage setting.

Workers earn a fixed non-employment compensation b_u[5] if they are jobless, a fixed wage, w_o, if they are employed in the old sector, and flexible wages w_n or w_i if they are in new or informal sector employment, respectively. We make the process of wage determination more explicit in section 3.7.

3.3 The Old Sector

The wage rate in the old sector, w_o, is fixed and assumed exogenously given. We postulate that old firms do not invest and do not hire, they just shed labour at exogenously given rate γ. Also old sector insiders are presumed to have enough power to extract all the rents so that, by and large, w_o represents worker's product in the sector.

3.4 The New Sector

Wages in the new sector are set flexibly at any level below worker's product in the sector, y. This product is greater than its counterpart in the old sector, w_o, - the fact which reflects higher productivity of new firms compared to old enterprises. New sector profits are taxed at some rate τ by the government and the remaining proceeds are invested into job creation. In section 3.7 we discuss wage determination and investment decisions in this sector in more detail. Finally, new sector firms are assumed to have no problem filling a vacancy, i.e. there is no matching problem for the firms.

The Bellman equation for a worker in the new sector can be written as:

$$rV_n = w_n + \lambda (V_u - V_n) + \frac{\partial V_n}{\partial t}, \tag{1}$$

where r is the interest rate, λ - is an exogenous probability[6] of job loss in the sector, V_n and V_u are the worker values of being employed in the new sector and being non-employed. The arbitrage equation states that the return on being employed in the new sector is equal to the utility drawn from wage w_n in the new sector less the expected loss from losing the job plus the change in the value of being employed in the new sector over time.

We assume that λ in the equation above represents some economy-wide shock leading to job break-ups. The magnitude of this shock may be greater than the rate of job destruction in the old sector, γ, if government accommodates part of the effect of the shock (for example, by subsidising the old sector) on old sector enterprises. Alternatively, it may be lower than γ if government speeds up the restructuring of old enterprises and goes on with reforms more vigorously.

Workers do not leave the new sector to become employed elsewhere because by assumption they can either produce or search for new jobs, i.e. perform only one activity at a time.

[5] Although we focus in this work on unemployment corresponding to the ILO definition, for simplicity we assume that all non-employed receive unemployment compensation from the government. In general, what is important for our further analysis is not the existence of non-employment benefits as such but the ability of the government to affect the utility of non-employed workers.

[6] Hereafter we deal only with flow probabilities as customary in the theory of matching functions. Such probabilities can take any value between zero and infinity, as according to a Poisson process they represent an average number of workers hired or laid off depending on the context. These probabilities do not have to be below one in the general case (for more details see, e.g., Saint-Paul, 1996; Pissarides, 2000). However, in our model we assumed that the labour supply in the economy is normalised to 1, so all the transition probabilities must be below 1.

3.5 The Informal Sector

Characteristics of the informal sector are very similar to those of the new sector. It is assumed that worker's productivity, y, is equal to her productivity in the new sector[7], firms do not face matching problems, set flexible wages and invest their profits (see section 3.7 for more detail). These assumptions are justified by the fact that in reality it is often the same new sector firms that run part of their businesses underground by hiring informally to escape taxes and high social security contributions (De Soto, 1989; Boeri and Garibaldi, 2001). Also the rich literature on the informal economy (for some discussion see Johnson et al., 2000a; Schneider and Enste, 2000) observes that tight regulation of the formal sectors, exposure to corruption and high barriers to entry force many entrepreneurs, who would otherwise have run their enterprises formally, start business in the shadow.

One of the differences between informal and new sector firms in our model is that profits of the former are not taxed by the government as taxes are effectively evaded in the informal sector. Another difference is that job destruction rate, and hence, labour force turnover are higher in the informal economy (for some corroborating evidence from developing countries see, e.g., Hoek, 2002). This can be due to monitoring or auditing activities of such bodies as tax police. Alternatively, there may exist some sector specific risks (e.g. exposure to criminal racket) leading to more job destruction in the absence of formal job security regulations.

Thus, the asset value of informal employment for a worker is given by

$$rV_i = w_i + (\lambda + \mu)(V_u - V_i) + \frac{\partial V_i}{\partial t}, \tag{2}$$

where w_i is the informal wage; λ - is, as before, an economy-wide shock leading to job loss, while μ is an idiosyncratic (sector specific) shock. Henceforth, we will assume that μ reflects the effect of monitoring activities carried out by the government, which, thus makes μ a possible policy parameter.

The arbitrage equation (2) states that the return on being in the informal sector is equal to the rate of informal income plus a change in the value of informal employment over time.

We do not consider direct shifts between new and informal employment assuming that full-time engagement in these firms do not leave workers enough time to perform job search (even when employment in one of the sectors brings worker a higher value then in the other sector). Also, if one thinks of the informal sector as representing low-tier jobs as opposed to high-tier new sector jobs, the impossibility of direct movements into new sector employment may be explained by deterioration of human capital in the informal sector.

3.6 Non-employment

Workers are *non-employed* when they are not working in any of the three sectors. While being non-employed a worker faces the following possibilities: she can find a job either in the new or the informal sector, or she can remain jobless.

Let assume that non-employed workers perform undirected search for jobs, i.e. the probability of moving into the new sector is independent of the probability of moving in the informal sector. Then the value of being non-employed is:

[7] We shall see later on that this is just a simplifying assumption which does not affect qualitatively the conclusions of our analysis.

$$rV_u = b_u + p_n (V_n - V_u) + p_i (V_i - V_u) + \frac{\partial V_u}{\partial t}, \tag{3}$$

where b_u is non-employment income (which *inter alia* depends on unemployment compensation); p_n is a probability of moving into the new sector; p_i is a probability of moving into informal jobs. Thus, the return on being non-employed includes utility from non-employment benefits plus the expected gain from changing into new sector or informal employment plus the change in the value of being non-employed over time.

3.7 Wages and Job Creation in the New and Informal Sectors

Collecting together all the arbitrage equations we get the following system of Bellman equations:

$$\begin{aligned} rV_n &= w_n + \lambda (V_u - V_n) + \frac{\partial V_n}{\partial t} \\ rV_i &= w_i + (\lambda + \mu) (V_u - V_i) + \frac{\partial V_i}{\partial t} \\ rV_u &= b_u + p_n (V_n - V_u) + p_i (V_i - V_u) + \frac{\partial V_u}{\partial t}. \end{aligned} \tag{4}$$

3.7.1 Wage determination

In our economy employment is assumed to be always better than non-employment. In the two emerging sectors it is modelled by assuming that wages in both new and informal firms are continuously set so that the value of corresponding employment is higher than the value of being non-employed. This is expressed by the two wage mark-up conditions:

$$V_n - V_u = c, \tag{5}$$

$$V_i - V_u = m, \tag{6}$$

for the new and informal sector, respectively, where c and m are some constants.

One can think of a number of reasons underpinning conditions (5) and (6).

Firstly, even if firms do not face matching problems and have all the bargaining power to hold down workers to their reservation value (i.e. V_u), they still may have to pay mark-ups over the value of non-employment to ensure, for example, that workers do not shirk. Other similar considerations from efficiency wage theories may equally be applicable here.

Secondly, the value of mark-ups, c and m, may reflect differences in preferences of workers over formal and informal work. For example, c may be viewed as disutility of working hard in the new sector, while m as disutility of working in the informal sector. This latter disutility can be derived from the value of formal pensions that informal workers forego, or from the feeling of guilt informal workers undergo while in the shadow sector.

Thirdly, Kehoe (1994) suggests that mark-ups similar to the ones above arise from introducing moral hazard into the job search. He illustrates that by supposing that workers can put an unobserved effort into

searching that allows them to find matches with positive probability as opposed to other workers who do not put any effort in and do not find matches. Putting effort into search is costly and workers will do so if and only if the future flow of consumption compensates for their actions. Thus, there must be a gap between the expected utility of workers who find new matches and those who do not.

Fourthly, in the spirit of Caballero and Hammour (1996) the mark-ups can reflect the different degree of appropriability of quasi-rents in the new and informal sectors. In particular, appropriability or hold-up (in the terminology of Acemoglu and Shimer, 1999) of investment is a problem of incomplete contracts that can afflict the efficiency of job-creating transaction between a firm and a worker. When part of the investment is "specific" to the firm and a binding and complete contract cannot be written, the firm fails to hold sway over the quasi-rents attributable to the investment. Then the ability of a worker to renegotiate and hold up the investment insures that the value of employment within a sector is greater than her non-employment utility.

Finally and somewhat related to the previous point, values of the two mark-ups may be affected by the existence of separation costs, redundancy pay, or relative bargaining power of workers and firms. Again, as in Caballero and Hammour (1996), it is often the ability of workers to exert enough bargaining power and renegotiate the contract that generates conditions (5) and (6). We illustrate this in more detail in Appendix A.

The mark-up conditions imply that $\frac{\partial V_n}{\partial t} = \frac{\partial V_i}{\partial t} = \frac{\partial V_u}{\partial t}$. Then by subtracting the third equation in (4) from the first and the second and using the mark-up conditions we obtain expressions for wages in the new and informal sectors, respectively:

$$w_n = b_u + (r + \lambda)\, c + p_n c + p_i m, \tag{7}$$

$$w_i = b_u + (r + \lambda + \mu)\, m + p_n c + p_i m. \tag{8}$$

Thus, the wages of a worker in the new and informal sectors depend on the level of non-employment income (which effectively provides a wage floor in our economy), job break-up rates, wage mark-ups, and probabilities of finding a job in both considered sectors. The wages are not constants, but rather are functions of the market tightness: job finding probabilities p_n and p_i are expressed as ratio of job creation rates in a particular sector to the pool of non-employed.

The wage differential between the new and informal sector is given by[8]:

$$w_n - w_i = (r + \lambda)\, c - (r + \lambda + \mu)\, m. \tag{9}$$

3.7.2 Job creation

As we have gathered from the background section, the job creation process is a foible of the OST literature. Here we follow the approach of Aghion and Blanchard (1994), assuming that firms in the new sector and

[8] If we explain the mark-ups c and m by hold-ups of firm-specific investment the resulting wage differential echoes the Caballero and Hammour (1996), who write: "When the degree of asset specificity and appropriable quasi-rents differ across sectors - as is normally the case, for example, between the formal and informal sectors - it is very natural that wages also differ in equilibrium. Appropriability can thus very naturally account for labour market segmentation, which is preponderant feature of labour markets in the developing world."

the informal economy invest out of retained profits.[9,10] In the simple version of the model borrowing is not possible due to underdeveloped financial markets - in section 3.11.1 we relax this assumption. The flow of investment transfers into the job creation in the absence of capital accumulation which is left out of the scope of this work.[11]

In the most general specification we define the amount per worker of investment into new job creation by

$$J_n = \alpha(\tau, \zeta)(y - w_n) \tag{10}$$

and

$$J_i = \beta(\mu, F, \xi)(y - w_i), \tag{11}$$

depending on whether she belongs to the new or informal sector, respectively.

In the two equations above y is the product/output per worker in the sectors; w_n is the wage in the new sector; w_i is the informal wage; $\alpha(\cdot)$ and $\beta(\cdot)$ are two functions that capture the effect on job creation/investment of various institutional factors and government policies towards either the new or the informal sector. We assume that both $\alpha(\cdot)$ and $\beta(\cdot)$ can take on values in between 0 and 1.

In the case of the new sector, $\alpha(\tau, \zeta)$ may depend on the tax rate levied on new firms, τ, as well as less tangible characteristics such as a level of corruption that makes life of formal firms more difficult. We use catch-all variable ζ to denote such factors. Ruggerone (1996) calls α the reactivity of new jobs creation to profitability. Blanchard (1997) notes that α is in fact very important for the development of transition: the more various constraints and adjustment costs facing the new sector the lower is α. The logic here is as follows. If an economic environment is favourable then the probable value of α is close to 1, which implies that firms can use all their profits (the output less the wage rate in our case) for investment, i.e. new job creation. Otherwise, if the economy is highly regulated or even corrupt the profits of new firms might be taken away through excessive regulation, taxation, corruption (e.g. bribing), etc. This has been the case of a number of transition countries, and Russia in particular (see Johnson et al., 1997). In such a situation the value of α is much lower than 1, and opportunities for job creation are scanty.

We assume that $\frac{\partial \alpha(\tau,\zeta)}{\partial \tau} < 0$ and $\frac{\partial \alpha(\tau,\zeta)}{\partial \zeta} < 0$, where ζ captures other (apart from taxes) factors "unfriendly" to new sector job creation.

