Slow Recoveries*

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Abstract

Economies respond differently to aggregate shocks that reduce output. While some countries rapidly recover their pre-crisis trend, others stagnate. Recent studies provide empirical support for a connection between aggregate growth and plant dynamics through their effect on productivity: the entry and exit of firms and the reallocation of resources from less to more efficient firms explain a relevant part of transitional productivity dynamics. In this paper we use a stochastic general equilibrium model with heterogeneous firms to study the effect on aggregate short-run growth of policies that distort the process of birth, growth and death of firms, as well as the reallocation of resources across economic units. Our findings show that indeed, policies that alter plant dynamics can explain slow recoveries.

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1. Introduction

Why do countries experience long lasting drops in economic activity? Exogenous shocks like the deterioration in terms of trade, the reduction in foreign capital flows, and the rise in interest rates that most Latin American countries faced during the 1980s caused large but similar initial declines in output. However, the recovery paths that followed were strikingly different across countries.

Recovery processes require significant amounts of resource reallocation. Furthermore, when technology is embodied in production units, these must be scrapped in order to free resources that can be used in the leading edge production sites. The main hypothesis of this paper is that slow recoveries are a result of impediments to this natural process of resource reallocation. For instance, excessive labor protection, financial markets underdevelopment, regulatory uncertainty, and institutions that protect powerful interest groups entail costs to the adjustment process. By reducing the extent of restructuring, these obstacles alter the recovery path that follows aggregate shocks, stagnating economic activity during long periods of time. Recent studies have suggested this connection between rigidities and recovery. Prescott (2002) provides a comprehensive analysis of this link. Specific examples are Hayashi and Prescott (2002) on financial distortions in Japan during the 1990s, Cole and Ohanian (2000) on labor market distortions in the United States during the 1930s, and Bergoeing et al. (2002a) on bankruptcy laws in Mexico and Chile during the 1980s and 1990s. In this paper we provide new cross country empirical evidence of a negative relationship between the severity of recessions and distortions, using a regulation index that considers financial restrictions, trade barriers, firm entry costs, inefficient bankruptcy procedures, bureaucratic red tape, tax burden, and labor regulations.

To model the link between slow recoveries and rigidities we extend the work of Campbell (1998) to allow for obstacles to restructuring. Specifically, we develop a dynamic general equilibrium model of heterogeneous plants, with aggregate and idiosyncratic shocks, and general rigidities, to study the link between plant dynamics and growth, and output recovery and inflexibility. We model these general rigidities as subsidies and taxes that change the relative cost of firm creation, expansion, and survival, altering the natural rate of factor reallocation. We then compare the recovery path of a distorted economy to that of fully flexible economy.

In the model there exist different types of capital, embodying different levels of technology. Capital embodying relatively low-level technology is scrapped as its productivity lags behind that of the best practice technology, which in turn grows as a random walk with drift. The salvage value of scrapped capital can be used to produce new capital that embodies the leading edge technology. In this context, an ongoing process of resource reallocation characterizes the economy's equilibrium path. When a distortion is introduced, such as a production subsidy to incumbent firms, the natural process of entry and exit is muted, reducing the amount of restructuring. The subsidy allows inefficient plants -- which would have otherwise exited -- to stay longer in business. This type of distortion enables low productivity firms to stay in business for an inefficiently long period of time, and promotes an inefficient allocation of resources pushing the economy inside its production possibilities frontier. Furthermore, they delay the adoption of new and better technologies, causing the balanced growth path of income per capita to lag with respect to the world's leading edge. We believe these explanations for growth and development are suggestive for a wide range of actual economic experiences.

In this paper we study two particular cases of impediments to reallocation that might shed light on the markedly different recovery paths we observe. In the first numerical exercise, we compare economies that start-off with different levels of a production subsidy to incumbent firms. We then expose these economies to the same aggregate shock, and compare their recovery paths. Under our benchmark calibration, we find that an economy with no distortions that faces a completely transitory aggregate shock equivalent to 5% of its steady state GDP per capita, loses in present value terms about 13% of its pre-shock GDP, and a recovery period of one quarter. However, an economy that starts-off with a 5% (10%) subsidy to incumbents loses 14.22% (14.29%) with a restructuring period of 9 (10) quarters. These differences in recovery paths are striking, particularly given that we assume that shocks are short-lived, and that these are the only distortions in the simulated economies.

In our second exercise the distortion is a policy response to the aggregate shock. When the exogenous recession hits the economy, jobs are lost and production units are scrapped. To reduce the distress associated to these losses, the government intervenes subsidizing incumbents one period after the shock hits the economy. This policy is transitory, as it follows an AR(1) with autocorrelation coefficient of 0.66; that is, it lasts about 3 quarters. In this case, an economy that initially imposes a 3% (6%) subsidy to incumbents loses 23.73% (36.34%) of GDP in present value terms with a recovery period that lasts 29 (37) quarters.

Our work builds on the firm heterogeneity models pioneered by Jovanovic (1982) and further extended by Hopenhayn (1992), Ericson and Pakes (1995), and Campbell (1998). It also complements the work developed by Caballero and Hammour (1998a). In a series of papers, Caballero and Hammour develop a model of inefficient creative destruction, in which transactional difficulties due to hold-up problems hamper the process of reallocation. They find that the economy is characterized by an inefficiently low creation rate and a decoupling of creation and destruction. They also find that too few low productivity units are scrapped in equilibrium, and that firms that continue in production are not necessarily the most productive ones, as entrepreneurial net worth is a key variable for firm creation. Our analysis differs from that of Caballero and Hammour in that, in our model, rigidities are the result of direct policy intervention. Furthermore, we focus on the creation and destruction margins, and do not attempt to explain the "scrambling" of production units according to their level of efficiency. In a closely related paper, Hopenhayn and Rogerson (1993) build a model of firm heterogeneity and study the effects of a tax on layoffs. They find large employment and welfare effects on the stationary equilibrium of the economy. In this paper we emphasize the transitional dynamics, and thus our work complements that of Hopenhayn and Rogerson (1993).

Finally, our work is also related to the job reallocation and plant dynamics literature. Davis, Haltiwanger and Schuh (1996) and others have extensively documented the international evidence on job reallocation. At any given time, and even within the same industry, jobs are created and destroyed, existing plants expand and contract, new plants start up, and old plants shut down. The facts documented in the literature show surprisingly similar rates of job reallocation across countries. If developing countries face larger shocks and need higher levels of restructuring, then we should observe higher rates of reallocation in these economies. The evidence is thus consistent with institutional differences in the ability of these economies to reshuffle resources across production units. Recent evidence shows large cross-country differences in the ability to reallocate resources at the micro level.[1]

The paper is organized as follows. The next section of the paper provides empirical support for a link between the recovery path of economies and policies that alter plant dynamics. In Section 3 we present a model with heterogeneous plants and policy distortions. We explain the mechanics of the model and describe its equilibrium solution. In Section 4 we calibrate and simulate our model economy to quantify the impact of policy distortions as a source for actual slow recoveries. The final section concludes.

2. Some Empirical Evidence

Our objective is to understand why some countries suffer to recover from temporary negative shocks. We present a microeconomic answer to this macroeconomic question. The microeconomic mechanism outlined in the model and illustrated in the simulation exercises is related to the negative effects that distortionary government-imposed regulations can have on firm dynamics, particularly the destruction of inefficient investment projects and the adoption of improved technologies. Given the crucial role that regulations play in our explanation, a necessary first-step is to examine whether regulations in fact are related to the severity of recessions and the growth performance of various countries. Here we illustrate the relevance of these relationships from a cross-country perspective.

