Demand Side Shocks and Macroeconomic Policy

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Abstract

The paper focuses on short run macroeconomic dynamics triggered by demand side shocks. In particular, the paper analyzes, in a general equilibrium framework, the impact of transitory demand side shocks on the behavior of macroeconomic variables and examines the relevance of policy instruments during downturns in economics activity. The paper establishes that transitory shocks can have persistent effects. It shows that stabilization is desirable even if shocks are transitory in nature. In particular, the article reveals that debt financed government spending is a viable stabilization tool and can improve welfare at all horizons even though it inhibits physical capital formation. Finally, the paper resolves apparently contradictory observations and shows that recessions are simultaneously times of cleansing and sullying.

JEL Classification: E3, E6, D5.

Key Words: Business Cycles, Policy, Debt, Welfare Costs.

1 Introduction

This paper analyzes, in a general equilibrium framework, the effects of demand side disturbances on macroeconomic variables. Specifically, the paper establishes that negative demand side shocks exacerbate informational imperfections and have persistent impact on macroeconomic variables even if

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their nature is transitory. In addition, the paper examines the issue of productivity during recessions. It is shown that recessions can be interpreted both as times of cleansing and periods of sullying. Finally, the paper shows that policy intervention can enhance welfare. In particular, it is shown that debt financed government spending can increase welfare at all horizons even though it inhibits physical capital formation.

The issues are approached in a general equilibrium setup with the assumption of imperfect competition, imperfect information, and fixed costs at the micro level. Specifically, it is assumed that economic agents, at the micro level, face individual market demand uncertainty. In particular, it is assumed that an agent who considers undertaking production and entering a market is unsure whether the demand for her product exists. The state of the individual market demand can only be verified by engaging in production and selling on the market. The paper shows that adverse shifts in the composition of aggregate demand, negative aggregate demand shocks, decrease expected profits and discourage economic agents from undertaking production. This leads to an endogenous suspension of least productive units in a given period. However, the decision to suspend the least productive entities implies that the individual markets demands are not observable in a given period and hence the amount of information that can be inferred about the states of the demands is reduced. As a result economic agents in subsequent periods face higher uncertainty with the regard to the state of the individual demands. Furthermore, an increase in the overall uncertainty in the economy lowers the desire of economic agents to take advantage of viable economic opportunities and in turn leads to slow recovery and persistence in output even when negative shocks to aggregate demand are no longer present. In other words, the paper formalizes an idea in which individual market demands are stochastic and only economic activities, production and sales, can resolve uncertainty and reveal information about the states of individual demands. Hence periods of high economic activity when producers enter many markets lead to a reduction of uncertainty and facilitate decision making in subsequent periods allowing for faster output growth. Similarly, adverse aggregate demand shocks can lead firms to suspend production, which prohibits uncertainty resolution and makes the decision process in future periods more intricate leading to slower output growth. Therefore, the paper shows that negative aggregate demand shocks exacerbate informational imperfections and impose negative costs on the economy. Specifically, even when shocks disappear, their effects to do not, as uncertainty is higher and the expected profits and aggregate output lower.

In addition, the paper makes a step towards reconciling the conflicting views expressed in other contributions and illustrates that recession are simultaneously times of cleansing and times of sullying. It is shown that during recessions the least promising units are suspended or liquidated, i.e., the paper confirms the finding of Caballero and Hammour [20] that recessions are times of cleansing. However, the elimination of the least promising units during economic downturns precludes specific demands from being observed. This inhibits uncertainty resolution and implies that future expected profits are lower. Therefore, recession bias the composition of all available profit opportunities downwards, i.e., recessions can be viewed as times of sullying a point confirmed in a recent contribution by Barlevy [9]. In summary, the paper establishes that conditional on the distribution of the qualities of available productive opportunities recessions are times of cleansing as the least productive units are suspended. At the same time the paper shows that the distribution of the qualities of available productive opportunities is itself affected during recessions. In particular, the average quality falls, i.e., recessions can be viewed as times of sullying.