In a similar vein, $\beta(\cdot)$ is the factor that defines the reactivity of informal job creation to profitability. It can depend on the level of monitoring of informal activities by the tax police, μ, the level of fines charged for running informal businesses, F, and other factors (e.g., such as existence of criminal rackets), represented by another catch-all variable ξ. Again we assume that $\frac{\partial \beta(\mu,F,\xi)}{\partial \mu} < 0$, $\frac{\partial \beta(\mu,F,\xi)}{\partial F} < 0$, and $\frac{\partial \beta(\mu,F,\xi)}{\partial \xi} < 0$.

[9] The results of the survey by Bratkowski et al. (2000) show that imperfections in capital markets in Central European economies do not seem to actually inhibit the growth of new private firms. Johnson et al. (2000b) argue that the reason for that is existence of an alternative to external finance, namely reinvesting their own profits. Lizal and Svejnar (2000) find that in the Czech Republic retained profit is a major determinant of new investment. Their results indicate that Czech firms cannot easily borrow investment funds externally and that net investment varies with retained profits. Pissarides et al. (2003) provide evidence that Bulgarian and Russian small and medium firms use internal finance to fund investment projects, but that constraints on external financing limit in important ways their obility to expand production.

[10] Another explanation for this specification of job creation can be costs of adjustment (learning-by-doing, accumulation of information, etc.).

[11] Capital accumulation issues are taken up in Castanheira and Roland (2000) and Castanheira (2003).

Importantly, in our model the definition of factors $\alpha(\cdot)$ and $\beta(\cdot)$ implies that the government can directly affect their level, thus impacting on the development of a particular sector. In general, at least one of the factors $\alpha(\cdot)$ and $\beta(\cdot)$ can be made endogenous to the system, or they can be linked together. We do not develop these opportunities in this work, rather assuming that $\alpha(\cdot)$ and $\beta(\cdot)$ depend on exogenous parameters, but we touch on possible departures in section 3.11.2.

Finally, if N and I are the numbers of workers in the new and informal sectors respectively, then the rates of job creation in the sectors will correspondingly be given by $J_n N$ and $J_i I$.

3.7.3 Open form solutions

The rates of job creation in the new and informal firms help define the transition probabilities p_n and p_i from non-employment to new sector or informal employment.

So, if J_n is the flow of created vacancies per worker in the new sector, then the rate of exit from non-employment to new sector jobs can be written as $p_n = \frac{J_n N}{U}$, where N is the number of new sector workers and U is the number of non-employed.

By the same token, transition probability p_i is equal to $\frac{J_i I}{U}$, where I is the stock of informal workers.[12]

Thus, on the one hand, wages in the new (7) and informal (8) sectors depend on transition probabilities p_n and p_i, which in turn depend on investment rates J_n and J_i. On the other hand, the investment rates in the new (10) and informal (11) sector depend on wages w_n and w_i. The system of these four equations (7), (8), (10), and (11) can readily be solved to obtain "open form" expressions for wages and job creation rates:

$$w_n = \left(y - \frac{US_n - \beta m I (S_i - S_n)}{(U + \alpha c N + \beta m I)} \right), \tag{12}$$

$$w_i = \left(y - \frac{US_i - \alpha c N (S_n - S_i)}{(U + \alpha c N + \beta m I)} \right), \tag{13}$$

$$J_n = \alpha \left(\frac{US_n - \beta m I (S_i - S_n)}{(U + \alpha c N + \beta m I)} \right), \tag{14}$$

$$J_i = \beta \left(\frac{US_i - \alpha c N (S_n - S_i)}{(U + \alpha c N + \beta m I)} \right), \tag{15}$$

where $S_n = (y - b_u - (r + \lambda) c)$, $S_i = (y - b_u - (r + \lambda + \mu) m)$, $\alpha \equiv \alpha(\cdot)$ and $\beta \equiv \beta(\cdot)$ are introduced for notational convenience.

It can be shown (henceforth see Appendix A for all technical details) that wages w_n and w_i are decreasing in the level of non-employment, U, but increasing in the size of employment in the new sector, N and the informal economy, I. At the same time both J_n and J_i are increasing in the level of non-employment, U, and decreasing in both N and I.

[12] The way we have written the transition probablities with job creation rates in the numerator reflects our assumption of no matching problem for firms. In more general case, if firms face a problem filling vacancies, the flow of hirings does not coincide with the number of vacancies posted. So, in that situation a matching function (of the number of vacancies and job seekers) will be put in the numerator instead of the job creation rates.

3.8 Dynamics

Above we considered Bellman equations for individual workers and defined rules for wage determination and job creation in the new and informal sectors. Now we can derive differential equations describing development of each sector in our model. In what follows we define by O the number of workers in the old sector, by N - the number of workers in the new sector, by I - the number of informal workers and by U - the number of the non-employed.

At the beginning of transition the bulk of the labour force belongs to the old sector. Then this employment begins to decrease at rate γ:

$$\frac{dO}{dt} = -\gamma O.^{13} \tag{16}$$

The equation (16) shows that on average γO old sector workers become non-employed each period.

At the same time, in the new sector, the dynamics of the total number of workers is described by the equation:

$$\frac{dN}{dt} = p_n U - \lambda N. \tag{17}$$

This equation reflects the fact that each period $p_n U$ workers are hired in the new sector from the non-employed ranks, while λN new sector workers lose their jobs as a result of an economy-wide shock λ.

Similarly, the informal employment follows:

$$\frac{dI}{dt} = p_i U - (\lambda + \mu) I. \tag{18}$$

Again, as in the case of the new sector a few workers are hired from the non-employment pool, $p_i U$, while $(\lambda + \mu) I$ informal workers become jobless due to the economy-wide shock λ and a sector specific shock μ.

Finally, the flows in and out of non-employment determine its dynamics as:

$$\frac{dU}{dt} = \gamma O + \lambda N + (\lambda + \mu) I - (p_n + p_i) U, \tag{19}$$

where the first two terms on the right hand side are inflows from the formal sectors, the third term describes inflows from the informal economy and the fourth term represents outflows to formal and informal employment.

Combining all the dynamic equations and substituting for $p_n = \frac{J_n N}{U}$ and $p_i = \frac{J_i I}{U}$ we obtain the following non-linear system describing the behaviour of the economy:

[13] Aghion and Blachard (1994) when considering dynamics use "change in variables" relations (i.e., e.g., $\frac{\partial O}{\partial t} = const$) rather than "rate of change" ones (i.e., e.g., $\frac{\partial O}{\partial t}/O = const$), although the latter formulation is more realistic given the interpretation of job creation through retained earnings constraint. They explain their choice by the need of better tractability of the model. However, this in fact shapes the essence of the steady states in their model, leading to discontinuities in dynamics and making steady state transition an inherent feature of their economy. Here we use the "rate of change" specification which generates smooth dynamics throughout. Then, transition is a process that occupies our economy before it reaches a steady state.

$$\begin{aligned}
\frac{dO}{dt} &= -\gamma O \\
\frac{dN}{dt} &= (J_n - \lambda) N \\
\frac{dI}{dt} &= (J_i - (\lambda + \mu)) I \\
\frac{dU}{dt} &= \gamma O + (\lambda - J_n) N + ((\lambda + \mu) - J_i) I, \qquad (20)
\end{aligned}$$

where w_n, w_i, J_n, and J_i, are determined by (12), (13), (14), (15), respectively.

The equations (20) satisfy the consistency condition $\dot{O} + \dot{N} + \dot{I} + \dot{U} = 0$ since $O + N + I + U = 1$. As functions on the right hand side of (20) are single-valued, continuous, and continuously differentiable in O, N, U, I, on the domain defined by $O \in (0, 1]$, $N \in (0, 1]$, $U \in (0, 1]$, and $I \in (0, 1]$, it can be proved (see, e.g., Kamien and Schwartz, 2001) that this system has a unique set of continuous solutions.

3.8.1 Steady states

The system (20) is in the steady state equilibrium when in addition to satisfying (12), (13), (14) and (15), $\dot{O} = \dot{N} = \dot{I} = \dot{U} = 0$. There are one trivial steady state ($N^* = 0$, $O^* = 0$, $U^* = 1$, $I^* = 0$) and three types of non-trivial ones.

Initial conditions: whence the transition? Given the way we defined job creation in the new and informal sectors (i.e. as functions of profits per worker), if the economy embarks on transition having all the labour force concentrated in the old sector, the only possible outcome is the trivial steady state: the new and informal sector simply cannot take off because there are no funds to invest into job creation. Also, as expressions in (14) and (15) indicate, one of the job creation rates J_n and J_i is necessarily negative if non-employment is nil at the start of transition. So, to ensure that the dynamic system (20) converges to one of non-trivial steady states analysed below, we need to assume that at the beginning of transition the labour force is distributed between all four labour market states: old, new and informal sector employment and non-employment. This assumption would not run counter to the existing evidence from transition countries (see, e.g., EBRD, 1999, for the share of the private sector in GDP at the beginning of transition; Feige and Urban, 2003, provide one of the most recent estimates of unrecorded economic activity in 1989-2001; Gregory and Collier, 1988, report on unemployment statistics for the Soviet Union[14]).

Thus, although we will not put the condition $O(0) = 1$, and $N(0) = U(0) = I(0) = 0$ as preceding transition, as was customary in many previous OST models, still we shall assume that the vast majority of the labour force was affiliated with the old sector, and some small fractions of workforce were involved in the new sector and the informal economy and were non-employed. This will guarantee that the economy escapes the trivial steady state and begins its journey to a non-trivial one.

Now we can move on to analysing the types of non-trivial steady states.

[14] In particular, Gregory and Collier (1988) report that, although the Soviet government claimed to have "liquidated" the unemployment in the early 1930s, many Western observers have agreed that the Soviet labour market shared many of the characteristics of its Western counterparts, including unemployment.

A steady state with the new sector alone In the steady state of the first type there exists only the new sector. From the dynamic system (20) it immediately follows that this takes place whenever $O^* = 0$, $J_n = \lambda$ and $J_i < \lambda + \mu$, while $I^* = 0$. That is, in the steady state the job creation rate in the new sector is equal to the job destruction, while in the informal sector the job creation rate is less than the job destruction rate $\lambda + \mu$. In such a situation the informal sector is not present in the steady state, neither is the old sector.

It is straightforward to show that in this steady state the number of new sector workers is equal to

$$N^* = \frac{(\alpha S_n - \lambda)}{(\alpha S_n - \lambda + \lambda\alpha c)}, \tag{21}$$

while non-employment is

$$U^* = \frac{\lambda\alpha c}{(\alpha S_n - \lambda + \lambda\alpha c)}. \tag{22}$$

This steady state occurs whenever the parameters of the model satisfy the condition

$$\alpha > \frac{\lambda\beta}{(\lambda + \mu) + \beta\,(S_n - S_i)}. \tag{23}$$

It can readily be shown that the steady state non-employment level U^* decreases in $\alpha\,(\cdot)$ and new sector surplus S_n, and increases in new sector mark-up c, and job destruction rate λ; while the level of new sector employment, N^*, increases in $\alpha\,(\cdot)$ and S_n, and decreases in c and λ accordingly.

A steady state with the informal sector alone By analogy to the previous case, there exists a steady state with the informal sector alone, where $O^* = 0$, $J_i = \lambda + \mu$ and $J_n < \lambda$, while $N^* = 0$. In this situation the new sector is not present in the steady state because the job destruction rate λ exceeds the job creation rate in the sector. At the same time flows into and out of the informal employment are balanced.

The stocks of informal workers and non-employed in this steady state are, respectively, given by:

$$I^* = \frac{(\beta S_i - (\lambda + \mu))}{(\beta S_i - (\lambda + \mu) + (\lambda + \mu)\,\beta m)}, \tag{24}$$

$$U^* = \frac{(\lambda + \mu)\,\beta m}{(\beta S_i - (\lambda + \mu) + (\lambda + \mu)\,\beta m)}. \tag{25}$$

The steady state turns out whenever

$$\alpha < \frac{\lambda\beta}{(\lambda + \mu) + \beta\,(S_n - S_i)}. \tag{26}$$

In this steady state the level of non-employment, U^*, decreases in $\beta\,(\cdot)$ and S_i, and increases in the informal mark-up m and job destruction rates λ and μ; while the level of employment in the informal economy, I^*, increases in $\beta\,(\cdot)$ and S_i, and decreases in m, λ and μ, accordingly.

A steady state with both sectors present Finally, the third type of steady state has both sectors present. This happens whenever $O^* = 0$, $J_n = \lambda$ and $J_i = \lambda + \mu$. Flows both into and out of the new and the informal sectors are balanced given their sizes and the level of non-employment.