There are a large variety of government-imposed regulations on private firms. Broadly speaking, we can divide them into regulations on entry, exit, and growth of firms and investment projects. In the model below, we study separately the most important of them and analyze their specific mechanisms. However, in this section, given that our purpose is to illustrate their overall, reduced-form effect, we combine various regulation

[1] Caballero, Engel and Micco (2003) characterize the degree of microeconomic inflexibility in several Latin American countries. For instance, they find that Chile is more flexible than Mexico. Bergoeing et al. (2002b) show that Chile and Mexico faced similarly sized negative aggregate shocks in the early 1980s, but that Chile recovered much more quickly.

measures into a single index. Using a variety of cross-country sources, we collected comparable data on the following types of government regulations (see the appendix for specific definitions, sources, and coverage): financial restrictions, trade barriers, firm entry costs, inefficient bankruptcy procedures, bureaucratic red tape, tax burden, and labor regulations. After normalizing these underlying indicators, we average them to obtain a single regulation index. Our sample consists of 77 countries, representing all major regions of the world. To get a sense for the prevalence of regulations across regions, Figure 1 presents the median of our index for various groups of countries. The regulatory burden is highest in Sub-Saharan Africa, Middle East and North Africa, and South Asia. East Asia and Pacific and Latin America and the Caribbean are in the middle of the range, and industrialized countries show the lowest level of overall regulations.[2]

As mentioned above, we would like to explore the cross-country connection between overall regulations and the severity of recessions. We also look at growth as it is naturally connected to our variable of interest. We use the average rate of per capita GDP growth as its appropriate measure. We followed the literature and computed the corresponding average for the period 1960-2000 for each country in the sample. The severity of recessions does not have a standard measure in the literature, however. Here we propose an original indicator. This captures the extent of downward GDP deviations from trend beyond a certain threshold (deviations within the threshold can be regarded as normal cyclical volatility). We set the threshold to equal one standard deviation of the world distribution of output-gap volatility. Using a common threshold generates absolute (as opposed to country-specific) measures for the severity of recessions and, thus, facilitates cross-country comparisons. In short, we obtain output-gap series per country by detrending the corresponding (log) of per-capita GDP using the Baxter-King filter. We then compute the common threshold, as mentioned above. Finally, we obtain the severity-of-recessions indicator as the country's sum of downward deviations of GDP beyond the threshold for the period 1960-2000.

The scatter plots in Figures 2 and 3 represent the simple relationship between the regulations index, on the one hand, and the severity of recessions and economic growth, on the other. Confirming our priors, stronger regulations are correlated with more severe recessions and lower economic growth.

A more formal evaluation of the connection between our variables of interest should take into account the additional determinants of the severity of recessions and economic growth. We do this by multiple regression analysis. In the case of recession severity, it is necessary to control for the various shocks that can affect the economy. Thus, we consider the possibility that the severity of recessions is not only related to regulations but also to the volatility of the terms of trade, the volatility of inflation, the degree of real exchange rate misalignment, and the frequency of banking crises. As shown in Table 1, the regression results indicate a positive and statistically significant effect of the regulation index on the severity of recessions. Turning to economic growth,

[2] We should note that this pattern is not homogeneous across types of regulations. For instance, contrary to the overall index, industrialized countries have the highest level of labor-related regulations

it is necessary to account for its basic determinants, as indicated by the new growth literature. Thus, apart from the regulation index, we include as explanatory variables the (log of) initial per capita GDP (to account for transitional convergence), the secondary school enrollment rate (to control for human capital investment), and the (log of) private credit to GDP ratio (to account for financial development). Table 2 shows that the regulation index carries a negative and significant coefficient, suggesting a negative effect of regulations on growth.

3. A Theory of Plant Selection

We develop a general equilibrium model with heterogeneous plants, vintage capital, and idiosyncratic shocks, based on Hopenhayn (1992) and Campbell (1998). We assume that there exists a distribution of plants characterized by different levels of productivity. In each period, plant managers decide whether to exit or to stay in business. If a plant stays, the manager has to decide how much labor to hire. If the plant exits, it is worth a sell-off value. New technologies are developed every period. Plants face three types of productivity shocks: a standard aggregate shock common to all establishments, an idiosyncratic shock, and a shock to the leading edge production process.

In this context, the economy is characterized by an ongoing process of plant entry and exit, and job creation and destruction. Plants may decide to exit in order to gain access to the leading edge technology –Schumpeter's process of creative destruction–, although at the cost of receiving a scrap value for its capital. These investment irreversibilities, as modeled by Caballero and Engel (1999), combined with idiosyncratic uncertainty, generate an equilibrium with plants rationally delaying exit decisions. Also, plants may decide whether to exit forever if the economic prospects loom negative.

Our model extends Campbell's (1998) analysis in three dimensions: First, by fully characterizing plant level dynamics, we consider both plant startups and shutdowns, and incumbents. This allows us to look not only at the entry and exit of plants but also at labor creation and destruction resulting from continuing plants.

Second, we consider both idiosyncratic and aggregate productivity shocks. Within this setting, firms can become more productive over time for two reasons: because they are exposed to better methods of production or because they thrive while others disappear. The distinction is relevant since these non-mutually exclusive methods of increasing aggregate productivity have different implications. In particular, while aggregate productivity changes are unbounded and do not entail substantial worker displacement, the increase in efficiency resulting from reallocation is bounded by the production possibilities frontier and involves significant reallocation of inputs across firms. Moreover, while the former predicts a negative correlation between entry and exit of plants and between labor creation and destruction, the latter implies both measures positively comoving.[3] Thus, by fully characterizing plant dynamics we can decompose aggregate productivity changes into within plant variations and a reallocation term.

Finally, we extend Campbell's model to allow for general rigidities. In particular, we study the effect of policies that alter firms´ decision to leave or stay in the market.

In what follows we describe our model in detail.

The model economy: The economy is populated by a continuum of heterogeneous plants. A plant needs labor (*n*) and capital (*k*) for production of the unique good, which can be used for consumption or investment. This unique production good is the numeraire.

Each plant's technology is given by

$$y_t = e^{\lambda_t} n_t^{\alpha} \left(e^{\theta_t} k_t\right)^{1-\alpha}$$

where λ_t is the aggregate productivity shock common to all establishments and θ_t is the idiosyncratic productivity shock. The aggregate productivity shock follows an AR(1) process described by

$$\lambda_{t+1} = \rho\lambda_t + \varepsilon_{t+1}^{\lambda}, \varepsilon_{t+1}^{\lambda} \sim \mathrm{N}\left(0, \sigma_{\lambda}^{2}\right)$$

N(·) is the normal distribution, $0 \le \rho \le 1$, and ε_t^{λ} is *i.i.d.*

Each type of capital embodies different levels of technology. Since technologies are characterized by constant returns to scale, we can restrict the size of all plants to be equal to one unit of capital. Thus, capital goods are identified with plants so that investing one unit of the aggregate good yields a unit mass of plants.

The aggregate production function of this model economy is:

$$Y_t = e^{\lambda_t} N_t^{\alpha} \left[\int_{-\infty}^{\infty} e^{\theta_t} k_t(\theta) d\theta \right]^{1-\alpha} = e^{\lambda_t} N_t^{\alpha} \overline{K}_t^{1-\alpha}$$

where $\overline{K}_t = \int_{-\infty}^{\infty} e^{\theta_t} k_t(\theta) d\theta$ is the effective capital stock.

[3] For instance, Chilean data from the Encuesta Nacional Industrial Anual (ENIA) show that the correlation between labor creation and destruction was –0.70 for the 1980s. During the 1990-99 period, however, this correlation rose to –0.22, possibly reflecting the increasing relative importance of idiosyncratic shocks during the last decade.

Capital embodying relatively low level of technology is scrapped as its productivity lags behind that of the leading edge technology. When a plant is retired, a unit of capital that is scrapped has salvage value $s < 1$. The total amount of salvaged capital in period t is then

$$S_t = (1-\delta)s \int_{-\infty}^{\overline{\theta_t}} k_t(\theta_t) d\theta_t$$

where $\overline{\theta_t}$ is the endogenous cut-off level of productivity that determines the exit decision of plants. Units of the production goods not consumed -- which are made up of investment and part of last period's scrapped capital --, are transformed into new units of capital embodied with the leading edge technology. That is, the initial productivity level of a plant born in period t is a random variable with a normal distribution $\theta_{t+1} \sim \mathrm{N}\left(\mathrm{z_t}, \sigma^2\right)$, where z_t is the index of embodied technology that represents the leading edge production process. This random variable follows a random walk with a positive drift μ_z according to

$$z_{t+1} = \mu_z + z_t + \varepsilon_{t+1}^z, \varepsilon_{t+1}^z \sim \mathrm{N}\left(0, \sigma_z^2\right).$$

This drift is the only source of long-run aggregate growth in our economy.

Capital that is not scrapped receives an idiosyncratic shock to its productivity level before next period production process starts, according to

$$\theta_{t+1} = \theta_t + \varepsilon_{t+1}^\theta, \varepsilon_{t+1}^\theta \sim \mathrm{N}\left(0, \sigma_\theta^2\right).$$

This idiosyncratic shock has zero mean and thus, it does not affect the economy´s long-run growth rate. The random walk property of the stochastic process ensures that the differences in average productivity across units of capital persist over time. Thus, at any t, the units of capital with more advanced technology have a lower probability of shutting down.