In a substantive sense the paper captures a general theme that the quality of signals generated by macroeconomic variables is damaged during recessions. Therefore, recessions not only impose direct losses on the economy, but also negatively impact the informativeness of economic variables. The fact that damage inflicted by recessions goes beyond output loss has been explored in other contributions. Bernanke and Gertler [12], Gali [25] stress the role of capital market imperfections. The authors argue that damage is done through the impact on the financial hierarchy of access to capital, popularized by Fazzari, Hubbard and Petersen [29], which relatively tightens against smaller businesses during recessions. Similarly, Brock and Evans [19] show that small businesses are relatively more affected during recessions. Moreover, Greenwald and Stiglitz [28], Akerlof working on the role of imperfect capital markets, adverse selection, and imperfect information reach the conclusion that the recessions can negatively influence the economy. In addition, some authors, Bernanke and Gertler [13], find that the composition of projects, a substantive point also explored in this paper, is affected during recessions..

The paper shares the general view that recessions can be costly. It shows that recessions are too deep and too long. This brings on the issue of policy. In practice, the existence of recessions has routinely led to active policy measures. In particular, countercyclical debt financed government spending remains a key policy instrument. Professional economists take an active interest in the roles of deficit and debt. Specifically, Angelatos [8] argues that debt can serve as a device that nearly assures market completeness, Barro [11] shows that debt can smooth distortions intertemporally, while Woodford [37] shows that public debt can serve as private liquidity. Others, Alesina and Tabellini [5], Perrson and Tabellini [31], note that debt can be an outcome of political process. However, modern macroeconomics theory does not perceive public debt as a stabilization tool. This paper makes a step and tries to bridge the gap between theory and policy. The paper shows that debt issues can serve as a stabilization device. In particular, the paper perceives public debt in a Keynesian mode, i.e., it shows that debt financed government spending increases contemporaneous output. Moreover, contrary to the conventional wisdom the paper establishes that the impact of government debt need not lead to a fall in future potential output even though it displaces physical capital. The mechanism that makes this result feasible is a simple one. A temporary boost to demand generated by government spending leads to higher expected profits and through the aggregate demand externality to higher level of output and to a higher level of equilibrium profits. Increased equilibrium profits encourage entry and lead to an expansion in production. As a consequence more market demands are observable. This leads to uncertainty resolution and enriches the informational sets. More information permits for better decision making in the future and allows the economy to attain a higher level of output. Naturally, debt financed government spending leads to a reduction of the level of investment in physical capital, which in turn implies a lower level of potential output in future periods. Obviously, the net effect depends on the relative strength of the two effects. If the effects of changes in physical capital dominate on effects of changes of informational capital then deficits decrease welfare on the other hand welfare can increase at all horizons.

The paper is organized in seven sections. Section (2) outlines the basic model. Section (3) determines the equilibrium. Section (4) describes the process of informational capital formation. The following section presents sample dynamics. Section (6) discusses policy issues. The last section concludes.

2 Model

The model is based on three building blocks: the OLG model of Diamond [24], the imperfect competition paradigm of Blanchard and Kiyotaki [15], and the assumption of incomplete information at the micro level. The paper illustrates that a model that incorporates these blocks can exhibit two key features. First of all, the model allows the composition of aggregate demand, apart from the supply side characteristics, to influence aggregate output. Secondly, the model shows that informativeness of economic variables is state dependent, i.e., it shows that aggregate variables can influence the informativeness of micro variables and hence are an important factor determining the quality of available information.

2.1 Agents

There are continuum of measure one of agents born each period. Economic agents live for two periods. Each young agent is endowed with a unit of labor in the first period of her life. The preferences of the representative agent are represented by the following utility function

$$U\left(c_{1,t}, c_{2,t+1}\right) = (1-\beta)\log\left(c_{1,t}\right) + \beta\log\left(c_{2,t+1}\right). \tag{1}$$

In addition there are continuum of measure one of managers. The preferences of a representative manager are summarized by

$$U\left(c_t\right) = \begin{cases} c_t - \theta \text{ if the manager opts to engage in production} \\ c_t \text{ if the manager decides not to produce,} \end{cases} \tag{2}$$

where c_t is the level of consumption, θ denotes a stochastic idiosyncratic shock capturing the utility costs of operating a productive unit[1]. θ is a random variable independent across time and across managers drawn from a uniform distribution on the interval $\left[\underline{\theta}, \overline{\theta}\right]$ and observable to the manager before she decides to produce or not.