As shown in Appendix A, conditions $J_n = \lambda$ and $J_i = \lambda + \mu$ are in fact identical and this takes place whenever the following equality holds:

$$\alpha = \frac{\lambda\beta}{(\lambda + \mu) + \beta\left(S_n - S_i\right)}. \tag{27}$$

Changes in parameters and their effects on steady states The knife-edge condition (27) defines a whole range of various combinations of values of r, c, m, λ, μ, $\alpha(\cdot)$, and $\beta(\cdot)$ that produce a steady state with various shares of both new and informal sectors (proved in Appendix A). However, in reality it is highly unlikely that the effects of a number parameters on the development of new and informal sectors are balanced to generate the equilibrium with both sectors. Thus, in what follows we do not focus on this type of steady state.

However, it is still interesting to examine how changes in parameters of the model impact on condition (27), shifting the balance of forces in the economy towards one or another sector, so that the steady states with new or informal economies result.

Reactivity coefficients $\alpha(\cdot)$ and $\beta(\cdot)$ Firstly, from (27) it is straightforward to see that *ceteris paribus* an increase in $\alpha(\cdot)$ (or, equivalently, a decrease in $\beta(\cdot)$) would upset the balance, so that conditions to develop successfully become more favourable to the new sector and it prevails in the end of transition, as described in section 3.8.1 above.

Sector mark-ups Secondly, without making an additional assumption regarding the relative value of mark-ups c and m, it can readily be seen that the right hand side of (27) is decreasing in m and increasing in c. If we assume that initially the condition (27) maintains, an increase in m, for example, would imply a higher burden on informal firms, so that the economy would eventually converge to the steady state where the informal sector is not present. Similarly, the steady state with the informal economy results if c rises. Thus, the higher is the mark-up that new/informal firms have to pay its workers over their reservation value, the more likely that the economy ends up in the steady state with informal/new firms only.

Monitoring of the informal sector Similarly to the effect of an increase in m, an increase in μ leads to a decrease in the right hand side of (27), so that the economy is likely to end up in the steady state with the new sector alone.

Sector surpluses While monitoring has its both direct and indirect (i.e. through sector surpluses S_n and S_i) effects on the knife-edge condition, the mark-ups act solely through the surpluses. In general, the relative size of sector surpluses S_n and S_i affects the resulting steady state. As the difference $S_n - S_i$ gets larger the economy gets more chances for the new sector to crown the end of transition. Thus, as we can see here, our assumption about the equal productivity in the new and informal sectors, y, does not affect the qualitative outcome. It is not the productivity *per se* but the relative size of profit margins that makes all the difference.

An increase in general intensity of shocks An increase in the rate of job destruction equally affecting the new and informal sector, λ, has an ambiguous effect on the right hand side of (27). However,

in Appendix A we show that it is more likely that such an increase would hurt new sector firms more than their informal counterparts, so that the economy is more likely to end up in the state where the informal sector prevails.

Unemployment benefits The higher is the level of unemployment benefits, b_u, the lower both the surplus S_n in the new sector and the surplus S_i in the informal sector. So there is no any effect of the unemployment compensation on the type of the resulting steady state. However, b_u still affects the level of unemployment (and hence, new or informal employment) in the equilibrium. This last result has a predicted effect common to the models of search in the labour market.

A rate of decrease in the size of the old sector Finally, condition (27) does not depend on γ - the rate at which the old sector is declining in our model. Hence, the choice of γ does not affect the steady state, where economy converges in the end of transition.

Destination matters: whither the transition? Having established the characteristics of the steady states it is time to discuss some differences between our simple model and the preceding OST literature.

In the backbone model by Aghion and Blanchard (1994), as we have mentioned in the background section, the steady states, when they exist, differ only in the resulting level of unemployment and wages. Also, because of fiscal externality effect on job creation there may exist both stable and unstable steady states, which however, qualitatively identical. That is, there the development of the new sector always crowns the transition. In more recent OST work the question of multiple steady states has hardly ever been discussed. Although, the stability issue has manifested itself in the equilibrium path along which the transition has solely been considered. This path leading to the steady state is a unique opportunity, consistent with rational expectations of the agents, for the successful transition as modelled in those studies. Shimer (1997) or Boeri (2000b) may be referred to for the proof. Other possible trajectories are exploding and would derail transition, as is shown by Aghion and Blanchard (1994) for an extension of their model where firms are forward-looking.

In our model, formal and informal firms have so far been assumed to be not forward-looking (or capital markets not perfect), so that the economy always converges to a stationary point. Also, for a single set of parameters only one non-trivial steady state exists. The multiplicity does not arise because we do not introduce feedback mechanisms such as, for example, endogenous government budget constraints that create externality effects in such models as Aghion and Blanchard (1994), Boeri (2000b), etc. Such complications would make functions $\alpha(\cdot)$ or/and $\beta(\cdot)$ depend on the level of non-employment (or numbers of the employed in either sector), and thus make linear solutions to conditions $J_n = \lambda$ or/and $J_i = \lambda + \mu$ impossible. We reflect on the consequences of introducing the government budget constraint, or other feedback mechanisms, in our model in section 3.11.2.

However, leaving aside for the time being the questions of equilibrium uniqueness/stability and formation of expectations, we would like to stress that the three types of steady states discussed in the previous section are qualitatively different. That is, different combinations of parameters define steady states either with or without the new or informal sector. So, the qualitative result of transition can be very different depending on the government policies even when derailment of transformation (i.e. non-existence of steady states) is excluded as a possibility.

3.8.2 Reaching the apex: transition trajectories

Now that we know where our economy is likely to end up, we address two more questions, namely: 1) What does the development of new and informal sector look like before a steady state is reached? and 2) How does the presence of the informal sector affect the length of transition? The insights are provided below.

Assume for convenience that the set of parameters is chosen so that the economy converges to the steady state where the new sector prevails in the end, i.e. condition (23) is satisfied. Other cases are easy to analyse by analogy.

The shape of trajectories From (20) it follows that the old sector is exponentially decreasing till its complete disappearance in the steady state. At the same time, the shape of trajectories followed by the new and informal sectors depends, on the one hand, on the initial conditions and, on the other hand, on the relative effects on the job creation rates (10) and (11) both of the growth of non-employment and of a change in sizes of the new and informal sectors.

The first consideration follows from the fact that initial conditions at the onset of transition define the relation between job creation functions J_n and J_i and job destruction rates λ and $\lambda + \mu$. If, for example, at the beginning $J_n > \lambda$ and/or $J_i > \lambda + \mu$ either one or the other (or both) sectors can be increasing in size for a while, regardless the type of the steady state the economy eventually converges to.

The second remark implies that the job creation rates vary as non-employment grows and levels of new and informal employment change. The full time derivatives of the two job creation functions are given by

$$\frac{dJ_n(U,N,I)}{dt} = \frac{\partial J_n}{\partial U}\frac{dU}{dt} + \frac{\partial J_n}{\partial N}\frac{dN}{dt} + \frac{\partial J_n}{\partial I}\frac{dI}{dt} \tag{28}$$

and

$$\frac{dJ_i(U,N,I)}{dt} = \frac{\partial J_i}{\partial U}\frac{dU}{dt} + \frac{\partial J_i}{\partial N}\frac{dN}{dt} + \frac{\partial J_i}{\partial I}\frac{dI}{dt}. \tag{29}$$

Given the signs of the derivatives of J_n and J_i with respect to U, N, and, I, in both equations above the first effect is positive if $\frac{dU}{dt}$ is positive, while the second and the third effects are positive only if N or I are decreasing. Thus, in principle, if the economy starts with, say $J_n > \lambda$ and $J_i < \lambda + \mu$, i.e. the new sector grows, while the informal economy shrinks, the positive effect of an increase in non-employment coupled with a positive effect of a decrease in the informal sector (that drives wages both in the new and the informal sector down) can outweigh the negative effect of the growth in the size of the new sector. Then J_i begins to rise and as soon as it becomes greater than $\lambda + \mu$, the informal economy can be growing too. This emphasises two important aspects.

First, as non-employment is increasing in the rate of old sector closure, the rate of reduction in old sector employment is a factor that has a bearing not only on the size of the new sector in transition as postulated by the previous OST literature, but also on the size of its informal counterpart. In particular, the higher that rate is, the more likely the informal economy will be growing in the process of reallocation of labour. Hence, the more likely the participation in the formal economy decreases too.

Second, (28) and (29) indicate that it is the interplay between the new and informal sector development that shapes the transition paths, but not only the development of non-employment alone. Appendix A

examines in more detail the behaviour of the job creation rates in the neighbourhood of no-growth levels λ and $\lambda + \mu$. In the end, it turns out that a set of parameters defining the resulting steady state is equally responsible for the shape of trajectories.

Thus, to sum up our short discussion, the transitional development paths result from two factors. On the one hand, the initial conditions do or do not give the impetus to the development of both new and informal sectors. On the other hand, even if the initial conditions were not favourable it is the set of policy parameters defined by the knife-edge condition and the rate of reduction in old sector employment that finally configures the path of the economy.

The effect of the informal sector on the length of transition Suppose that model parameters do not change so that steady state levels of new sector employment and non-employment are pre-defined. Then the timing of transition clearly depends on the presence of the informal sector. In Appendix A we prove that the length of transition is shorter if the informal sector is absent, i.e. if the economy starts with $I(0) = 0$.

If the economy starts off with some positive level of informal sector employment, then changes in parameters affecting its size, but not influencing the resulting steady state, would also have an unambiguous impact on the length of transition. For example, an increase in the level of monitoring μ does not affect the steady state level of new sector employment, N^*, and non-employment, U^*. However, it is easy to verify that $\frac{\partial J_n(U,N,I)}{\partial \mu} \geq 0$, while $\frac{\partial J_i(U,N,I)}{\partial \mu} \leq 0$. Thus, by using an approach similar to the one employed to prove the negative effect of the presence of the informal sector, it is easy to show that a rise in μ speeds up the transition, by eliminating the shadow economy faster.

All this clearly provides another illustration to the Caballero and Hammour (1996) argument that the existence of informality slows down the adjustment process. The reasons for that in our model are the same as the ones mentioned in the background section 2.2.2.

3.8.3 Notes on Dynamic Efficiency

Thus far, we have been silent on the welfare implications of parameter choices, pointing only to the possibility of two qualitatively different outcomes. However, changes in parameters also impact on the welfare of the economy through their effect on job creation functions that shape employment trajectories. Different paths taken by old, new, and informal sector employment and non-employment affect the distribution of gains during transition. For example, a choice of higher rate of closure of the old sector, γ, does not have any effect on the eventual outcome, but leads to a faster increase in non-employment. At the same time, as mentioned above, this may also lead to an increase in the informal sector activity especially at the beginning of transition, when the negative externality from the new sector is small. Meanwhile, an increase in the rate of monitoring, μ, allows to eliminate the shadow sector faster (if the economy converges to a steady state without informality). Either an increase in γ (or μ) may imply both gains and losses to the government. Thus, on the one hand, the higher is the value of γ the higher is the maximum level of non-employment, which apparently creates higher pressures on the government budget. On the other hand, more non-employment implies lower wages, lower pressures on the new sector, and hence a higher level of job creation. There should exist a value of γ, that balances these two effects and makes the reallocation of labour dynamically optimal. Burda (1993), Aghion and Blanchard (1994), Chadha and Coricelli (1994), Castanheira and Roland (2000)

all study the effects on the economy of too slow or too high a speed of transition. In the most recent work on this topic Castanheira (2003) points to the differences in the optimal speed from the private and social viewpoints.

In our setting the issue of finding an optimal speed of scale-down of old enterprises presents a serious difficulty, because even within this simple model with three sectors the algebra becomes really involved. However, on the basis of our results for the effect of the informal sector on the length of transition, we can argue that the optimal speed is not generally equal for the system with and without the informal sector. This implies that if the government is to reform the economy without taking into the account the presence of the shadow sector, it is likely to pursue at least not optimal set of policies.

In the next section we provide numerical simulations of our model to illustrate the issues we have been discussing and to see how well it corresponds to the stylised facts.

3.9 Simulations

As we have seen in the preceding sections a choice of policy parameters determines the steady state where the economy eventually converges in the end of transition. However, it is the development of the economy before the steady state is reached which is of great interest. It is this dynamics that is normally compared to the stylised facts and paths exhibited by economies in reality. Although we have provided some insights into the shapes of trajectories, now we illustrate the dynamics by numerically simulating our simple model for two sets of parameters. Simulations were run in GiveWin 2.10, using Ox for programming a fourth order Runge-Kutta algorithm for numerical solution of the dynamic system of ordinary differential equations (20).

3.9.1 Choosing parameters

We simplify by letting α and β be constant, and putting $\beta = 1 - \alpha$. In section 3.7 $\alpha(\cdot)$ and $\beta(\cdot)$ are defined as functions that capture the effect of institutions and regulations on job creation in the new and informal sectors. Here we assume that these effects are constant, and that by functioning in the shadow informal firms lose access to some boons available to new formal firms and reflected in the level of α. Then, if the total burden of regulations is measured from 0 to 1, and is equal to $1 - \alpha$, new formal firms can enjoy only share α of their profits. At the same time, informal firms save $\beta = 1 - \alpha$, but give up share α of their profits.