Summarizing, there are three sources of uncertainty: First, an idiosyncratic productivity shock, e_t^θ , that determines the plant level decisions of incumbents. This shock does not alter the aggregate equilibrium allocation. Second, an idiosyncratic productivity shock, ε_t^z , that governs the economy wide growth. Notice that plants, as they decide to stay or leave, choose between the following distributions:

$$\theta_{t+1} \sim \mathrm{N}\left(\theta_\mathrm{t}, \sigma_\theta^2\right)$$

$$\theta_{t+1} \sim \mathrm{N}\left(\mathrm{z_t}, \sigma^2\right)$$

Finally, an aggregate shock, e_t^{λ} , that introduces aggregate uncertainty, moving transitorily the economy´s production possibility frontier.

Plants last one period. At the beginning of the period, firms decide production and hiring. The wage rate in period t is ω_t , and the beginning and end of period prices of a plant with productivity θ_t are $q_t^0(\theta_t)$ and $q_t^1(\theta_t)$, respectively. Within this setting, given the number of units of capital with productivity θ_t, $k_t(\theta_t)$, the employment assigned to each plant is given by

$$n_t(\theta_t) = N_t^{\alpha} e^{\theta_t} / \overline{K}_t \, .$$

After production, firms decide which plants should be scrapped and which ones kept in business. Firms sell their production and salvaged capital to the consumer and to a construction firm that produces capital embodying the leading edge technology.

Capital evolves according to the law of motion

$$k_{t+1}^0(\theta_{t+1}) = \int_{-\infty}^{\infty} \frac{1}{\sigma_\theta} \phi\left(\frac{\theta_{t+1} - \theta_t}{\sigma_\theta}\right) k_t^1(\theta_t) d\theta_t + \phi\left(\frac{\theta_{t+1} - z_t}{\sigma}\right) I_t^c$$

Since asset prices equal discounted expected dividend streams, increases in the level of productivity raise these prices; and since the scrap value of a plant is independent of its productivity, only plants with productivity level below the threshold $\overline{\theta_t}$, will exit the market. The marginal plant, that is, the one with productivity level $\overline{\theta_t}$, has a market value given by the scrap value. The following equation states this condition.

$$s = q_t^1(\overline{\theta_t}) \, .$$

Finally, the purchasing price of a unit of capital is determined not only by its marginal productivity but also by the price at which the capital left after depreciation may be sold at the end of the period. Thus, for each θ_t, the purchase and sale decisions of capital units must be characterized by the zero profit condition:

$$q_t^0(\theta_t) = (1-\alpha)\left(\frac{\overline{K}_t}{N_t}\right)^{-\alpha} e^{\theta_t} + (1-\delta)\left[1\{\theta_t < \overline{\theta_t}\}s + 1\{\theta_t < \overline{\theta_t}\}q_t^1(\theta_t)\right]$$

where $1\{\cdot\}$ is an indicator function that equals one if its argument is true and zero otherwise. This condition restricts the beginning of period price to be the return from using the capital plus the price at which it can be sold at the end of the period.

There is a construction firm whose sole purpose is to incorporate the leading edge technology into the goods produced by the firm. A construction firm which buys I_t^c units of the aggregate good from the producer incorporates the leading edge technology at zero cost, and then sells it to consumers at the end of the period at a price per unit q_t^{1i} . Profit maximization requires the price of the construction project to be equal to the cost of inputs utilized. That is,

$$q_t^{1i} = 1 \; .$$

Government subsidies - or taxes -, τ_t , follow an AR(1) process as the one described for the aggregate productivity shock, λ_t. We consider policies that allow plants to stay longer in the market than they would have without government intervention. We represent them by a subsidy to incumbents that increases the end of period price of an old plant. The government´s budget constraint is guaranteed to be satisfied by imposing a lump-sum transfer to consumers.

The remainder of the model is standard. There is a continuum of identical infinitely lived consumers who own labor and equity. Their preferences are given by

$$E_0\left[\sum_{t=0}^{\infty} \log(c_t) + \gamma(1-n_t)\right]$$

where c_t and 1 - n_t are consumption and leisure respectively, and $\beta \in (0,1)$ is the subjective time discount factor. Every period consumers have a time endowment equal to 1. Following Hansen (1985) and Rogerson (1988), we assume that consumers can work a fixed number of hours or none at all. To avoid non-convexities, consumers are assumed to trade employment lotteries. As a consequence, n_t is interpreted as the fraction of the population that works.

Definition of the equilibrium: A *Competitive Equilibrium* in this economy is a set of contingent plans $\{c_t, I_t, Y_t, \overline{K}_t, N_t, S_t\}_{t=0}^{\infty}$, and contingent prices $\{\omega_t, q_t^1, q_t^0, q_t^{1i}\}_{t=0}^{\infty}$ of labor, plants at the beginning of the period, plants at the end of the period, and construction projects, and a vector $\{\overline{\theta}_t\}_{t=0}^{\infty}$ such that, given contingent prices, the transfer T_t , and production and government stochastic processes $\{z_t, \theta_t, \lambda_t, \tau_t\}$, at each period t:

1) The representative consumer solves

$$E_0\left[\sum_{t=0}^{\infty}\log(c_t)+\gamma(1-n_t)\right]$$

$$c_t + I_t^c q_t^{1i} + (1-\tau_t)\int_{-\infty}^{\infty} q_t^1(\theta_t)k_t^1(\theta_t)d\theta = \omega_t n_t + \int_{-\infty}^{\infty} q_t^0(\theta_t)k_t^0(\theta_t)d\theta - T_t$$

$$k_{t+1}^0(\theta_{t+1}) = \int_{-\infty}^{\infty}\frac{1}{\sigma_\theta}\phi\left(\frac{\theta_{t+1}-\theta_t}{\sigma_\theta}\right)k_t^1(\theta_t)d\theta_t + \phi\left(\frac{\theta_{t+1}-z_t}{\sigma}\right)I_t^c$$

2) The producer of the consumption good satisfies

$$n_t(\theta) = N_t^\alpha e^{\theta_t} / \overline{K}_t$$

$$\omega_t = \alpha e^{\lambda_t}\left(\frac{\overline{K}_t}{N_t}\right)^{1-\alpha}$$

$$q_t^1(\overline{\theta_t}) = s$$

$$q_t^0(\theta_t) = (1-\alpha)\left(\frac{\overline{K}_t}{N_t}\right)^{-\alpha} e^{\theta_t} + (1-\delta)\left[1\{\theta_t < \overline{\theta_t}\}s + 1\{\theta_t < \overline{\theta_t}\}q_t^1(\theta_t)\right]$$

3) The intermediary satisfies

$$I_t^i = q_t^{1i} I_t^c$$

4) The government satisfies

$$\tau_t \int_{-\infty}^{\infty} q_t^1(\theta_t)k_t^1(\theta_t)d\theta = T_t$$

5) The market clearing restriction is satisfied

$$c_t + I_t = Y_t + S_t$$

4. A Numerical Evaluation

We simulate the transitional path that follows aggregate productivity shocks. We study slow recoveries resulting from distortions that alter plants dynamics. Although these distortions may take various forms, we will model a specific policy that subsidizes incumbents. Plants that would have exited after the shock stay longer in the market when the subsidy is positive. To approximate actual experiences we simulate equilibria for a wide range of policy values.

Solution method

To solve for the numerical equilibria we use a three-step strategy. First, we compute the non-stochastic steady state values for the model variables. Second, we linearize the system of equations that characterize the solution around the long-run values of the variables. Third, we apply the method of undetermined coefficients described in Christiano (1998). We solve the model scaling the variables by the long-run growth rate such that they converge to a steady state. Then, a mapping takes the solution from the scaled objects solved for in the computations to the unscaled objects of interest.

Parameter values

We can separate the parameters in three types: aggregate parameters, given by the vector $\{\beta, \delta, \gamma, \mu_z, \alpha, s, \sigma_\lambda, \rho_\lambda\}$; plant specific parameters, given by the vector $\{\sigma, \sigma_\theta\}$; and a vector of policy parameters $\{\tau, \sigma_\tau, \rho_\tau\}$.

The aggregate parameters are calibrated as in a representative firm economy. A period is one quarter. Long-run growth is given by $\mu_z(1-\alpha)/\alpha$, which also represents the growth rate of income per capita since population is stationary. Thus, to have an annual trend growth rate of 2%, and given α equal to 0.6 – a standard value in the literature-, we use μ_z equal to 0.52%. The marginal utility of leisure, γ, determines the fraction of available time allocated to labor. We chose γ consistently with N equal to 0.35. The irreversibility s is fixed in 0.9. The remaining aggregate parameters, β, α, and δ, are chosen as in the standard growth literature.

Plant specific parameters are taken from Campbell (1998). There are two reasons to do so. First, long series of plant level data are generally not available for a large sample of countries. Second, we see our economies as equal in all respect but policy. We use the United States as our undistorted benchmark.