[1] Managers are by assumption myopic. Shortsightedness of managers is not required for the results to obtain. However, it strengthens the results in the quantitative sense. θ represents a fixed costs in terms of utility. It would be more natural to model θ purely as a fixed cost related to the process of production. This alternative route is not followed in order to preserve analytic tractability of the model.

2.2 Goods

There are two classes of final goods in this economy and a class of intermediate goods. There is a single final consumption good. There are a continuum of measure n of intermediate goods, which are used as inputs in the production process of the final consumption good. In addition, there is physical capital, which plays both the role of an investment good, used as a form of saving, and of a productive input.

2.3 Production

The final consumption good is produced from intermediate goods via the following CES production function

$$c_t = (\int_0^n c_{i,t}^{\gamma} di)^{\frac{1}{\gamma}}, \tag{3}$$

where $c_{i,t}$ denotes the input of the intermediate good i. The market for the consumption good is perfectly competitive.

The intermediate goods are produced using a Cobb-Douglas technology

$$c_{i,t} = k_{i,t}^{\alpha} l_{i,t}^{1-\alpha}, \tag{4}$$

where $k_{i,t}$ denotes the amount of capital and $l_{i,t}$ denotes the amount of labor used in the process of production of good i. The markets for the intermediate goods are monopolistic. The demand for good i takes the form

$$p_t^i = D_t^{1-\gamma} p_t^{\gamma} c_{i,t}^{\gamma-1}, \tag{5}$$

where D_t denotes the level of demand for the final consumption good and p_t^i and p_t denote the price of the intermediate good i and the consumption good, respectively.

Physical capital is produced using a Cobb-Douglas technology

$$Q_k = (k_t^c)^{\alpha} (l_t^c)^{1-\alpha}, \tag{6}$$

out of labor and physical capital, where l_t^c and k_t^c denote the amount of labor and capital used in the production of physical capital. In addition, it is assumed that the market for physical capital is perfectly competitive. The input output matrix is presented in figure (1.)

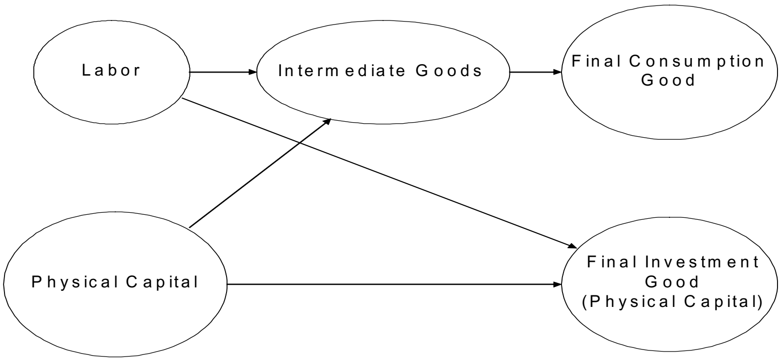

Figure 1: Input-Output Matrix

2.4 Income

There are several sources of income in this economy. First of all, factors of production receive rental fees. Secondly, imperfect competition in the intermediate goods sectors allows profits to arise in equilibrium. Production in the intermediate goods sector is undertaken by managers. Accordingly, it is assumed that managers receive profits generated in the economy. Hence, their income is

$$y_{m,t} = \pi_t. \tag{7}$$

The income of young agents comes from labor supply and is equal to the wage income, given by,

$$y_{1,t} = w_t. \tag{8}$$

The income of old agents comes from two sources. Recall that savings take the form of physical capital. Therefore, old agents can sell the capital stock that they own, the capital stock they acquired the period before net of depreciation. In addition, they can rent out their capital and receive the return on it. Thus, old agents collect the gross return on their savings. The income of the old is given by,

$$y_{2,t} = (1 - \delta)\, p_t^k k_t + r_t k_t, \tag{9}$$

where p_t^k denotes the equilibrium price of a unit of physical capital, δ the rate of depreciation of physical capital, r_t the rental costs.