Having done that, the basic set of parameters is chosen as $w_o = 1$; $y = 2$; $b_u = 0.5$; $c = 1$; $m = 1$; $r = 0.1$; $\lambda = 0.1$.

The wage/product per worker in the old sector, w_o, is normalised to 1 for convenience. Workers in new/informal firms are seen as twice as productive, $y = 2$, which is the level of differential in private/state marginal products of labour chosen by Brixiova (1997). The level of unemployment benefits is taken as 50% of the old sector wage. This could seem to be a high value. For example, Boeri (1999) in the context of his model treats the value of benefit replacing 35% of the wage earned in old sector as already very high. This value does, however, look plausible for, e.g., the Russian experience, where state enterprises are notable for a very low level of wages. Also in our model, as labour is reallocated in the process of transition to new or informal firms, paying a higher wage than the old sector, the ratio of benefits to the average wage will become smaller. For example, if we assume that workers in the new sector receive their product of labour, equal to 2, and assign equal weights to wages in the old and the new sectors then the average wage will be

1.5. Then, unemployment benefits replace the third of the average official wage - a figure consistent with the ratio of the average unemployment benefit to the average wage reported by Rutkowski (1999) for Russia.

The mark-up values c and m are taken to be equal to 1 across the new and informal sectors. These values reflect the degree of inefficiency in market relationships between a firm and a worker (Caballero and Hammour, 1996) and are simply chosen as 50% of the maximum potential investment y that can be held up in the absence of any other costs. The choice serves well our purpose in giving an illustrative example.

Finally, we put the interest rate, r, to be equal to 10%, and the rate of economy-wide job destruction, λ, to 10%. Davis and Haltiwanger (1999) report that in most western economies roughly 1 in 10 jobs is destroyed every year.

What is left is to define the values of parameters γ, μ, and α. Here we consider two scenarios. The first is broadly defined as a "lagging reformer", supposedly reflecting the experience of such countries as Russia or Ukraine, with the rate of old sector job destruction, γ, not greater than the economy-wide shock, λ (i.e. it is implicitly assumed that the jobs in the old sector may be maintained due to subsidies or soft budget constraints), slack monitoring of the informal sector, and the legal and economic environment not friendly to the development of the new sector (α is low). The second scenario is called an "advanced reformer", purportedly mirroring the Polish or Estonian cases, with rate γ greater than the economy-wide shock, λ, tighter monitoring of the informal economy and improved conditions on the legal, institutional, financial, etc. front (α is high).

For the lagging reformer we put $\gamma = 0.06$ (a figure obtained by Richter and Schaffer, 1996, for Russian state-owned enterprises), $\mu = 0$ (i.e. informal firms are destroyed as often as in the rest of the economy), and $\alpha = 0.35$ (i.e. $\beta = 0.65$). Assuming that $\alpha = 1$ implies an economy free of corruption and where regulations are not much of a burden to the new sector, the value of 0.35 seems reasonable for such countries as Russia or Ukraine. Similar figures can be obtained by re-scaling to $[0, 1]$ various indices of the legal and regulatory environment reported in EBRD (1999) and Johnson et al. (2000b) for the two countries.

The advanced reformer in our exercise has $\gamma = 0.15$, $\mu = 0.05$ and $\alpha = 0.7$ ($\beta = 0.3$). The figure for the rate of job destruction is consistent with the one reported for the early 90s in Estonia by Haltiwanger and Vodopivec (2002). With $\mu = 0.05$ the cumulative rate of job destruction in the informal sector is 0.15, which is one and a half times greater than the similar rate for the lagging reformer scenario. If μ is seen as a direct result of monitoring by the tax police, then its value reflects tax police efficiency. EBRD (1999) reports that the efficiency of tax collection was roughly 1.5 times greater in Poland and Estonia than in Russia in the mid 90s. Finally, according to the value of α for this scenario it is twice as high as the one for the lagging reformer. This is again broadly consistent with indices reported in EBRD (1999) and Johnson et al. (2000b)[15] for, on the one hand, Poland or Estonia, and, on the other hand, Russia or Ukraine.

Before seeing the results of simulations we need to assign initial values to stocks of workers in each of the labour market states. For both scenarios we put $O(0) = 0.9$, $N(0) = I(0) = 0.045$ and $U(0) = 0.01$. This implies that at the beginning of transition 90% of workers are employed in the old sector, new and informal sector employment is small and comparable in size, and non-employment is about 1% of the labour force (this is taken from Gregory and Collier, 1988, who estimate unemployment in the Soviet Union).

The output of simulations for the two set of parameters is presented in Fig.2 and 3.

[15] In Johnson et al. (2000b), for example, see also the data on time that managers of start-ups spend on government and regulatory matters in Poland, Russia and Ukraine.

3.9.2 Correspondence to stylised facts

Fig.2 displays the case of the lagging reformer, with the new sector starting off well but then being crowded out by the informal sector. In the meantime, the growth of the former is sustainable. The formal output exhibits a L-type dynamics, while the total output follows a J-type trajectory. Such a type of dynamics characterises the situation when condition (26) applies, i.e. the burden of regulations, etc. on the informal firms is lighter than that on the new sector firms.

The case of the advanced reformer is given in Fig.3. The contrast is obvious: the new sector quickly gains speed, while the informal sector is declining after a short period of prominence. Both formal output and total output in the economy follow a J-type trajectory: a decline is followed by growth. These trajectories result from a combination of parameters satisfying condition (23).

It is interesting that in both cases the informal sector grows at the beginning of transition. This, as we suggested in section 3.8.2 above, is explained by the favourable initial conditions and the rise in non-employment, whose effect for some time outweighs the negative externality from the growing new sector, which is small at start. However, in the first case the rise in informality is sustained, while in the second case worker participation in the formal economy recovers after a while. In both cases non-employment follows an inverted L-type trajectory, reaching some peak in the midst of transition, decreasing somewhat afterwards and stabilising at a non-zero level eventually.

In general, Fig.2 and 3 correspond to all the main stylised facts about employment and output dynamics in transitional countries: old sector employment declines, new sector employment grows, the non-employment path resembles an inverted L-curve. An increase in informal activity at the beginning of transition in both cases may be seen as consistent with the evidence that participation in the labour force has lowered not only in Russia or Ukraine, where the informal sector is believed to be notoriously big, but also in the East European transition countries.

In the background section we have mentioned that as a rule the OST studies cannot explain the falling new/old sector wage differentials and declining transition probabilities from unemployment. Fig.4 illustrates that our model can generate dynamics in accordance with these stylised facts too (the set of parameters is the one for the advanced reformer). Top panel shows that even for the advanced reformer average wages slightly decline at the start of transition, but quickly regain their pre-transition level afterwards. At the same time the probability of movement out of non-employment to the new sector declines as the economy converges to the steady state. As this happens, the pool of non-employed becomes more stagnant, for the duration of non-employment is decreasing in probabilities of exit. Thus, the growing stagnancy of non-employment pools across all the transition countries can be a natural feature as their economies get closer to the steady state.

As regards the stylised facts on the difference in CEEC and CIS transitional experience, in our view the two cases presented above are telling. Broadly speaking, the first type of dynamics considered is consistent with fortunes of such countries as Russia or Ukraine. The second type of dynamics is more fitting for Czech, Slovak, Hungarian, Polish, or Estonian transition. Fig.5 and 6 illustrate the development of informal sectors in the two categories of countries in the first half of the 90s. More recent data are available in Feige and Urban (2003, Fig.A1-A4), which pertain to the share of unrecorded income in transitional countries. Fig.2 and 3 (bottom right panel) give the dynamics of the share in our model, which is generally consistent with dynamic tendencies estimated by Feige and Urban (2003) for the two groups of countries.

Finally, Fig.2 clearly shows the difference in the dynamics of formal and total output in a country, the lagging reformer. This may be seen as supporting the point often made in the literature: the decline of output in Russia may in fact have been overestimated - if one takes into account the growing informal economy, the degree of the decline is much lower (see, for example, Stiglitz, 2002, p.152, who also points to the controversy over the GDP decline in Russia).[16]

3.10 Further Discussion and Policy Implications

Obviously, there are stylised facts that our model cannot explain. For example, a drop in real wages in the old sector, or a drop in total labour productivity observed both in Russia and CEEC. However, its main purpose is to account for evolution of the informal sector in transition and its effect on the emerging new sector. The main message it provides is that the asymmetries in the development of the CIS and CEEC may well be sought in the different degree of presence of the informal economy as well as the policies towards the new emerging sector.

The model does identify the parameters that tune up the economy for convergence either to a "good" equilibrium, where the new sector is present in the end of transition, or to a "bad" equilibrium where the informal sector crowns the system. Interestingly, the speed of old sector closure, γ, in the setting we have considered (without embedded fiscal externalities) does not affect the eventual outcome of transformation, although should have a bearing on distribution of gains. In general, from condition (27) and the subsequent analysis of the effects of changes in parameters, it follows that the higher the ratio of α to β, the lower the mark up c in relation to m (or, more generally, the bigger is the difference between the new and informal sector surpluses, $S_n - S_i$) the more chances the economy has to end up in a "good" equilibrium. This has an unequivocal implication that the governments in transition should create a favourable climate for the new sector to develop, if the transformation is to be successful. This seems to be more important than a choice of a right speed of transition - the topic in the very centre of the OST debate.

The parameters α, β, c and m in our model reflect institutional features of the economy and inefficiencies in the new and informal sectors arising from specific investment. They impact on the development of the emerging sectors by affecting job creation through the amount of firms' profits available for investing. So, to ensure that the new sector takes off and thrives to succeed in transition the government must address the institutional ills. Such an implication is very much in line with earlier arguments of Caballero and Hammour (1996). In particular in respect of the aforementioned hold-up problem they write: "When appropriability problems cannot be overcome at the microeconomic level, they receive a highly inefficient macroeconomic "solution" in the form of depressed investment and thus more difficult employment opportunities for workers. By restraining the bargaining position of workers in their transactions with firms, this endogenous response allows the economic system to guarantee the required return on investment." In our model a reduced bargaining power of workers in the new sector implies a lower mark-up c, which raises the odds that new firms succeed. Similarly, if c reflects firms' investment that is held up because of regulations (e.g. redundancy pay), the reduction in the burden of such regulations should provide an additional incentive for the new sector firms.

[16] We do not provide here the results of simulations for the intermediate case with both new and informal sectors present in the steady state, which happens whenever condition (27) is met. However, the dynamics observed for such sets of parameters is very similar to the case of the lagging reformer where the informal economy prevails in the end: the economy exhibits a non-recovering drop in formal activity, while the evolution of formal output resembles L-curve.

In general, our result that unfavourable institutions stifle successful growth during adjustment periods resembles findings of a few previous work. On the one hand, it echoes what Caballero and Hammour (1996, 2000a,b) call "sclerosis" - the inefficient survival of low-productivity jobs. In this paper we show that poor institutions lead to the development of the informal economy at the expense of the formal one, although the productivity of both are equal. However, it is not difficult to think of a less productive informal sector in our context too, as what matters for the conclusions is not the level of productivity but the size of surpluses in the new and informal sector (see section 3.8.1). On the other hand, our model suggests that the higher is the surplus in the new sector (i.e. the lower various costs and inefficiencies facing it), the more intense is the "entry" of new sector jobs and the more likely the transition turns out to be successful. This may be seen as a complement to the result of Berkowitz and Cooper (1997): in their model decreasing the cost discrimination against the entrant makes it more likely that the economy eventually converges to a high development equilibrium, i.e. the equilibrium where *de novo* firms supply high quality goods, as opposed to the low development equilibrium, in which start-ups provide lower quality goods and the overall supply of goods is lower. The parallels between these two types of steady states and our "good" and "bad" outcomes are clear. Still, however, despite these similarities the distinct feature of our model is the explicit development of the informal economy.

Finally, once a favourable to the new sector set of parameters is chosen, the government can think of ways to speed up the transition. Above we have shown that the presence of the informal sector in fact prolongs the convergence to a "good" equilibrium. So, the efforts may be taken to ward it off faster by increasing monitoring of firms, μ, or punishment measures, F, for tax evasion at the start of transition, when the rise in non-employment makes it more likely that the informal sector grows. At the same time, taxes should be reduced to attract more entrepreneurs in the new sector. As soon as the economy is over the hump in informal sector development the taxes on formal firms could be raised, provided that they still are held at such a level that does not switch the economy towards a "bad" equilibrium. In general, what is important for the new sector development is not the burden created by taxes or other factors *per se*, but their effect *in comparison* to the burden on the informal sector. Thus, it is likely that the government has enough flexibility to achieve a desirable outcome of transition.