Policy parameters are also complicated to calibrate since comparable series for plant level distortions are typically not available across countries. Thus, we approximate different actual experiences by simulating transitional growth using a wide range of policy values. These distortions are intended to capture the different regulations that reduce competition, raise the costs of firm formation and slow down technological adoption. They may also represent other impediments to the natural process of reallocation across firms such as financial markets imperfections. In general, any policy that affects current and expected productivity, interfering with the natural process of birth, growth, and death of firms will have a detrimental effect on aggregate growth. For instance, as the cost of entering and exiting the economy changes, the distribution of firms is altered: too many inefficient firms remain in the market and too few efficient firms enter the market. As a result, both the reshuffling of resources from less to more efficient firms and the adoption of the leading edge technology are impeded. The evidence presented in Section 2 establishes an empirical link between transitional growth and distortions on exit decisions. Moreover, evidence from the job reallocation and plant dynamics literature documents surprisingly similar rates of job reallocation across countries. However, since developing countries have higher volatility of output, higher rates of reallocation should be observed in these economies. This is consistent with institutional differences across countries with respect to their ability to reshuffle resources across production units.

Finally, the remaining parameters, σ_λ, ρ_λ, σ_τ and ρ_τ, are picked along with our simulation exercises; i.e., they are used to fix the size and persistent of the shocks imposed on our simulated economies. Table 3 summarizes our parameter choices.

Our model abstracts from reality in several dimensions that are relevant for the specification of parameters as well as for the interpretation of our results. First, the concept of plants in our model differs from the concept implicit in the data. Our measure of economic units can be thought of as projects; we do not observe projects in the data, however. For this reason, our model generates much higher creation and destruction of labor than observed in the data. Second, only new plants invest. In the data investment is carried out by both new and old plants. Third, plants may adopt new technologies without actually closing.

Simulating transitional growth

Our benchmark equilibrium is given by an economy without distortions that faces a 5% reduction in its aggregate productivity level. This shock has no persistency; that is, it lasts only one period. The role of this assumption is to abstract from the intertemporal effects of the shock.

Figure 4 shows the impulse responses for four key macroeconomic elements of the benchmark equilibrium: output, consumption, investment and hours worked. We see that, as expected, a negative aggregate shock to productivity reduces all of them. These impulse responses are consistent with those observed in a representative firm economy. A model with plant heterogeneity introduces and additional margin by allowing entry and exit and reshuffling of resources across existing plants. These reallocation effects are relevant for aggregate productivity dynamics. Figure 5 and 6 show impulse responses for the cut-off level of productivity that determines endogenous exit decisions, and job creation and destruction rates, respectively. A one period reduction in the level of aggregate productivity increases the cut-off level of productivity since it forces relatively inefficient plants to exit. Moreover, job creation falls and job destruction increases. The aggregate labor response is the net result of these two margins of adjustment.

To study differences in recovery paths we analyze two particular cases of impediments to reallocation. They might shed light on actual differences in recovery paths. In the first numerical exercise, we compare economies that start-off with different levels of a production subsidy to incumbent firms. We then expose these economies to the same 5% aggregate shock, and compare their recovery paths to their own trend. The second exercise simulates an economy with no distortions that imposes a transitory subsidy to incumbents, a period after the aggregate shock occurs. When the exogenous recession hits the economy, jobs are lost and production units are scrapped. To reduce the distress associated to these losses, the government intervenes subsidizing incumbents one period after the shock hits the economy. This policy is short lived, as it follows an AR(1) with autocorrelation coefficient of 0.66; that is, it lasts about 3 quarters.[4]

Figure 7 shows the recovery path for our first exercise. The trend has been normalized to one in both economies. Initially, the economy that protects incumbents experiments a smaller fall in output. This is precisely why policies as this are typically implemented: to reduce volatility. Over time, however, the protected economy also experiments a slow recovery. The results are similar in the second exercise. Figure 8 shows the recovery path in this case. As before, the economy that subsidizes existing plants experiences stagnating growth and recovers its pre crisis output trend level later.[5]

To measure the differences in the recovery paths of the undistorted and distorted economies, we provide two types of indicators. The first type relates to the size of output losses, whereas the second to the time that output takes to recover its long-run trend.

To construct the first indicator (from now on, the loss), we start by normalizing the path of output and its trend in such a way that all economies start off with the same level of output; that is, GDP per capita and its trend at time $t = 0$ are all equal to 1. We do this to account for the fact that distorted economies have lower output in steady state. Let Y^{τ}_t represent the actual GDP of the economy with distortion at level τ in period t, and let YT^{τ}_t its trend. Thus the loss is the present value of output deviations from its trend as a fraction of pre-shock output:

$$\frac{\sum_{t=0}^{T} \beta^t (Y_t^{\tau} - YT_t^{\tau})}{Y_0^{\tau}}$$

[4] Our exercise is highly stylized since the endogeneous policy response is more likely to happen in reality when aggregate shocks are persistent.
[5] Figure 8b plots a longer time-line to show that the economy does return to its balanced growth path.

We use two sets of recovery length indicators. The first one measures the time it takes the economy to recover its trend after the economy is struck by the exogenous aggregate shock. That is, it is the number of quarters the output gap reduces to a certain ratio. The second indicator is the fraction of the loss that is realized in a certain number of quarters.

Table 4 reports these indicators for the simulated economies. The fully flexible economy loses a significant fraction of its pre-crisis GDP over the recovery path: 13.1% in present value terms. The economy does not recover instantaneously because there exist technological rigidities – a scrap value below 1, and a lag between investment decisions and its availability for production. These rigidities imply that the loss of output is larger than the actual shock. If the economy is already distorted when the shock strikes, the loss increases to slightly over 14%. This difference, about a 1% of pre-crisis GDP, is totally due to reduced reallocation, and thus lower aggregate TFP growth. Recall that we measure the loss after normalizing the path of output, so the loss does not incorporate the fact that the distorted economy is poorer in steady-state. This additional loss is large. The measured losses associated to the subsidy that is given right after the crisis starts are much larger. The first line of the second panel shows these losses. The larger size of these losses are due to the fact that the tax puts the economy below its trend for a long period of time (see Figure 8).

The second measure shows that the undistorted economy quickly recovers its output trend: it takes only 1 quarter to reduce the gap to less than one fifth of a one percent. The subsidized economies take 9 and 10 quarters, respectively. The length of the recovery period increases substantially when the government subsidizes firms right after the crisis has started, with catch-up periods that rise over 30 quarters. Thus the policy intervention reduces volatility and firm destruction, at the cost of a long period of stagnation.

Our final measure, the fraction of the loss that is realized in 1, 5, 10, 20 and 30 quarters, is reported at the bottom of each panel. Most of the loss is quickly realized in the fully flexible economy, with over 84% of it happening within the first crisis period. Subsidized economies spread these losses over time, with 68% to 72% realized within the first quarter. Only after 10 quarters all three simulated economies behave similarly, having realized about 95% of the loss. Once again, the differences with the economy that is intervened during the crisis are striking: only 30% to 46% of the loss is realized within the first quarter, spreading the recovery path over a much longer period of time. It takes about 30 quarters to realize 95% of the loss, i.e., 5 years more than the undistorted economy.

Our results show that the costs associated to incumbent protection are substantial, both in terms of lost output and recovery length. These costs are much larger whenever the economy is distorted along the recovery path, because within a short period of time, the economy faces two shocks: the exogenous aggregate shock, and the policy response to the shock. If the government lets the economy adjust on its own, the initial fall in output is much sharper, but concentrated over a significantly shorter period of time.

5. Conclusions

In this paper we have linked microeconomic rigidities to aggregate transitional growth. By subsidizing incumbents, we have altered the reallocation process, a key source of aggregate efficiency. As plants that would have exited the economy stay longer in the market, aggregate efficiency lowers and growth stagnates. As a result, economies experience slow recoveries and large output losses.

Our findings are consistent with observed recovery paths. The evidence on plant dynamics across countries is also consistent with our findings. Developing and developed economies show surprisingly similar rates of job reallocation, although output volatility is markedly higher in poor countries. This high volatililty suggests the need for higher restructuring. Thus the evidence is consistent with sluggish restructuring in developing countries, perhaps as a result of institutional impediments to resource mobility across production units.

Finally, our results suggest further research on other growth-related issues. Market oriented reforms have been ubiquitously undertaken during the last two decades. However, most reforms are implemented sequentially, so when one reform is undertaken other obstacles to reallocation stay in place. Our results, thus, suggest that the benefits from liberalizing international trade or from privatizing publicly owned firms will be largely reduced if impediments to plant dynamics are not eliminated simultaneously.