3 Informational Capital

The intermediate goods being inputs in the process of production of the final consumption good are sold on monopolistically competitive markets. Moreover, it is assumed that the demands for intermediate goods are stochastic. The value of a given demand is either positive and then depends on the fundamentals and takes the standard form given by equation (5) or is equal to zero. Furthermore, the demand for a given good that is positive in a given period remains positive in the following period with a positive probability q and expires and turns to zero in the following period with a positive probability $1-q$. In other words, if $D_t^i \neq 0$,where D_t^i denotes the demand for good i in period t, then $D_{t+1}^i \neq 0$, with D_{t+1}^i being the demand for good i in period $t+1$, with probability equal to q and $D_{t+1}^i = 0$ with probability $1-q$. In addition, it is assumed that the demand for a good, which is not coveted during a given period remains equal to zero in all future periods. The set of intermediate goods that can be potentially demanded and produced expands. Specifically, a set of new goods of measure one[2] arrives each period. The new goods, if produced, are sold in monopolistic markets. Moreover, the probability that the demand for a given new good is positive is equal to q^k, where $k > 1$ denotes a positive integer, and the probability that the demand is equal to zero is $1-q^k$.

Production and sales reveal the status of a given demand. An undertaking of production of a given good in a given period reveals whether the given good is coveted or not. Furthermore, if a given good is produced in a given period and it turns out that it is not demanded then the demand will remain equal to zero in all future periods and hence the good will not be produced. On the other hand, if it turns out that the demand for the good is positive

[2]Throughout the paper it is assumed that the speed at which new projects arrive is exogenous and, in particular, independent of the aggregate state of nature. In reality identification of new productive opportunities is costly and requires incentives at least in the form of a higher reward. Therefore, it would be more realistic to assume that the size of the set of new project (goods) is procyclical (higher profits encourage more intensive search or ease constraints.) However, making the size of the set of new projects procyclical would actually strengthen the results presented in the paper. The same pertains to the assumption of the invariant distribution of the utility costs $\left[\underline{\theta}, \overline{\theta}\right]$.

then the demand for the good in the subsequent period will be positive with probability q and equal to zero with probability $1 - q$. In addition, if the demand for a given good is positive with probability q^i, where i is a positive integer, and the good is not produced in a given period then the demand is not observed and it remains positive in the following period with probability q^{i+1}. Moreover, goods of type q^k, goods demanded with probability q^k, not produced in a given period are discarded and never produced. This is due to the fact that the goods turn to type q^{k+1} in the following period and it is optimal to discard them in favor of new goods of type q^k. The set of admissible types, identifying the probability that the demand for a given good is positive with the type, or the quality, of the good[3], of goods is given by

$$S = \left\{ q, q^2, q^3, ..., q^k \right\}. \tag{10}$$

Managers decide whether a given good is produced in a given period or not. Preferences of managers at time t given by (2) and the fact that profits are the sole source of income to managers imply that the level of utility obtained by a manager who decides to produce is given by $\frac{\pi_t^i}{p_t} - \theta$, π_t^i denotes the profits generated by manager i, and the level of utility of a manager who decides not to produce is equal to zero. Naturally, production is undertaken if the level of utility obtained from undertaking production exceeds the level of utility derived from staying idle. This defines a level of θ

$$\theta_c^i = \frac{\pi_t^i}{p_t}, \tag{11}$$

such that a manager whose realized θ is below θ_c^i opts for production and a manager whose θ is above θ_c^i prefers not to produce.