3.11 Departures from Basic Model

The model we have been considering so far is in fact very basic and lacks a few useful features that can make it more realistic. Here we briefly discuss two such complications: forward-looking firms in the new and informal sectors, and feedback mechanisms introducing externality effects.

3.11.1 Forward looking firms

From (4) it is obvious that workers in our model are forward looking. This is, however, not true of the firms in the new and informal sectors. Expressions (10) and (11) indicate that all of current profits per worker, corrected only for reactivity coefficients α and β, are myopically invested by firms. However, Aghion and Blanchard (1994) notice that job creation is likely to be at least in part forward-looking. They emphasise that many new formally established firms, and especially foreign direct investors in transitional countries, will not invest if they expect conditions to worsen and profits to get lower in the future. One should expect

that similar reasoning can be applied to the newly established firms in the informal economy too.

To patch our model up to take account of expectations on firms' side we can modify the expressions (10) and (11) for job creation per worker to read:

$$rJ_n = \alpha(\tau, \zeta)(y - w_n) + \frac{dJ_n}{dt}, \tag{30}$$

and

$$rJ_i = \beta(\mu, F, \xi)(y - w_i) + \frac{dJ_i}{dt}. \tag{31}$$

Then total job creation in the new sector will be rJ_nN, while in the informal economy it will equal rJ_iI. So, instead of investing the current profits into new job creation, firms invest the present value of their profits. Here we implicitly relax the assumption of capital market constraints.

In the so modified model the expressions for wages (7) and (8) stay the same, while the transition probabilities are now re-defined as $p_n = \frac{rJ_nN}{U}$ and $p_i = \frac{rJ_iI}{U}$. Substituting the expressions for wages into the Bellman equations (30) and (31) one can reduce them to:

$$\frac{dJ_n}{dt} = rJ_n\left(\frac{U + \alpha cN}{U}\right) + rJ_i\frac{\alpha mI}{U} - \alpha S_n, \tag{32}$$

$$\frac{dJ_i}{dt} = rJ_i\left(\frac{U + \beta mI}{U}\right) + rJ_n\frac{\beta cN}{U} - \beta S_i \tag{33}$$

Together with four differential equations (20) they determine dynamics of our economy. The same as before three types of steady states of this system are defined by the conditions: 1) $O^* = 0$, $rJ_n = \lambda$ while $rJ_i < \lambda + \mu$ and $I^* = 0$ (when only the new sector is present); 2) $O^* = 0$, $rJ_i = \lambda + \mu$, while $rJ_n < \lambda$ and $N^* = 0$ (when only the informal sector is present); 3) $O^* = 0$, $rJ_n = \lambda$, $rJ_i = \lambda + \mu$ (when both the new and informal sectors are present). It is easy to show that in steady states:

$$rJ_n = \alpha\left(\frac{US_n - \beta mI(S_i - S_n)}{(U + \alpha cN + \beta mI)}\right) \tag{34}$$

and

$$rJ_i = \beta\left(\frac{US_i - \alpha cN(S_n - S_i)}{(U + \alpha cN + \beta mI)}\right), \tag{35}$$

which are essentially the same expressions as in (14) and (15). Thus, the conditions for the steady states are the same as in the case of myopic firms.

The introduction of forward looking job creation affects only paths leading to an equilibrium point, but not the steady states themselves. Aghion and Blanchard (1994) show that convergence to a steady state will in such case depend not only on the initial levels of non-employment and employment in sectors, but also on the initial level of investment into new job creation. In such a situation expectations matter a lot and they become self-fulfilling: if job creation is low at the beginning of transition the steady state may never be reached.

3.11.2 Feedback mechanisms and multiple equilibria

Leaving aside the forward-looking firms, we move on to another important departure from our basic model. This would be an introduction of fiscal or other types of externalities leading to multiple equilibria for each set of parameters. Algebraically, it would imply that functions $\alpha(\tau, \zeta)$ or/and $\beta(\mu, F, \xi)$ in addition to policy parameters such as τ, μ, F, also depend on stocks of workers N, U, I. This may happen if, for example, the government always runs a balanced budget such that $\tau J_n N = b_u U$. An alternative feedback mechanism can be at work when the effectiveness of monitoring of the informal sector directly depends on the funds available in the state budget, i.e., generally speaking, amount of taxes collected: $\mu = \tau J_n N$.

In such cases the above expressions for w_n, w_i, J_n, and J_i become very complicated. The signs of their derivatives with respect to U (or/and N and I) become ambiguous as a result of additional externality effects brought in. Then solutions to the conditions $J_n = \lambda$ or/and $J_i = \lambda + \mu$ could well no longer be unique. The number of possible steady states of the dynamic system could well increase. So, the problem of choosing a correct combination of policy parameters becomes more involved. In particular, one should expect that the choice of speed of the old sector closure, γ, is no longer neutral with respect to the eventual outcome: through the effect on the size of non-employment it would have a direct bearing on the convergence properties of the system.

4 Concluding Remarks

In this work we provided an extensive review of the literature taking up the issue of finding the Optimal Speed of Transition. In our critical comments we highlight that the obvious weak spot of these studies is their ignorance about informal sector employment widely observed in transitional countries. On the policy front, they excessively focus on proper engineering of the job destruction in the old inefficient sector, and a reasonable choice of social support programmes (unemployment benefits, wage floors, etc.). The job creation part of the transition process and policies towards the emerging new sector have received hardly any attention in the theory. The major failure of this literature, pretending to provide a theoretical model of transition, is the inability to explain convincingly the noticeable differences in the development of East European countries, on the one hand, and the countries of the Former Soviet Union (apart from the Baltic states), on the other hand.

In our attempt to close the gap, we have presented a model of transition in the presence of the informal sector, where qualitatively different outcomes of transformation depend on the choice of various parameters, many of which can be affected by the government. In particular, we have showed that transition can fail if the pressure of various factors on new formal firms outweighs the pressure on the informal sector. In such a case it is the informal firms that dominate the post-transition economy. We argue that the convergence to qualitatively different equilibria helps explain the varying experience of CEE and CIS countries. This point should be seen as complementing rather than substituting the previous attempts to explain the CEE and CIS divide made by Garibaldi and Brixiova (1998) and Boeri and Terrell (2002), who argue that it is the differences in unemployment benefits, minimum wages and other labour market institutions that have contributed to the divergence in question.

In general, our model highlights three main aspects theoretically vitally important in shaping the transition outcome.

First, we support in the main the point made earlier by many other researchers that creation of institutions favourable to the development of the new sector should be the paramount objective of transition. While the speed of transition - the darling of many previous OST studies - does make the difference for the distribution of gains, it may not be at all important for the qualitative result, as our model shows. At the same time, the burden of taxes, labour market regulations and legal infrastructure, etc., captured by "reactivity coefficients" measuring friendliness of the economic environment towards particular sectors, defines the proportion of profits directed to investment purposes and the rate of job creation.[17] What is interesting, however, is that the model suggests that it is not, for instance, the high taxes *per se* that may be blamed for snarling up the successful development of the new sector, but rather the burden they create on new firms in comparison to the burden on their informal counterparts.

Second and getting more specific, we argue that it is the labour market conditions in the formal and informal sectors that make the difference. In particular, we consider the mark-ups that new formal and informal firms pay their workers over the value of being non-employed. As discussed in the text these mark-ups can be given a host of explanations, but we suggest to see them as resulting from the appropriability problem raised in the developing economics context by Caballero and Hammour (1996, 2000a,b). Reducing the opportunities for investment hold-ups in the new sector in comparison with the informal sector is one of the policy implications of the model for successful transition.

Finally, the presence of the informal sector undoubtedly prolongs the timing of transition. However, the upsurge in non-employment at the start of transition as well as the initial conditions can lead to an increase in the size of the shadow economy, regardless of the type of steady state the economy eventually converges to. Thus, efforts could be made to reduce the extent of informality as quickly as possible provided that in general the economic environment is favourable to the development of the new formal sector. It is suggested that such a reduction can be achieved, for example, through more efficient monitoring of informal activities that would affect the rate of death of informal firms. This has a direct impact on the labour turnover in the sector and, thus, development of informality. By increasing monitoring efficiency, leading to higher incidence of detection of informal activities, and their liquidation, the authorities can hinder the take-off of the informal economy and ensure the success of transformation.

All in all, the main message of our model is that costs and the eventual success of transformation are determined not only by the speed of restructuring of the old sector, but also, importantly, the policies towards emerging new businesses. If such policies are highly regulatory and restrictive especially in comparison to the policies towards the notorious informal economy, it is the latter not the formal new firms that prevail in the economy eventually.

More generally, the model presented here supports the point recently made by Stiglitz (2002, p.57) that "privatization needs to be part of a more comprehensive program, which entails creating jobs in tandem with the inevitable job destruction that privatization often entails."

[17] EBRD (2000) reports that in CEE setting up a business was not unusual even before the transition, whereas in other countries - Ukraine, e.g., - it was discouraged by a punitive use of taxation and other measures.

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A New and Informal Sector Mark-ups: Cost of Separation Interpretation

Consider new sector firms and non-employed workers. The values of working in the new sector, V_n, and of being non-employed, V_u, are given in (1) and (3). In the main text we do not explicitly consider the values of an open vacancy and of a filled job to the firm. Let us denote these by V_v and V_j, respectively. Then the total surplus of a match is given by $S = V_n - V_u + V_j - V_v$. The generalised Nash bargaining solution implies that the wage is chosen so as to split the surplus as $V_n - V_u = \epsilon S$ and $V_j - V_v = (1-\epsilon) S$, where ϵ is seen as a parameter reflecting impatience of the two sides, or bargaining power of workers.

Under the assumption of no matching problem for firms the surplus of having a job filled rather than vacant is equal to zero (Blanchard, 1998). That is if worker leaves or is fired another one can be hired on the spot. Then whatever is the bargaining power of workers, they are effectively held down to their reservation value while haggling over the wage: $V_n - V_u = 0$. However, suppose that separation implies a cost to the firm. This may be interpreted as initial training (lasting one instant) that employer provides the worker with at some cost k, or a state imposed redundancy cost. In both cases, it is supposed that worker can renegotiate after being officially hired. In this case, the cost to the firm of separating and hiring another worker is k, which is independent of labour market conditions because of the no matching problem assumption (ibid.). Then Nash bargaining implies:

$$V_j - V_v = (1-\epsilon) S = k$$

and

$$V_n - V_u = \epsilon S = \frac{\epsilon k}{(1-\epsilon)}.$$

Thus, as we can see from the two equations above, constant c, defined in the main text as equal to $V_n - V_u$, depends on the value of separation costs in the new sector and the relative bargaining power of workers and firms: $c = \frac{\epsilon k}{(1-\epsilon)}$.

Similarly, for the informal sector constant m, equal to $V_i - V_u$, depends on the value of separation costs in the informal sector and the relative bargaining of workers in the informal economy.

A Derivation of Basic Results

A.1 Wages and Job Creation in the New and Informal Sectors

Wages in the new and informal sectors are given by, respectively:

$w_n(U,N,I) = \left(y - \frac{US_n - \beta mI(S_i - S_n)}{(U+\alpha cN+\beta mI)}\right)$

and

$w_i(U,N,I) = \left(y - \frac{US_i - \alpha cN(S_n - S_i)}{(U+\alpha cN+\beta mI)}\right)$

Job creation rates per worker employed in the new and informal sectors are, respectively:

$J_n(U,N,I) = \alpha(\cdot)(y - w_n) = \alpha\left(\frac{US_n - \beta mI(S_i - S_n)}{(U+\alpha cN+\beta mI)}\right)$

and

$J_i(U,N,I) = \beta(\cdot)(y - w_i) = \beta\left(\frac{US_i - \alpha cN(S_n - S_i)}{(U+\alpha cN+\beta mI)}\right)$,

where $S_n = (y - b_u - (r+\lambda)c)$, $S_i = (y - b_u - (r+\lambda+\mu)m)$, $\alpha \equiv \alpha(\cdot)$ and $\beta \equiv \beta(\cdot)$.

The necessary condition for both sectors to exist is that both $J_n(U,N,I)$ and $J_i(U,N,I)$ are positive. Otherwise, sector profits are negative, as by assumption both $\alpha \equiv \alpha(\cdot)$ and $\beta \equiv \beta(\cdot)$ belong to $[0,1]$.