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Appendix: Regulation Index Components and Sources

Component name	Data source	Description
BANK	IEF	• Measures the relative openness of a country's banking and financial system: whether foreign banks and financial services firms are able to operate freely, how difficult it is to open domestic banks and other financial services firms, how heavily regulated the financial system is, the presence of state-owned banks, whether the government influences allocation of credit, and whether banks are free to provide customers with insurance and invest in securities (and vice-versa). • Annual data for **1995-2003** • **163** countries
	EFW	• Ranks the percentage of total domestic credit extended to private sector. • 5-year data for **1970-2000** (additionally 2001) • at least 77 countries in 1970 (out of **123**), 110 in 1990
		• Avoidance of interest rate controls and regulations that lead to negative real interest rates. Measures the extent to which the interest rate is set by market forces. • 5-year data for **1970-2000** (additionally 2001) • at least 19 countries in 1970 (out of **123**), 106 in 1990.
	A. Abiad and A. Mody	• Financial liberalization index • **1973-1996** (annual) • **36** countries
	Loayza, Fajnzylber and Caderon (2002)	• Index of the private credit share of total credit
TRADE	IEF	• Based on a country's weighted average tariff rate—weighted by imports from the country's trading partners. The higher the rate, the worse (or higher) the score. For consistency, the most recent weighted average tariff rate reported for a country is used as the primary source. When the weighted average tariff rate is not available, the country's average tariff rate is used; otherwise, grading is based on the revenue raised from tariffs and duties as a percentage of total imports of goods. In the very few cases in which data on duties and customs revenues are not available, the authors use data on international trade taxes instead. If non-tariff barriers exist in sufficient quantity, or if there is ample evidence of corruption, a country's score based solely on tariff rates receives an additional point on the scale (representing decreased economic freedom). • Annual data for **1995-2003** • **163** countries
	EFW	• Regulatory trade barriers. Average of hidden import barriers (no barriers other than published tariffs and quotas) and costs of importing (measures the additional cost of importing created by the combination of import tariffs, license fees, bank fees, and the time required for administrative red-tape) • Data for **1995, 2000, and 2001** • **120-122** countries

CLOSE	World Bank – Doing Business, Bankruptcy Database	• Measures the success of a jurisdiction in reaching the three goals of insolvency, as stated in Hart (1999). It is calculated as the **simple average of the cost of insolvency** (rescaled from 0 to 1, where higher scores indicate less cost), **time of insolvency** (rescaled from 0 to 1, where higher scores indicate less time), **the observance of absolute priority of claims, and the efficient outcome achieved.** A 1 on the Goals-of-Insolvency Index means perfect efficiency, a 0 means that the insolvency system does not function. • Data available for **2003** only • **108** countries
OPERATE	BERI	• The objective of the Operations Risk Index (ORI) is to gauge the business operations climate. There are two variables being measured: (1) the degree to which nationals are given preferential treatment and (2) the general quality of the business climate, including bureaucratic and political continuity. 15 criteria measure the country's business environment from 0 (unacceptable conditions) to 4 (superior conditions). The criteria are weighted to emphasize critical success factors, and this expands the 15 to a weighted total of 25. A rating of 4 on each criterion gives a perfect environment of 100. • **1992-2003** (annual) • **50** countries
START	IEF	• Measures how easy or difficult it is to **open and operate a business**. The factor also examines the degree of corruption in government and whether regulations are applied uniformly to all businesses. Another consideration is whether the country has state planning agencies that set production limits and quotas. The measure includes the extent of government corruption, how uniformly regulations are applied, and the extent to which regulations impose a burden on business. • Annual data for **1995-2003** • **163** countries
	ROE	• Ranking of the number of different procedures that a start-up has to comply with in order to obtain a legal status, i.e. to start operating as a legal entity. • Data for **1999** only • **85** countries
TAX	KPMG	• Ranks **maximum corporate tax rates.** • Annual data for **1997-2003** • **69** countries
	IEF	• Index that combines rankings of **individual income tax, corporate tax, and government expenditures.** • Annual data for 1995-2003 • 163 countries
FIRE	LMI	• Simple average of rankings of: **minimum industrial wage/average Industrial wage, social security contributions (%), union membership/labor force, and general government employment/labor force** • 5-year data for **1945-2000** • **117** countries
REGULATION INDEX	Authors' calculations	• Simple average of TAX, FIRE, BANK, TRADE, START, CLOSE, OPERATE • over time as well, roughly from **1960-2003** • **77** countries

Table 1. Severity of Recessions and Regulation

Dependent Variable: Measure of severity of recessions

	Coefficient		Standard Error	t-ratio
Regulation index	1.166	**	0.461	2.53
Exchange rate misalignment (logs)	0.209	*	0.108	1.94
Standard deviation of terms of trade growtl	0.006		0.010	0.59
Standard deviation of inflation rate	0.001		0.002	0.70
Frequency of banking crises	1.183	*	0.663	1.79
Constant	-1.106	**	0.351	-3.15

Number of Countries: 77. R-squared = 0.42

** means significant at 5% and * means significant at 10%

Table 2. Economic Growth and Regulation

Dependent Variable: Rate of per capita GDP growth

	Coefficient		Standard Error	t-ratio
Regulation Index	-4.682	**	2.331	-2.01
Initial GDP per capita (logs)	-0.917	**	0.177	5.18
Secondary enrolment rate (logs)	1.538	**	0.320	4.81
Ratio of private credit to GDP (logs)	0.865	**	0.283	3.06
Constant	2.132		2.611	0.82

Number of Countries: 77. R-squared = 0.55

** means significant at 5% and * means significant at 10%

Table 3. Parameterization

Aggregate parameters		
Discount factor	β	0.98
Marginal utility of leisure	γ	(2.25, 1.91)
Labor share	α	0.6
Technology drift	μ_z	0.0052
Irreversibility	s	0.9
Depreciation rate	δ	0.02
Plant level parameters		
Standard deviation of shock to incumbents	σ_θ	0.03
Standard deviation of shock to startups	σ	0.25
Simulation parameters		
Productivity shock	σ_λ	-0.05
Productivity shock persistence	ρ_λ	0
Policy level	τ	(-0.1,-0.05, 0)
Policy shock	σ_τ	(-0.06,-0.03, 0)
Policy shock persistence	ρ_τ	0.66

Table 4. Simulated Slow Recovery Indicators

Exercise 1

		Subsidy (%)		
		0	5	10
Loss (% of pre-shock GDP)		13.1	14.2	14.3
Catching up with the trend (quarters)	0.2%	1	9	10
	0.5%	1	2	4
% of the loss realized in	1	84.2	72.3	68.1
	5	91.1	88.7	90.1
	10	94.5	94.9	96.5
	20	97.8	98.9	99.6
	30	99.1	99.8	100.0

Exercise 2

		Subsidy (%)		
		0	3	6
Loss (% of pre-shock GDP)		13.1	23.7	36.3
Catching up with the trend (quarters)	0.2%	1	29	37
	0.5%	1	17	26
% of the loss realized in	1 quarter	84.2	46.4	30.3
	5 quarters	91.1	57.2	43.6
	10 quarters	94.5	71.9	63.5
	20 quarters	97.8	88.9	86.0
	30 quarters	99.1	95.6	94.6