Let n_t^i denote the number of goods of type q^i, $i \in \{1, ..., k\}$, available for production in period t. In other words, n_t^i denotes the number of markets in which the demand is non zero with probability q^i in period t. Observe that managers who face a project of type q^i and draw a favorable shock $\theta \in \left[\underline{\theta}, \theta_c^i\right]$ decide to produce and those with unfavorable shocks $\theta \in \left[\theta_c^i, \overline{\theta}\right]$ decide to stay idle. The law of large numbers implies that the number of actually operated projects of type q^i at time t η_t^i is given by

$$\eta_t^i = \frac{\theta_c^i - \underline{\theta}}{\overline{\theta} - \underline{\theta}} n_t^i.$$

[3]Throughout the paper the words: "type" and "quality" are used interchangeably. Similarly, words "good" and "project" are treated as synonyms.

Production and sales, if undertaken, reveal fully whether a given good is demanded or not, i.e., allow for perfect identification of the demand. The law of large numbers allows for the determination of the following laws of motion governing the numbers of goods of different types, the distribution of project types, in different periods

$$
\begin{aligned}
n_{t+1}^{1} &= \sum_{i=1}^{k} q^{i}\left(1-z_{t}^{i}\right) n_{t}^{i} \\
n_{t+1}^{2} &= z_{t}^{1} n_{t}^{1} \\
&\vdots \\
n_{t+1}^{k-1} &= z_{t}^{k-2} n_{t}^{k-2} \\
n_{t+1}^{k} &= z_{t}^{k-1} n_{t}^{k-1} + z_{t}^{k} n_{t}^{k} + \sum_{i=1}^{k}\left(1-q^{i}\right)\left(1-z_{t}^{i}\right) n_{t}^{i},
\end{aligned}
\tag{12}
$$

where $z_t^i = 1 - \frac{\eta_t^i}{n_t^i}$ denotes the fraction of projects of type q^i available for production at time t which are not utilized. At any point in time the total mass of all available projects is equal to one, the mass of newly arriving projects. This is due to the fact that by assumption a single manager can at a given point in time operate at most one project and the mass of managers is equal to one.

The system (12) is characterized by a fixed point property, the Appendix provides a more detailed description, and the distribution of available projects $\left\{n_t^1, n_t^2, ..., n_t^k\right\}$ converges to an ergodic distribution. Moreover, it turns out that the level of demand for the final consumption good is a major determinant of the ergodic distribution of projects. Specifically, the higher the level of the demand the more projects are operated and the more information collected about the economy hence the higher the average type of available projects. The distribution of types of available projects $\left\{n_t^1, n_t^2, ..., n_t^k\right\}$ and in particular its mean $\Sigma_{i=1}^k q^i n_t^i$ can serve as a measure of informational capital.

4 Equilibrium

The equilibrium in this model encompasses both the intertemporal and the intratemporal aspects. The within period and intertemporal allocations require the determination of optimal behavior of consumers and managers on the demand side and the behavior of managers on the supply side. The paper approaches the problem of determination of equilibrium by analyzing the intertemporal problem first and then turning to the problem of within period allocations. It is assumed, in order to simplify the exposition, to avoid potential corner solutions, that the rate of depreciation of physical capital is equal to 1, i.e., $\delta = 1$.

4.1 Consumer Problem

The representative young agent maximizes her intertemporal utility subject to the budget constraints, i.e., she solves the following problem

$$\begin{aligned} \max_{\{c_{1,t}, c_{2,t+1}\}} U\left(c_{1,t}, c_{2,t+1}\right) &= (1-\beta)\log\left(c_{1,t}\right) + \beta\log\left(c_{2,t+1}\right) \\ p_t c_{1,t} + s_t &= y_{1,t} = w_t \\ p_t^k k_{t+1} &= s_t \\ p_{t+1} c_{2,t+1} &= y_{2,t+1} = r_{t+1} k_{t+1}, \end{aligned}$$

where p_t and p_{t+1} denote the prices of the consumption good in periods t and $t+1$ and p_t^k is the price of a unit of physical capital. In equilibrium each young agent saves a fraction β of her income, i.e., $s_t = \beta y_{1,t}$. Therefore, the accumulation equation is given by

$$k_{t+1} = \frac{s_t}{p_t^k} = \beta \frac{w_t}{p_t^k} = \beta\left(1-\alpha\right) k_t^{\alpha}. \tag{13}$$

Equation (13) completes the description of the intertemporal aspects of the equilibrium and is identical to the accumulation equation in the Diamond model.