A.1.1 Properties of functions $J_n(U,N,I)$ and $w_n(U,N,I)$

$J_n(U,N,I) = \alpha\left(\frac{US_n - \beta mI(S_i - S_n)}{(U+\alpha cN+\beta mI)}\right) \geq 0$ (by simple logic - otherwise the sector ceases to exist as profits become negative)

$\frac{\partial J_n(U,N,I)}{\partial U} = \alpha\left(\frac{S_n(\alpha cN+\beta mI)+\beta mI(S_n - S_i)}{(U+\alpha cN+\beta mI)^2}\right) = \alpha\left(\frac{\alpha cNS_n+\beta mIS_i}{(U+\alpha cN+\beta mI)^2}\right) > 0$,

whenever $S_n > 0$ and $S_i > 0$ (otherwise one of sectors simply does not exist, because, again, sector profits become negative)

$\frac{\partial J_n(U,N,I)}{\partial N} = -\alpha^2 c\left(\frac{(US_n - \beta mI(S_i - S_n))}{(U+\alpha cN+\beta mI)^2}\right) \leq 0$

$\frac{\partial J_n(U,N,I)}{\partial I} = -\alpha\beta m\left(\frac{US_n - \alpha cN(S_n - S_i)}{(U+\alpha cN+\beta mI)^2}\right) \leq 0$

(follows from the fact that $J_i(U,N,I) \geq 0$)

$w_n(U,N,I) = \left(y - \frac{US_n - \beta mI(S_i - S_n)}{(U+\alpha cN+\beta mI)}\right)$

$\frac{\partial w_n(U,N,I)}{\partial U} = -\frac{\alpha cNS_n+\beta mIS_i}{(U+\alpha cN+\beta mI)^2} \leq 0$

$\frac{\partial w_n(U,N,I)}{\partial N} = \alpha c\frac{US_n - \beta mI(S_i - S_n)}{(U+\alpha cN+\beta mI)^2} \geq 0$

(as $J_n(U,N,I) \geq 0$)

$\frac{\partial w_n(U,N,I)}{\partial I} = \beta m\frac{US_n - \alpha cN(S_n - S_i)}{(U+\alpha cN+\beta mI)^2} \geq 0$

(as $J_i(U,N,I) \geq 0$)

A.1.2 Properties of functions $J_i(U,N,I)$ and $w_i(U,N,I)$

$J_i(U,N,I) = \beta\left(\frac{US_i - \alpha cN(S_n - S_i)}{(U+\alpha cN+\beta mI)}\right) \geq 0$

$\frac{\partial J_i(U,N,I)}{\partial U} = \beta\left(\frac{\alpha cNS_n+\beta mIS_i}{(U+\alpha cN+\beta mI)^2}\right) \geq 0$,

whenever $S_n > 0$ and $S_i > 0$ (otherwise one of sectors simply does not exist).

$\frac{\partial J_i(U,N,I)}{\partial N} = -\alpha c\beta\left(\frac{US_n - \beta mI(S_i - S_n)}{(U+\alpha cN+\beta mI)}\right) \leq 0$

(as $J_n(U,N,I) \geq 0$)

$\frac{\partial J_i(U,N,I)}{\partial I} = -\beta^2 m\left(\frac{US_i - \alpha cN(S_n - S_i)}{(U+\alpha cN+\beta mI)^2}\right) \leq 0$

(as $J_i(U,N,I) \geq 0$)

$w_i(U,N,I) = \left(y - \frac{US_i - \alpha cN(S_n - S_i)}{(U+\alpha cN+\beta mI)}\right)$

$\frac{\partial w_i(U,N,I)}{\partial U} = -\frac{\alpha cNS_n + \beta mIS_i}{(U+\alpha cN+\beta mI)^2} \leq 0$

$\frac{\partial w_i(U,N,I)}{\partial N} = \alpha c\frac{US_n - \beta mI(S_i - S_n)}{(U+\alpha cN+\beta mI)^2} \geq 0$
(as $J_n(U,N,I) \geq 0$)

$\frac{\partial w_i(U,N,I)}{\partial I} = \beta m\frac{US_i - \alpha cN(S_n - S_i)}{(U+\alpha cN+\beta mI)^2} \geq 0$
(as $J_i(U,N,I) \geq 0$)

A.2 Steady States

A.2.1 Only the new sector is present

Conditions for this steady state are $J_n = \lambda$, while $J_i < (\lambda + \mu)$ and $I^* = 0$, $O^* = 0$.

Re-writing the condition $J_n = \lambda$ as $\alpha\left(\frac{U^*S_n + \beta mI^*(S_n - S_i)}{(U^*+\alpha cN^*+\beta mI^*)}\right) = \lambda$, and recalling that $U^* = 1 - N^*$ in steady state, yields:

$N^* = \frac{(\alpha S_n - \lambda)}{(\alpha S_n - \lambda + \lambda\alpha c)}$

and

$U^* = \frac{\lambda\alpha c}{(\alpha S_n + \lambda(\alpha c - 1))} = \frac{\lambda\alpha c}{(\alpha S_n - \lambda + \lambda\alpha c)}$.

The necessary and sufficient condition for N^* and U^* to be positive in the steady state is $\alpha S_n > \lambda$.

The existence condition

Re-writing the condition $J_i < (\lambda + \mu)$:

$J_i = \beta\left(\frac{US_i - \alpha cN(S_n - S_i)}{(U+\alpha cN+\beta mI)}\right)|_{ss} < (\lambda + \mu)$

Which is equivalent to:

$\beta\left(\frac{\lambda\alpha cS_i - \alpha c(\alpha S_n - \lambda)(S_n - S_i)}{\lambda\alpha c + \alpha c(\alpha S_n - \lambda)}\right) < (\lambda + \mu)$ or $\beta < \frac{(\lambda+\mu)}{\left(\frac{\lambda\alpha cS_i - \alpha c(\alpha S_n - \lambda)(S_n - S_i)}{\lambda\alpha c + \alpha c(\alpha S_n - \lambda)}\right)}$ and then $\alpha > \frac{\lambda\beta}{((\lambda+\mu)+\beta(S_n - S_i))}$.

So, this steady state exists whenever $\alpha > \frac{\lambda\beta}{((\lambda+\mu)+\beta(S_n - S_i))}$.

The effect of parameter changes
on equilibrium value of non-employment

$\frac{\partial U^*}{\partial \alpha} = \frac{\partial}{\partial \alpha}\left(\frac{\lambda\alpha c}{(\alpha S_n + \lambda(\alpha c - 1))}\right) = -\frac{\lambda^2 c}{(\alpha S_n + \lambda(\alpha c - 1))^2} < 0$

$\frac{\partial U^*}{\partial \mu} = \frac{\partial}{\partial \mu}\left(\frac{\lambda\alpha c}{(\alpha S_n + \lambda(\alpha c - 1))}\right) = 0$ (unless α depends on μ)

$\frac{\partial U^*}{\partial c} = \frac{\partial}{\partial c}\left(\frac{\lambda\alpha c}{(\alpha S_n + \lambda(\alpha c - 1))}\right) = \lambda\alpha\frac{\alpha(y - b_u) - \lambda}{(\alpha S_n + \lambda(\alpha c - 1))} > 0$
(if the necessary and sufficient condition for U^* to be positive holds).

$\frac{\partial U^*}{\partial m} = \frac{\partial}{\partial m}\left(\frac{\lambda\alpha c}{(\alpha S_n + \lambda(\alpha c - 1))}\right) = 0$

A.2.2 Only the informal sector is present

Conditions for this steady state are $J_i = (\lambda + \mu)$, while $J_n < \lambda$ and $N^* = 0$, $O^* = 0$.

Then by re-writing $J_i = (\lambda + \mu)$ as $\beta\left(\frac{U^*S_i - \alpha cN^*(S_n - S_i)}{(U^*+\alpha cN^*+\beta mI^*)}\right) = (\lambda + \mu)$ with $U^* = 1 - I^*$ we get

$I^* = \frac{(\beta S_i - (\lambda+\mu))}{(\beta S_i - (\lambda+\mu) + (\lambda+\mu)\beta m)}$

and

$U^* = \frac{(\lambda+\mu)\beta m}{(\beta S_i - (\lambda+\mu) + (\lambda+\mu)\beta m)} = \frac{(\lambda+\mu)\beta m}{(\beta S_i + (\lambda+\mu)(\beta m - 1))}$.

The necessary and sufficient condition for I^* and U^* to be positive in the steady state is $\beta S_i > (\lambda + \mu)$.

The existence condition

The condition $J_n < \lambda$ implies $J_n = \alpha\left(\frac{US_n+\beta mI(S_n-S_i)}{(U+\alpha cN+\beta mI)}\right)|_{ss} < \lambda$, from which it follows that the steady state exists whenever $\alpha < \frac{\lambda}{\left(\frac{(\lambda+\mu)\beta mS_n+\beta m(\beta S_i-(\lambda+\mu))(S_n-S_i)}{(\lambda+\mu)\beta m+\beta m(\beta S_i-(\lambda+\mu))}\right)}$ or $\alpha < \frac{\lambda\beta}{((\lambda+\mu)+\beta(S_n-S_i))}$.

The effect of parameter changes
on equilibrium value of non-employment

$\frac{\partial U^*}{\partial \beta} = \frac{\partial}{\partial \beta}\left(\frac{(\lambda+\mu)\beta m}{(\beta S_i-(\lambda+\mu)+(\lambda+\mu)\beta m)}\right) = -\frac{(\lambda+\mu)^2 m}{(\beta S_i-(\lambda+\mu)+(\lambda+\mu)\beta m)} < 0$

$\frac{\partial U^*}{\partial \mu} = \frac{\partial}{\partial \mu}\left(\frac{(\lambda+\mu)\beta m}{(\beta S_i-(\lambda+\mu)+(\lambda+\mu)\beta m)}\right) = \frac{\beta^2 m(y-b_u-\mu m)}{(\beta S_i-(\lambda+\mu)+(\lambda+\mu)\beta m)} > 0$

$\frac{\partial U^*}{\partial c} = \frac{\partial}{\partial c}\left(\frac{(\lambda+\mu)\beta m}{(\beta S_i-(\lambda+\mu)+(\lambda+\mu)\beta m)}\right) = 0$

$\frac{\partial U^*}{\partial m} = \frac{\partial}{\partial m}\left(\frac{(\lambda+\mu)\beta m}{(\beta S_i-(\lambda+\mu)+(\lambda+\mu)\beta m)}\right) = (\lambda+\mu)\beta\frac{\beta(y-b_u)-(\lambda+\mu)}{(\beta S_i-(\lambda+\mu)+(\lambda+\mu)\beta m)} > 0$ (if the necessary and sufficient condition for U^* to be positive maintains in this steady state).

A.2.3 Both new and informal sectors are present

The conditions for this steady state to take place are $J_n = \lambda$ and $J_i = (\lambda + \mu)$, while $O^* = 0$. The conditions can be re-written as:

$\alpha\left(\frac{US_n+\beta mI(S_n-S_i)}{(U+\alpha cN+\beta mI)}\right) = \lambda$

and

$\beta\left(\frac{US_i-\alpha cN(S_n-S_i)}{(U+\alpha cN+\beta mI)}\right) = (\lambda+\mu)$,

where $U^* = 1 - N^* - I^*$.

The existence condition

It is easy to see that in fact J_n can be re-expressed through J_i :

$J_n = \alpha\left(\frac{US_n+\beta mI(S_n-S_i)}{(U+\alpha cN+\beta mI)}\right) = \frac{\alpha}{\beta}\beta\left(\frac{US_n+US_i-\alpha cN(S_n-S_i)-US_i+\alpha cN(S_n-S_i)+\beta mI(S_n-S_i)}{(U+\alpha cN+\beta mI)}\right) =$

$= \frac{\alpha}{\beta}\beta\left(\frac{US_i-\alpha cN(S_n-S_i)+(S_n-S_i)(U+\alpha cN+\beta mI)}{(U+\alpha cN+\beta mI)}\right) = \frac{\alpha}{\beta}\beta\left(\frac{US_i-\alpha cN(S_n-S_i)}{(U+\alpha cN+\beta mI)} + (S_n-S_i)\right) =$

$= \frac{\alpha}{\beta}\beta\left(\frac{US_i-\alpha cN(S_n-S_i)}{(U+\alpha cN+\beta mI)}\right) + \alpha(S_n-S_i) = \frac{\alpha}{\beta}J_i + \alpha(S_n-S_i)$.

So, if in the steady state $J_i = (\lambda + \mu)$ then $\frac{\alpha}{\beta}(\lambda+\mu) + \alpha(S_n - S_i) = \lambda$.

This last equality implies that the steady state exists whenever $\alpha = \frac{\beta\lambda}{((\lambda+\mu)+\beta(S_n-S_i))}$ - the knife-edge condition (27) in the main text.

Multiplicity of equilibria When the knife-edge condition holds it is possible to show that the equilibria are linked by the relation:

$N^* = \frac{(\beta S_i-(\lambda+\mu))}{(\beta S_i-(\lambda+\mu)+\beta c\lambda)} - I^*\frac{(\beta S_i-(\lambda+\mu)+\beta m(\lambda+\mu))}{(\beta S_i-(\lambda+\mu)+\beta c\lambda)}$.