Figure 1. Regulation Index by Region

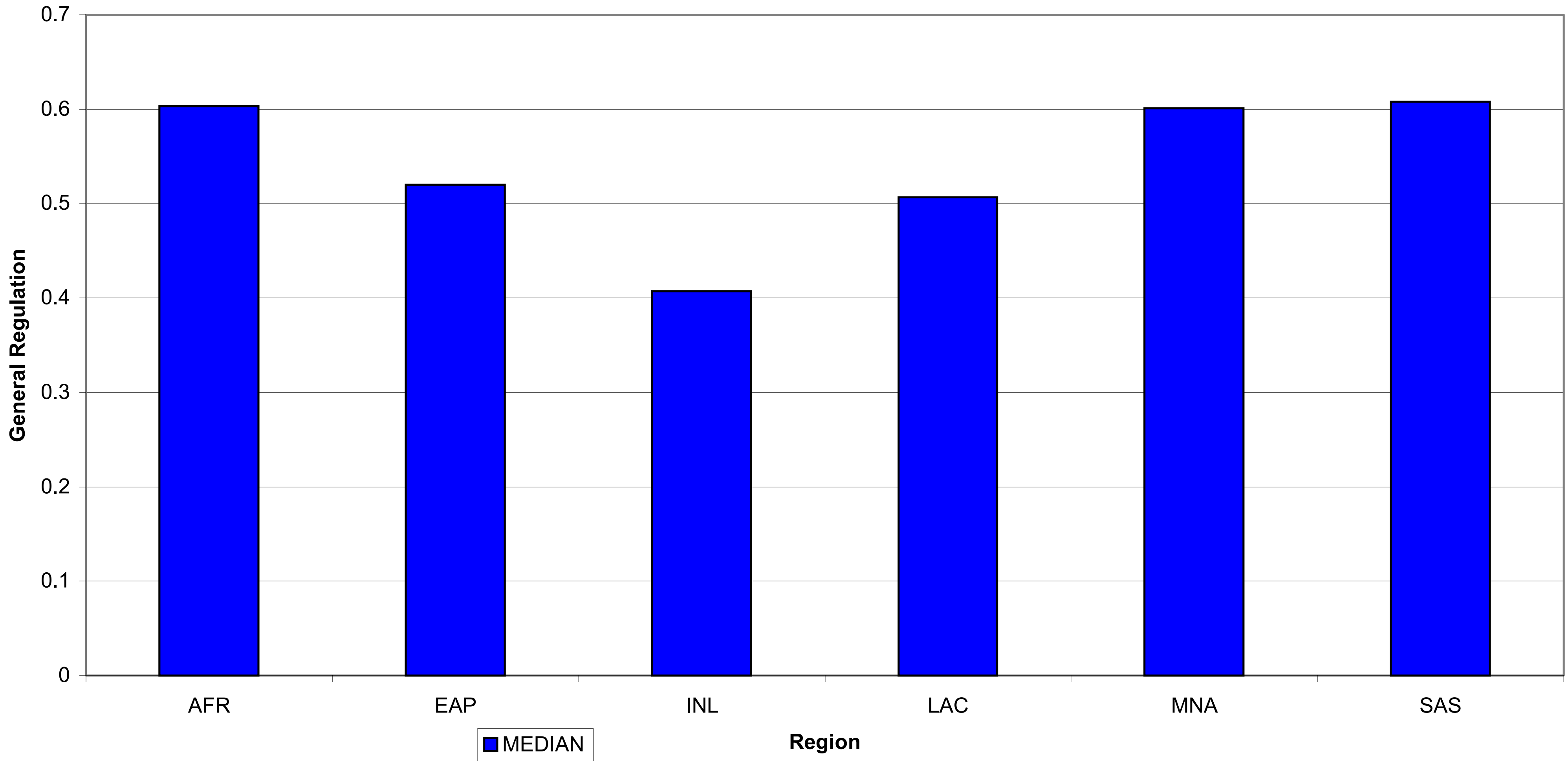


Figure 2. Severity of Recessions vs. Regulation
(Correlation: 0.40)

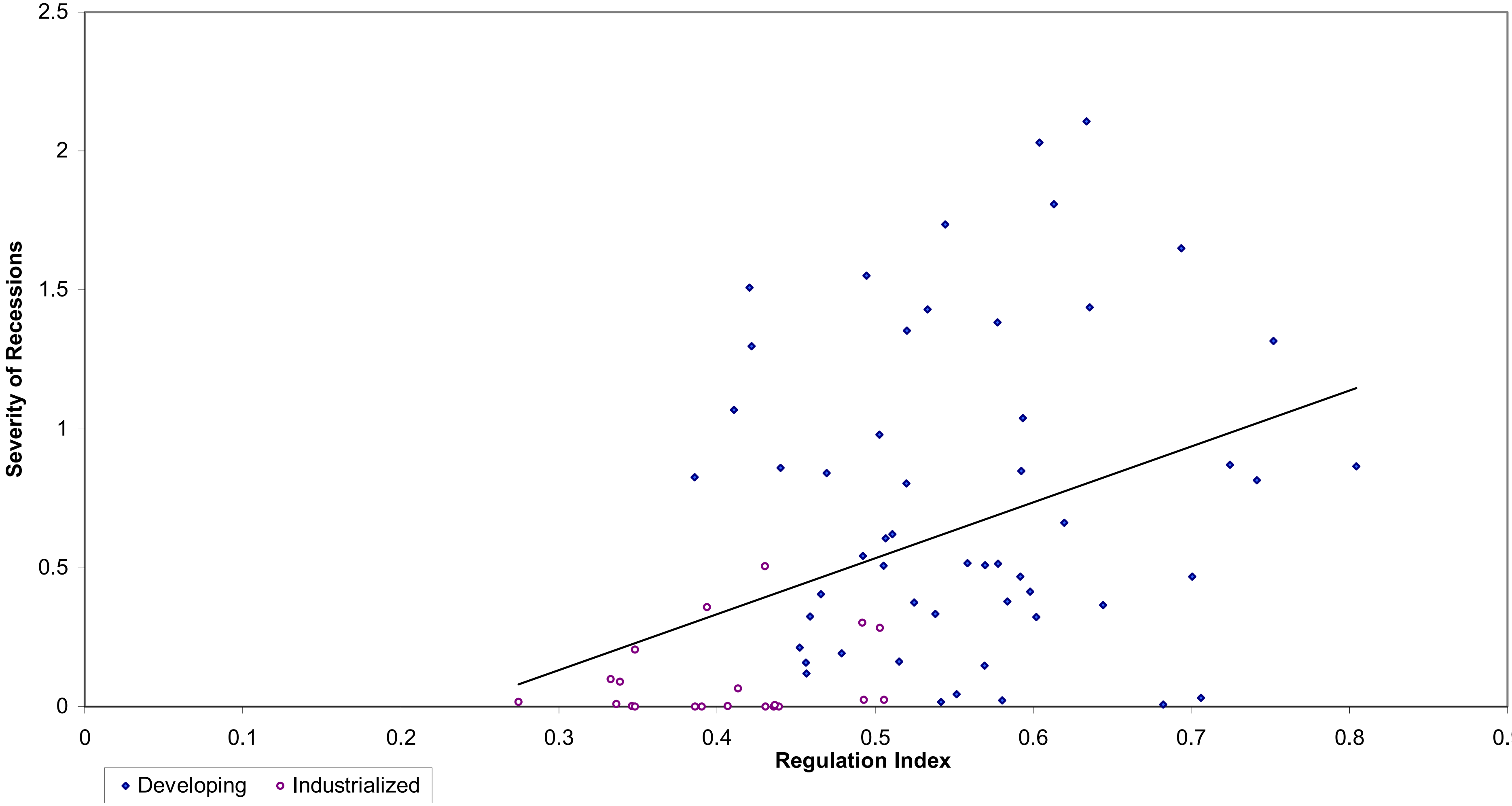


Figure 3. GDP Growth vs. Regulation
(Correlation: -0.43)