4.2 Producer Problem

There are three types of goods produced in a given period: the final consumption good, the investment good and the intermediate goods. The final consumption good is produced using a CES technology out of intermediate goods. The market is perfectly competitive hence equilibrium profits are equal to zero and the price of the final consumption good is equal to the marginal costs, i.e.,

$$p_t = \left(\int_0^n (p_t^i)^{-\frac{1}{\sigma}} di\right)^{-\sigma}, \tag{14}$$

where $\sigma = \frac{1-\gamma}{\gamma}$.

The investment good is produced using a Cobb-Douglas technology and is sold on a competitive market. Therefore, equilibrium profits generated in the investment good sector are zero and the price of a unit of physical capital is equal to marginal costs. Moreover, the intermediate goods are produced using the same production function and the level of demand for a single intermediate good is given by (5) or equal to zero hence in equilibrium capital and labor are employed in the same proportion in all sectors equal to the ratio of capital to labor in the economy. Therefore, in equilibrium the price of physical capital is given by

$$p_t^k = \frac{w_t}{1-\alpha} k_t^{-\alpha}. \tag{15}$$

The market for the intermediate goods are monopolistic. In equilibrium, managers decide whether to produce or not before they know whether demand for specific goods exist or not. In particular, if a given manager faces a good of type q^i and decides to produce then the expected profits are given by

$$\pi_t^i = q^i \left(1-\gamma\right) q^{\frac{i}{\sigma}} \phi_t^{-1} D_t + \left(1-q^i\right) 0, \tag{16}$$

where $\phi_t = \Sigma_{j=1}^k \eta_t^j q^{\frac{j}{\gamma\sigma}}$ denotes a weighted average of the quality of operated projects and D_t represents the level of the demand for the final consumption good at time t. Moreover, the price of the good will be equal to zero if the demand for the good does not exist and will take the form of a markup value of $\frac{1}{\gamma q^i}$ over marginal costs if the demand exists. Therefore, the price of the final consumption good is given by

$$p_t = \frac{1}{\gamma} \frac{w_t}{1-\alpha} \phi_t^{-\sigma} k_t^{-\alpha}. \tag{17}$$

Finally, relationships (16) and (11) define the cutoff value determining the behavior of a manager who faces a project of quality i as

$$\theta_c^i = \left(1-\gamma\right) q^{\frac{i}{\gamma\sigma}} \phi_t^{-1} d_t, \tag{18}$$

where $d_t = \frac{D_t}{p_t}$, denotes the real value of the demand for the final consumption good in period t.

4.3 Equilibrium Demand and Output

In equilibrium the economy generates profits in the intermediate goods sector. The level of profits generated at a given point in time in this economy can be expressed as

$$\pi_t = (1-\gamma)\, D_t. \tag{19}$$

The demand for the final consumption good originates at three sources. The expenditures of the old, the managers, and the young contribute to the demand for the final consumption good. Note that both the old and the managers do not save, thus the demand for the final good at a given period is represented by

$$D_t = y_{2,t} + y_{1,t} - s_t + y_{m,t} = y_{2,t} + (1-\beta)\, y_{1,t} + y_{m,t}.$$

Furthermore, the income of the old can be written as

$$y_{2,t} = r_t k_t = \alpha\gamma D_t + \alpha D_t^k,$$

where $D_t^k = s_t$ denotes the demand for the investment good and the income of managers is equal to economy wide profits given by (19.)

In equilibrium the level of the demand for the final consumption good in terms of the price of the final consumption good is given by

$$d_t = (1-\beta\,(1-\alpha))\phi_t^{\sigma} k_t^{\alpha} \tag{20}$$

and the level of output defined as the sum of incomes of all agents in a given period in terms of the price of the final consumption good takes the form

$$y_t = (1-\beta\,(1-\gamma)\,(1-\alpha))\phi_t^{\sigma} k_t^{\alpha}. \tag{21}$$