The concrete size of the formal and informal sectors in such an equilibrium depends on initial conditions as well as various combinations of policy parameters.

Indeed, in equilibrium

$N^* = \exp\left(\int_0^{t^*}(J_n-\lambda)\,dt\right)N(0)$, and $I^* = \exp\left(\int_0^{t^*}(J_i-\lambda-\mu)\,dt\right)I(0)$,

where t^* is time necessary to reach the steady state. It is also possible to show that the condition (27) implies $(J_n - \lambda) = \frac{\alpha}{\beta}(J_i - (\lambda + \mu))$.

Then $N^* = \exp\left(\frac{\alpha}{\beta}\int_0^{t^*}(J_i - (\lambda+\mu))\,dt\right)N(0)$, so that $\frac{N^*}{I^*} = \exp\left(\left(\frac{\alpha}{\beta} - 1\right)\int_0^{t^*}(J_i - \lambda - \mu)\,dt\right)\frac{N(0)}{I(0)}$.

First, as we can see from the factor before the integral in the expression above, the relative size of N^* and I^* depends on the ratio of $\alpha(\cdot)$ and $\beta(\cdot)$, even if the integral is the same for various sets of policy parameters satisfying the knife-edge condition, and if $N(0) = I(0)$. That is, by changing r, c, m, λ, μ, $\alpha(\cdot)$ and $\beta(\cdot)$ so that the condition (27) holds, the value of $\frac{N^*}{I^*}$ depends, *ceteris paribus*, on the ratio of $\alpha(\cdot)$ and $\beta(\cdot)$. So, for any set of initial conditions the knife-edge equilibrium is not generally unique.

Second, the value of the integral in turn depends on the initial conditions, namely $U(0)$, $N(0)$ and $I(0)$, in addition to the values of r, c, m, λ, μ, $\alpha(\cdot)$, and $\beta(\cdot)$, through job creation function $J_i(U,N,I)$. Thus, for each knife-edge condition the corresponding steady state is not generally unique either, and depends on the initial conditions.

From the multiplicity of equilibria it follows that we clearly have a coordination problem in this case: under the restriction that $\alpha = \frac{\beta\lambda}{((\lambda+\mu)+\beta(S_f - S_i))}$ the government can still affect the relative level of informal employment and achieve various levels of welfare by changing correspondence between parameters, in particular $\alpha(\cdot)$ and $\beta(\cdot)$.

The effect of parameter changes

Obviously, whenever the knife-edge condition is violated we immediately end up in one of the two cases considered above - the system start converging to another steady state equilibrium. This implies that these steady states are very sensitive to parameter changes.

For example, consider what happens if λ rises. The derivative of the right hand side of (27) is $\frac{\partial}{\partial\lambda}\frac{\beta\lambda}{((\lambda+\mu)+\beta(S_f-S_i))} = \frac{\partial}{\partial\lambda}\frac{\lambda\beta}{((\lambda+\mu)+\beta((r+\lambda+\mu)m-(r+\lambda)c))} = \frac{\beta\mu+\beta^2((r+\mu)m-rc)}{((\lambda+\mu)+\beta((r+\lambda+\mu)m-(r+\lambda)c))^2}$.
The sign of this expression is ambiguous, unless one makes an additional *ad hoc* assumption regarding the relative value of m and c. However, by assumption $\beta < 1$ so that the second term in the numerator is likely to be very low. Then it is likely that an increase in λ leads to an increase in the right hand side of the knife-edge condition, thus putting the economy in the situation when it converges to the steady state without the new sector.

A Behaviour of job creation functions

In this appendix we pay some more attention to the behaviour of job creation rates in the neighbourhood of no-growth points $J_n(U,N,I) = \lambda$ and $J_i(U,N,I) = \lambda + \mu$. This provides some insight into the shape of trajectories as the economy converges to a steady state.

Above we have shown that

$J_n(U,N,I) = \frac{\alpha}{\beta}J_i(U,N,I) + \alpha(S_n - S_i)$,

where S_n and S_i are the surpluses in the new and informal sectors respectively.

Also, it is straightforward to derive that

$\frac{dJ_n(U,N,I)}{dt} = \frac{\alpha}{\beta}\frac{dJ_i(U,N,I)}{dt}$.

Consider the case when the policy parameters are favourable to the steady state with the new sector alone to arise in the end of transition (other cases can be analysed by analogy). That is

$\alpha > \frac{\lambda\beta}{((\lambda+\mu)+\beta(S_n-S_i))}$.

It can readily be shown that under this condition we have

$J_n - \lambda > \frac{\alpha}{\beta}\left(J_i - (\lambda+\mu)\right)$.

In other words, whenever the informal sector is growing, i.e. $J_i > (\lambda+\mu)$, the new sector is growing too, while whenever the new sector is declining, $J_n < \lambda$, the informal economy is in recession as well. Assume that from the start of transition both sectors are growing. We know that in the steady state $J_n = \lambda$. This means that the rates J_n and J_i must be decreasing. What happens to the size of the two sectors?

Let us denote by t_n and t_i the times necessary to achieve the point where the sector sizes start to decrease. That is, if at time moment t_0 we have $J_n = J_n^* > \lambda$ and $J_i = J_i^* > \lambda + \mu$, and J_n and J_i are decreasing, as $\frac{\partial J_n}{\partial N} < 0$, $\frac{\partial J_n}{\partial I} < 0$, $\frac{\partial J_i}{\partial N} < 0$, and $\frac{\partial J_n}{\partial I} < 0$, it takes t_n and t_i for the new and the informal sectors, respectively, to reach the points where $J_n = \lambda$ and $J_i = \lambda + \mu$. Then t_n and t_i satisfy the equations:

$\int_{t_0}^{t_n} \frac{dJ_n(U,N,I)}{dt} dt = J_n^* - \lambda$

and

$\int_{t_0}^{t_i} \frac{dJ_i(U,N,I)}{dt} dt = J_i^* - \lambda - \mu$

respectively.

Applying the above relations between J_n and J_i and their full derivatives to the first integral yields

$\int_{t_0}^{t_n} \frac{dJ_n(U,N,I)}{dt} dt = \frac{\alpha}{\beta} \int_{t_0}^{t_n} \frac{dJ_i(U,N,I)}{dt} dt = \frac{\alpha}{\beta} J_i^* + \alpha\left(S_n - S_i\right) - \lambda$. $(*)$

From $\frac{\alpha}{\beta} > \frac{\lambda}{(\lambda+\mu)+\beta(S_n-S_i)}$ it follows that $(\lambda+\mu) > \frac{\beta}{\alpha}\lambda - \beta\left(S_n - S_i\right)$, i.e.

$J_i^* + \beta\left(S_n - S_i\right) - \frac{\beta}{\alpha}\lambda > J_i^* - \lambda - \mu$.

Thus, from $(*)$ and the second integral it follows that $t_i < t_n$.

This implies that even when initially both sectors grow, the informal sector is first to reach the edge when it starts to decrease, while the new sector will still be growing until it gets into the steady state (meanwhile, the informal sector must completely disappear as the steady state is reached). So, the shape of the trajectory followed by the new sector resembles an inverted L-curve, while the path taken by the informal sector mimics an inverted J-curve.

Now let us assume that the initial conditions are such that $J_n^* < \lambda$ and $J_i^* < \lambda + \mu$, i.e. both sectors are decreasing at the start of transition. As they decrease and non-employment increases $\frac{dJ_n(U,N,I)}{dt}$ and $\frac{dJ_i(U,N,I)}{dt}$ become positive, so that the decline in size of the new and informal sectors gets more moderate. By applying a reasoning similar to the one above, it can be shown that the new sector is first to achieve the point where $J_n > \lambda$ and it could start growing, while the informal sector will still be shrinking.

Numerical simulations in section 3.9 provide an illustrative example of the dynamics of our economy.

A The Effect of the Informal Sector on the Length of Transition

In the main text we argue that the presence of the informal sector slows down the transition. To see this, let us assume that a set of parameters is chosen so that the condition (23) favourable to the prevalence of the new sector in the end is satisfied. The fixed set of parameters defines the resulting steady state level of new sector employment, N^*, and non-employment, U^*.

Let us consider two paths followed by new sector employment (see Fig.A1). The first trajectory is given by the solution $N_n(t)$ to the system (20) with initial conditions $O(0) = O_0$, $N(0) = N_n(0) = N_0$, $I(0) = 0$,

$U(0) = U_0$. The second trajectory is given by the solution, $N_i(t)$, to the dynamic system with initial conditions $O(0) = O_0$, $N(0) = N_i(0) = N_0 - \varepsilon$, $I(0) = \varepsilon$, $U(0) = U_0$, where ε is some infinitesimally small number. From continuity of function $J_n(U, N, I)$ it follows that it is always possible to choose ε so that $J_n(U_0, N_0, 0) > J_n(U_0, N_0 - \varepsilon, \varepsilon)$. By putting $\varepsilon \to 0$ one can prove that the new sector takes off faster in the absence of the informal sector. Does it mean that it is the first to arrive at N^*?

Let us denote the time $N_n(t)$ arrives at steady state by T_n. Suppose now, that despite the fact that initially $N_i(t)$ grows slower than $N_n(t)$, after some time it catches up and arrives at steady state N^* at some time $T_i < T_n$. This implies that, as $N_0 - \varepsilon < N_0$, the path $N_i(t)$ must cross the path $N_n(t)$ from below at least once. Suppose it happens at some moment of time t_c. Then $N_n(t_c) = N_i(t_c) = N(t_c)$, while the level of old sector employment is $O(t_c)$ (it is the same for both sets of initial conditions, as development of the old sector does not depend on N, U or I). Let $U_n(t_c) = U_n$ and $U_i(t_c) = U_i$, be the levels of non-employment, and $I_n(t_c) = 0$ and $I_i(t_c) = I_i$ be the levels of shadow employment for the two sets of initial conditions (note that the informal sector does not take off if $I_n(0) = 0$). From the consistency conditions evaluated at t_c we have that $O(t_c) + N(t_c) + U_n = O(t_c) + N(t_c) + U_i + I_i$, or, equivalently $U_n = U_i + I_i$. The fact that $N_i(t)$ crosses the path $N_n(t)$ from below implies that $J_n(U_i, N(t_c), I_i) > J_n(U_n, N(t_c), 0)$. However, from $\frac{\partial J_n(\cdot)}{\partial U} > 0$, $\frac{\partial J_n(\cdot)}{\partial I} < 0$ and $U_n > U_i$, $I_i > 0$ we can conclude that $J_n(U_i, N(t_c), I_i) < J_n(U_n, N(t_c), 0)$. The contradiction proves that the path $N_n(t)$ lies above the path $N_i(t)$, and that $T_i > T_n$, i.e. the new sector reaches the steady state faster in the absence of the informal counterpart.