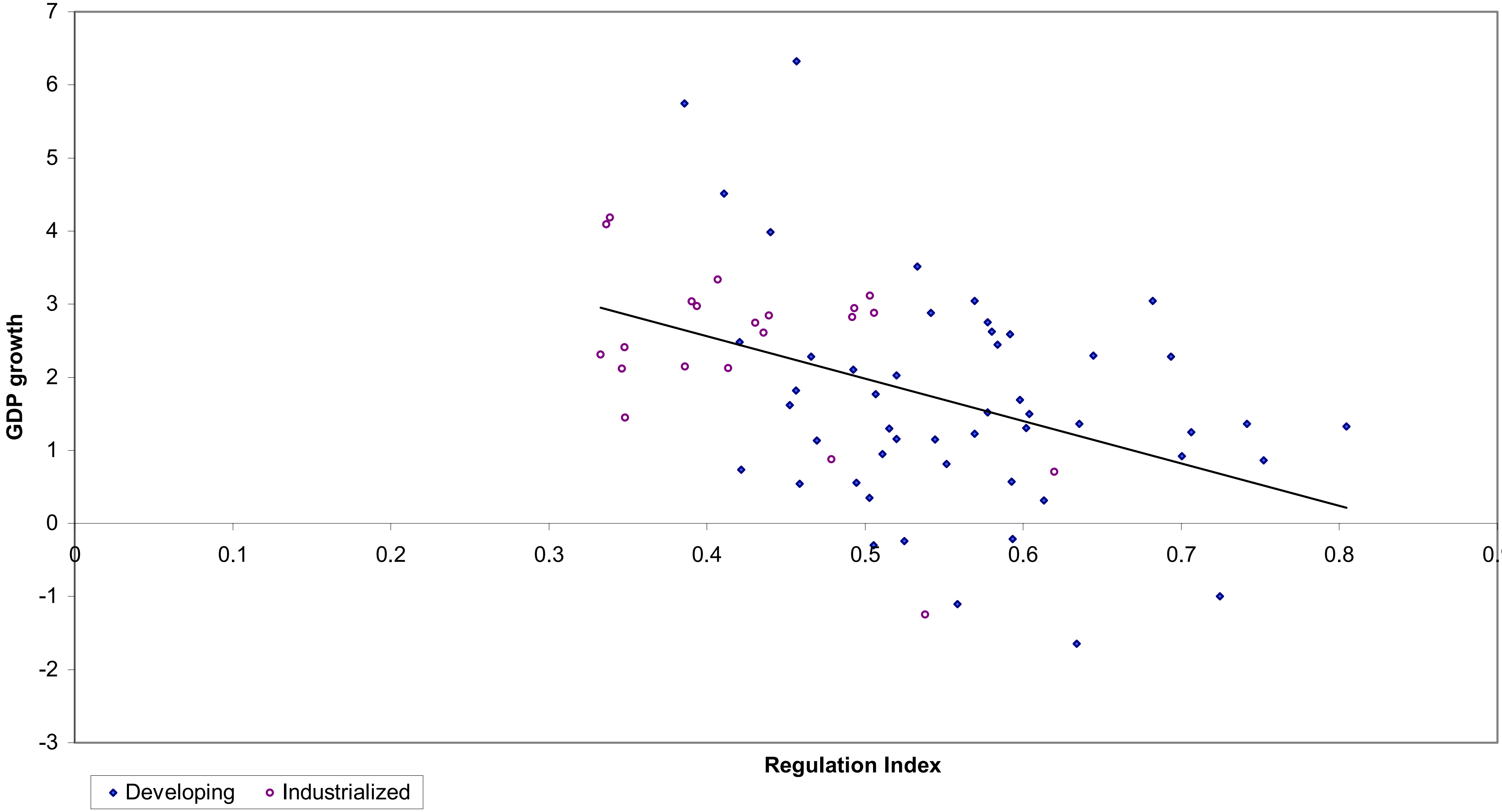


Figure 4. Impulse Response for Macro Variables

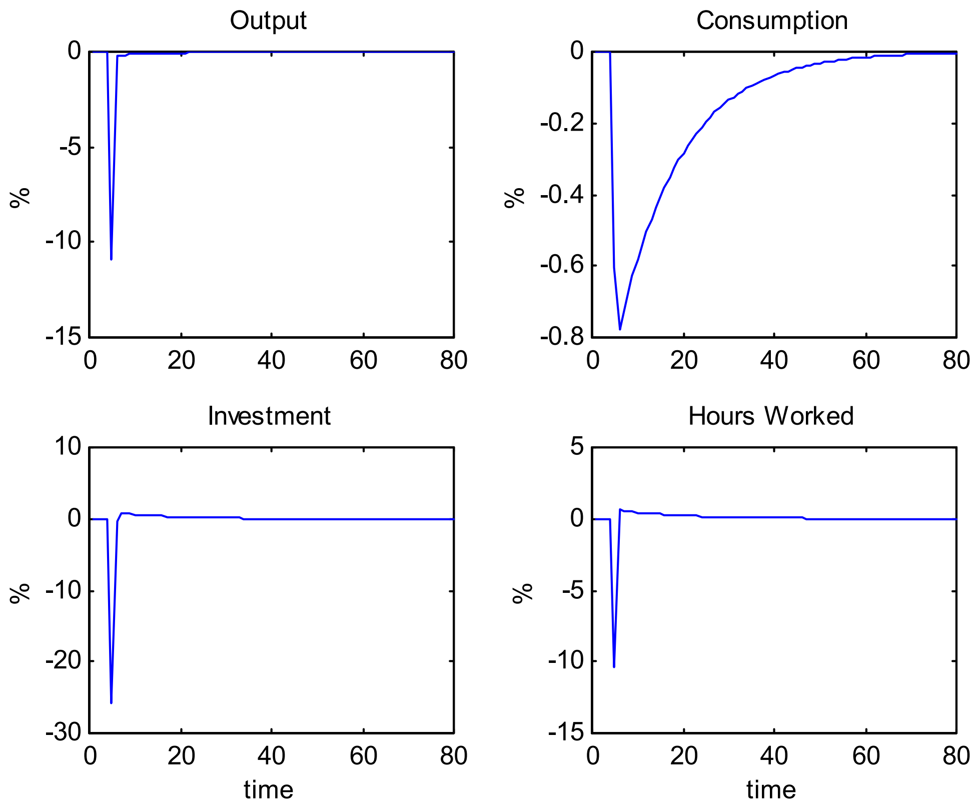


Figure 5. Impulse Response for Cut-Off Level

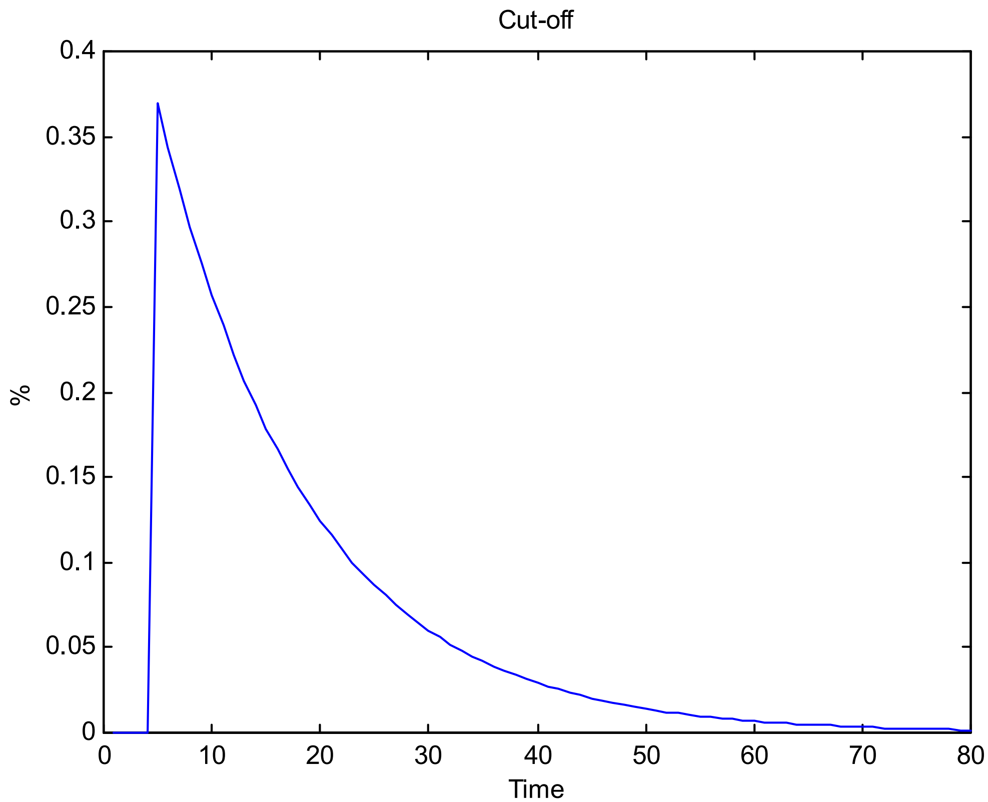


Figure 6. Impulse Response for Job Creation and Destruction Rates

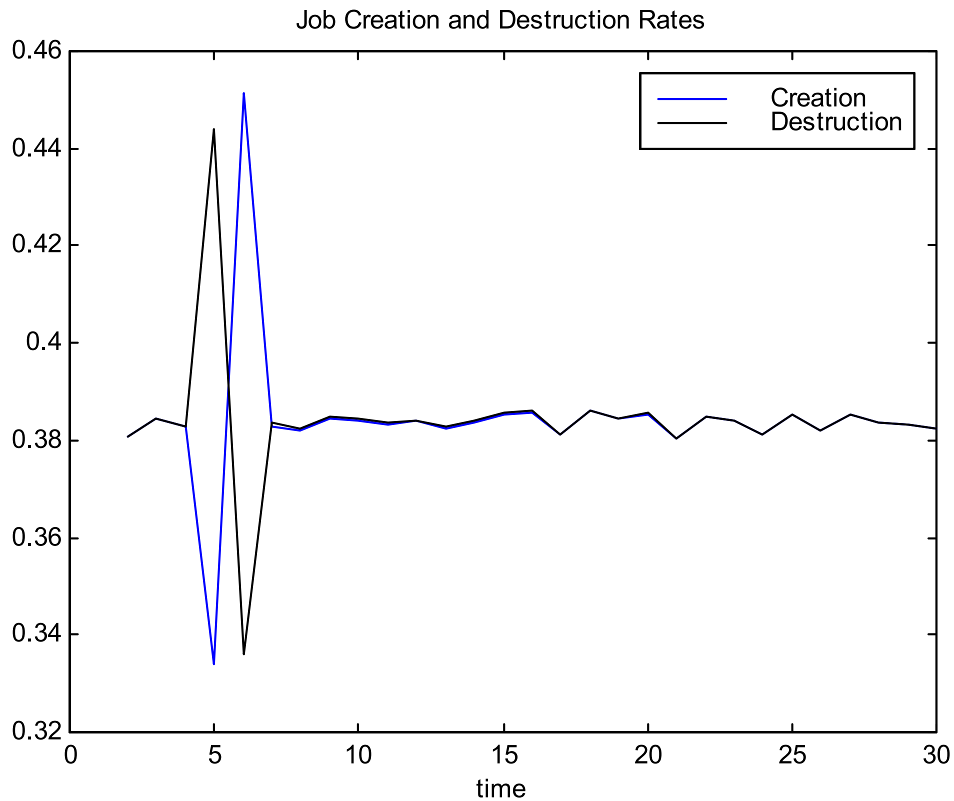
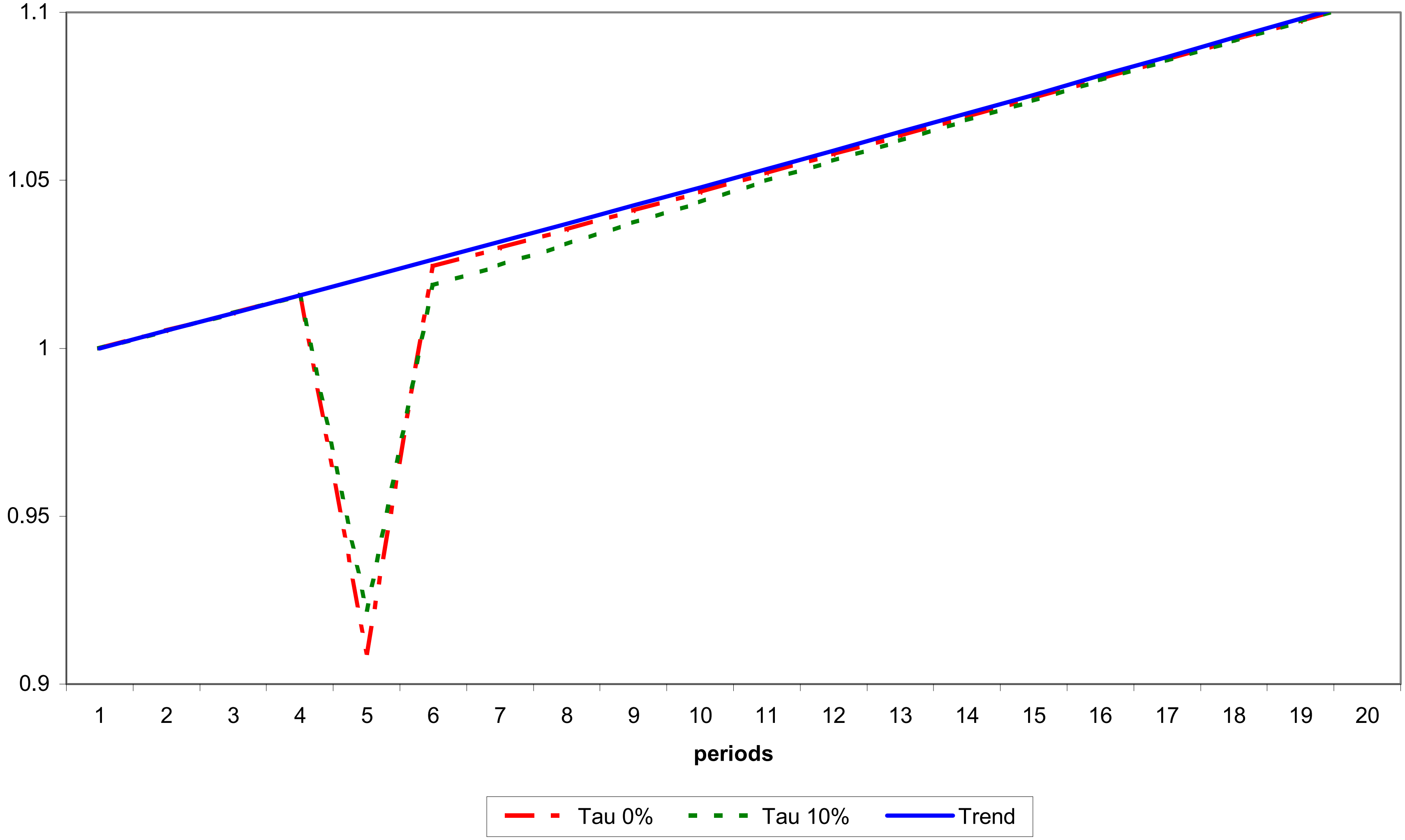