B Figures

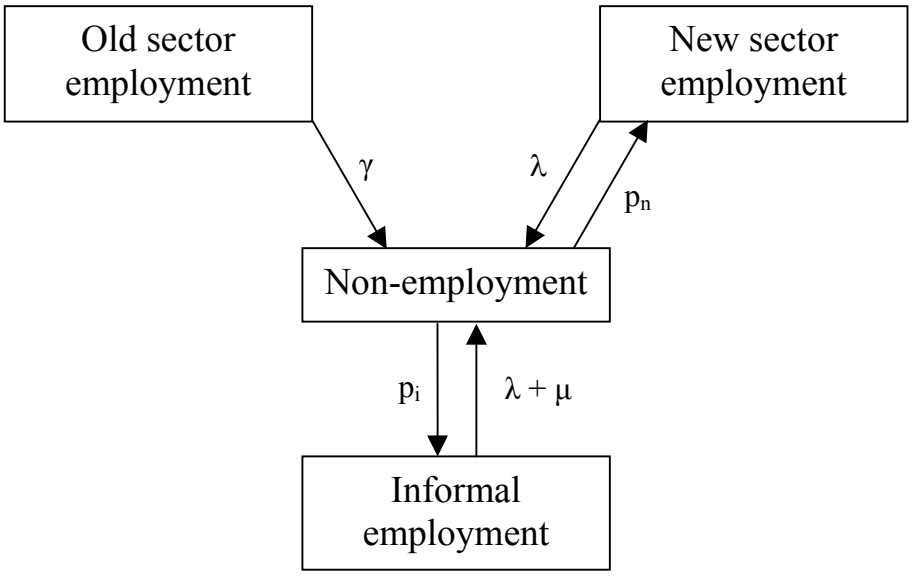

Figure 1 Flows of labour in the model

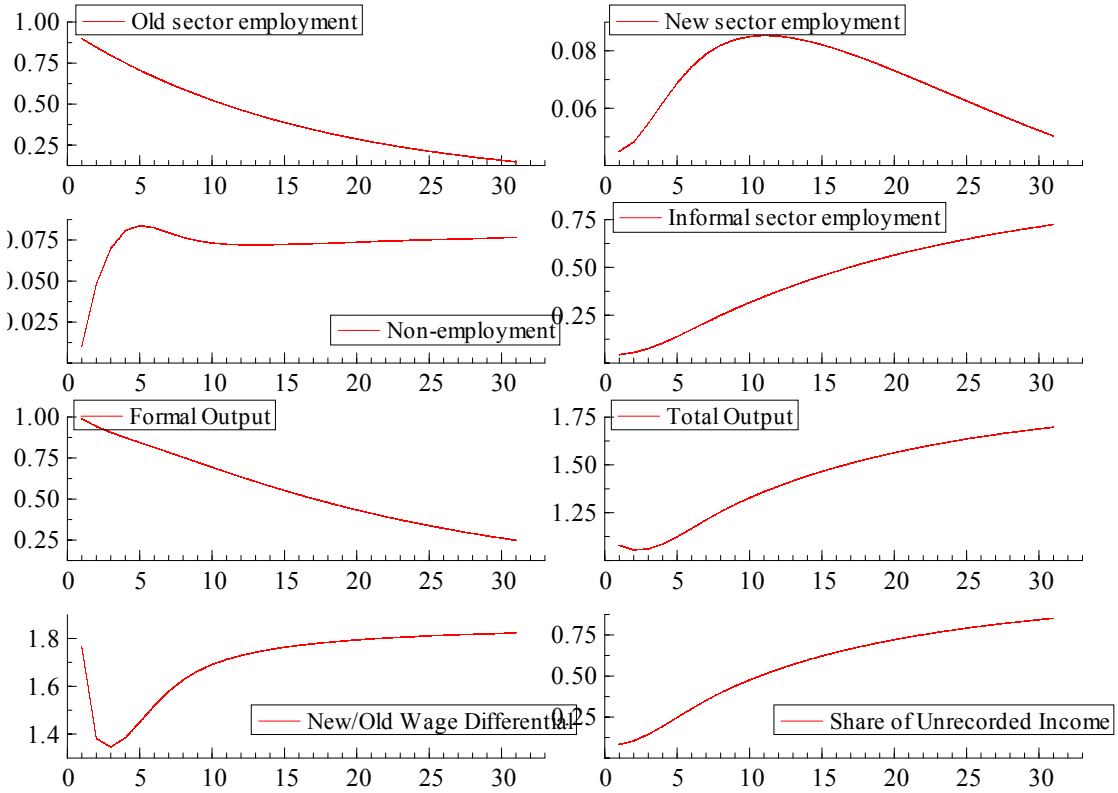

Figure 2 Simulations. A case of the lagging reformer: the economy converges to the steady state without the new sector

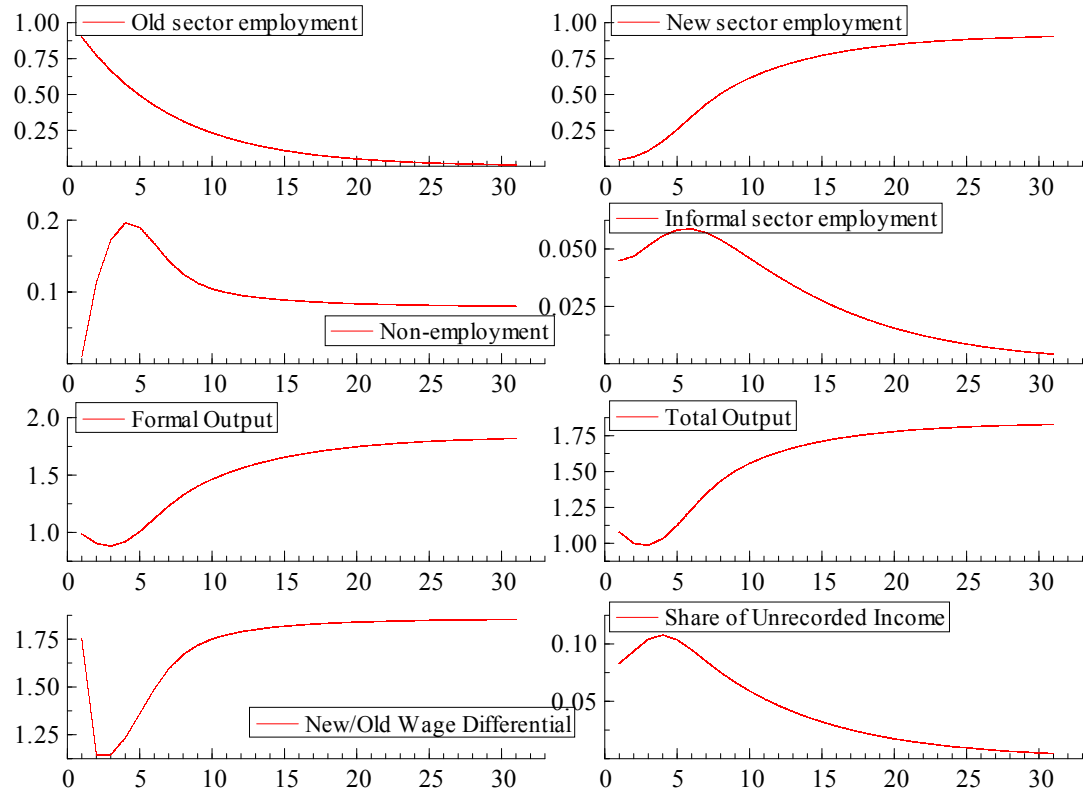

Figure 3 Simulations. A case of the advanced reformer: the economy converges to the steady state without the informal sector.

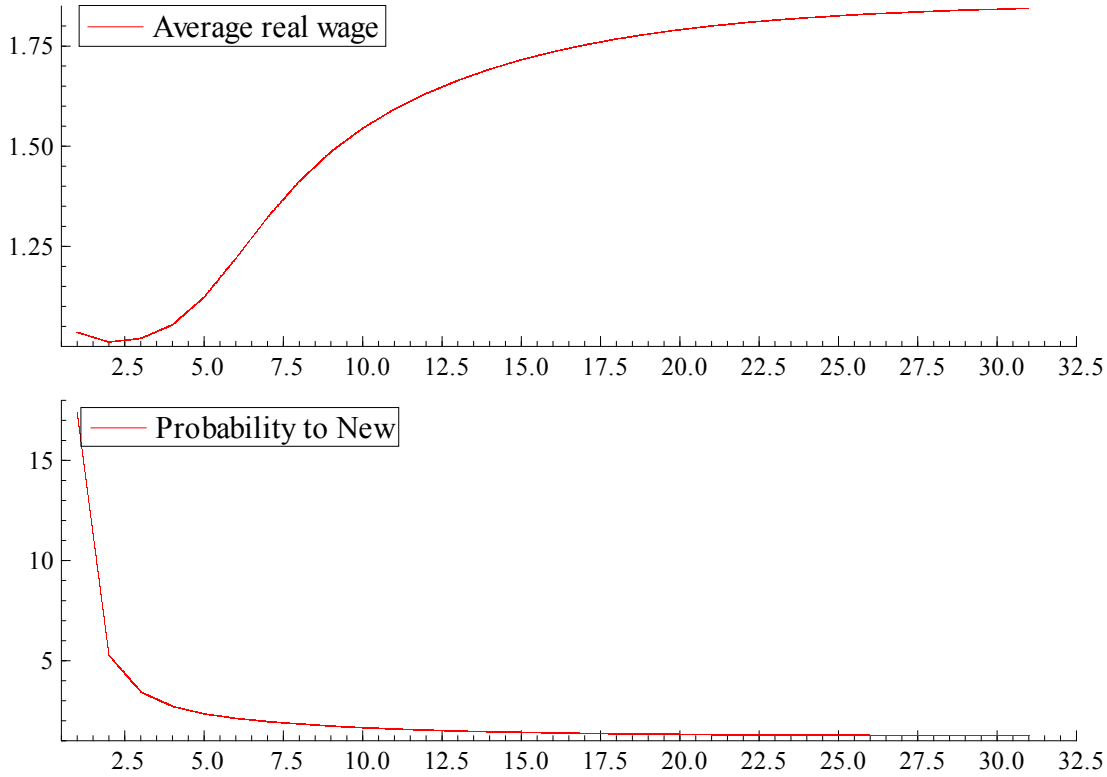

Figure 4 Simulations. Behaviour of average wages and transition probabilities.

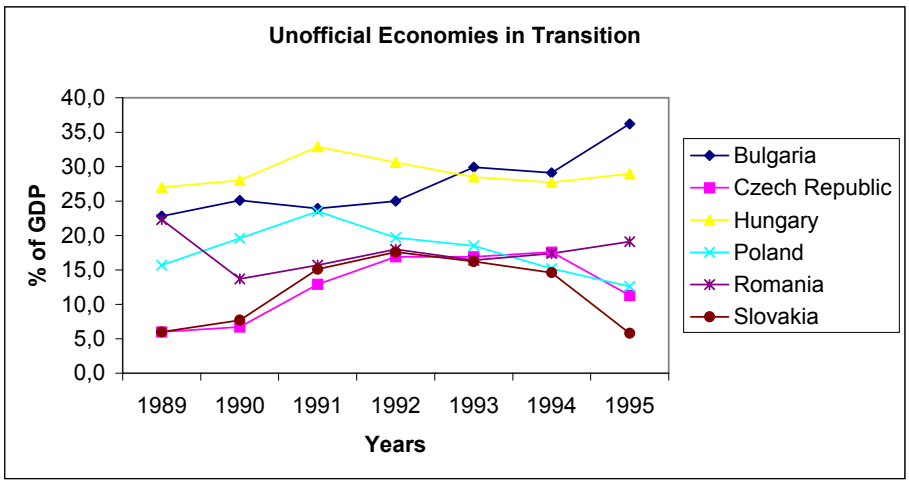

Figure 5 Informal sector in selected European transition countries (Source: Johnson et al., 1997)

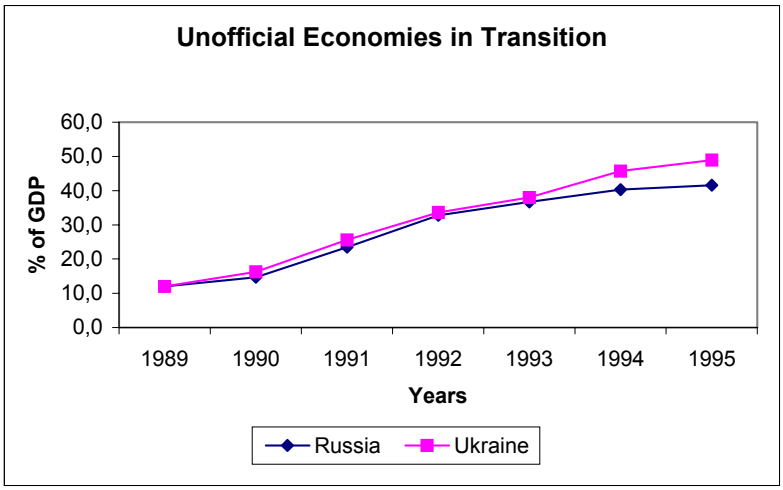

Figure 6 Informal sector in selected FSU countries (Source: Johnson et al., 1997)

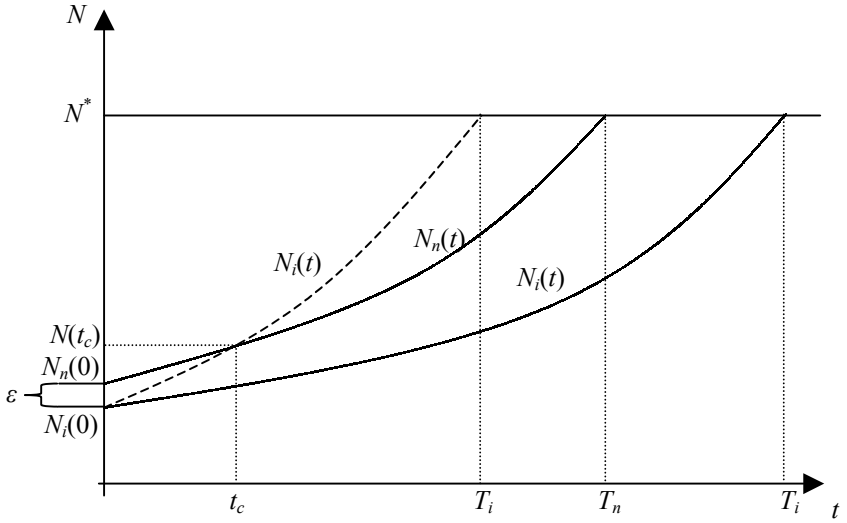

Figure A1 Length of Transition

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