Figure 7. Slow Recovery
(normalized output level)



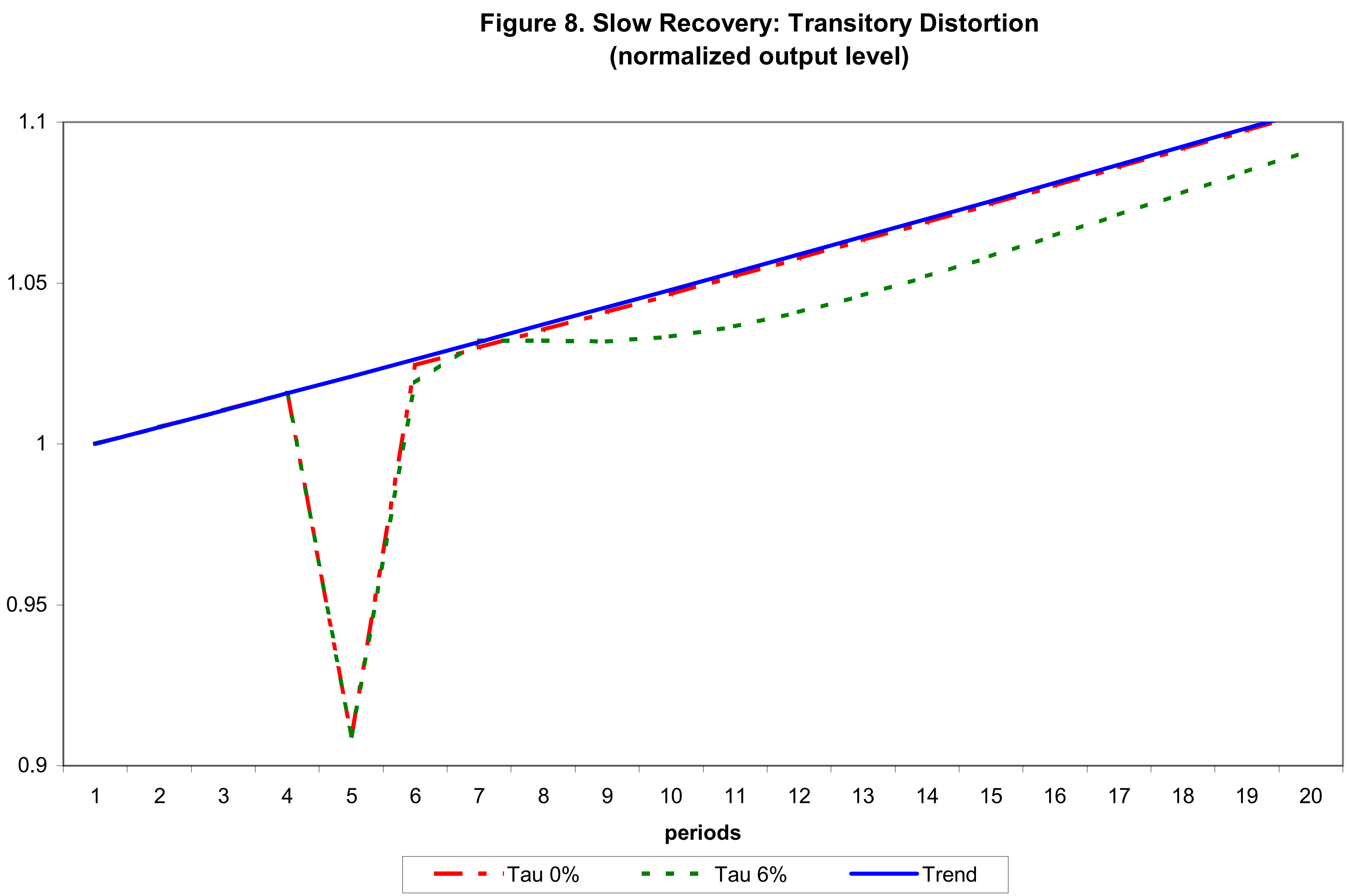


Figure 8. Slow Recovery: Transitory Distortion
(normalized output level)
1.1
1.05
1
0.95
0.9
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
periods
Tau 0%
Tau 6%
Trend

Figure 8b. Slow Recovery: Transitory Distortion
(normalized output level)