Both the demand for the final consumption good and the gross domestic product are decreasing functions of the marginal propensity to save β and increasing functions of ϕ_t, i.e., increasing functions of the "average" probability that the demand for a given intermediate good produced in a given period is positive. Moreover, the model displays the multiplier effect with respect to the marginal propensity to save. A decrease in the marginal propensity to save, i.e., an increase in the level of consumption leads to an increase in the level of profits in the intermediate goods sector, this, however, increases income and in turn consumption. This process ultimately culminates in an increase in the equilibrium level of income. This crucial property of the model is due to differences in the market structure for the consumption good and the investment good. The results hinge on the presence of this property. Furthermore, the level of output and the level of demand are monotone increasing with ϕ_t, a measure of the quality of operated units, which is directly related to the quality of available information. Therefore, output is high when available information is rich as inputs are efficiently utilized. Similarly, output is low when there is substantial uncertainty since resources are inefficiently allocated. Naturally, both the level of demand and the level of output are increasing functions of the amount of physical capital k_t, which is itself predetermined by the decisions of consumers in preceding periods.

5 Dynamics

There are two forms of accumulable resources in the model: informational capital and physical capital. Physical capital is formed through a purposeful accumulation activity whereas informational capital is accumulated as a by-product of economic activity.

The equilibrium level of demand, equation (20,) and aggregate output, equation (21,) in terms of the price of the final consumption good depend on resources available in the economy ϕ_t, k_t, and on a single parameter β reflecting the composition of aggregate demand. This characteristic of the model allows shifts in the composition of aggregate demand to influence contemporaneous level of output and to influence the process of formation of physical capital and informational capital and influence long run output.

The process of formation of physical capital in this model is analogous to that in the conventional Diamond model. Savings of the current young constitute the future capital stock. The level of physical capital stock in period $t+1$, equation (13,) depends only the characteristics of the technology and preferences.

The process of accumulation of informational capital is governed implicitly by the decisions of managers. Recall that managers consider undertaking projects depending on their types, the state of aggregate demand, and the idiosyncratic utility costs. In particular, projects are undertaken if the idiosyncratic utility cost is below the cutoff level. The cutoff values θ_c^i, equation (18,) determine the equilibrium distribution of project types. Moreover, the higher the level of demand the higher the cutoff values θ_c^i and in turn a larger number of projects are undertaken in given period. Higher activity, more projects operated, leads to more information revelation and allows for a faster informational capital buildup.

It turns out that β, the marginal propensity to save, is a key variable responsible for the processes of accumulation of physical capital and informational capital as well as for the magnitude of output. Naturally, the process of formation of physical capital must depend on the marginal propensity to save. However, the parameter β also influences the informativeness of macroeconomic variables and is the key determinant of the informational capital stock. Recall that β is the principal determinant of the aggregate demand. Specifically, the lesser the value of β the higher the value of the aggregate demand. In consequence the larger the cutoff level of θ_c^i and the larger the number of projects undertaken in equilibrium. Undertaken projects reveal information regarding the status of demands. This resolves uncertainty and allows for the determination of the true type of a given project. The process leads ultimately to a higher informativeness of economic variables larger informational capital stock and facilitates decision making process in future periods.

5.1 Long Lasting Effects of Transitory Shocks

The level of informational capital and physical capital stock converge to steady state values. Absent any changes in the fundamentals the economy remains in the steady state and only shocks can push the economy out of its long run equilibrium. The paper focuses only on demand side shocks. Specifically, as noted earlier the marginal propensity to save β is one of the determinants of the equilibrium level of output. Therefore, shifts in β lead to changes in aggregate output. In particular, a rise in β leads to an increase in the level of savings, a fall in consumption, and it turn to, through the multiplier effect, a fall in output. However, shifts in β not only influence the current equilibrium values, but also influence the process of formation of both forms of capital. Specifically, a rise in the marginal propensity to save β leads to an increase in the level of physical capital stock in future periods and to a decrease in the level of demand for the final consumption good in the current period. The fall in the demand decreases expected profits and makes entering a market less attractive. This decreases the number of operated productive units and increases the number of suspended units. Therefore, the set of observable individual market demands becomes smaller. As a result the decisions to suspend operation of a greater number of units exacerbate

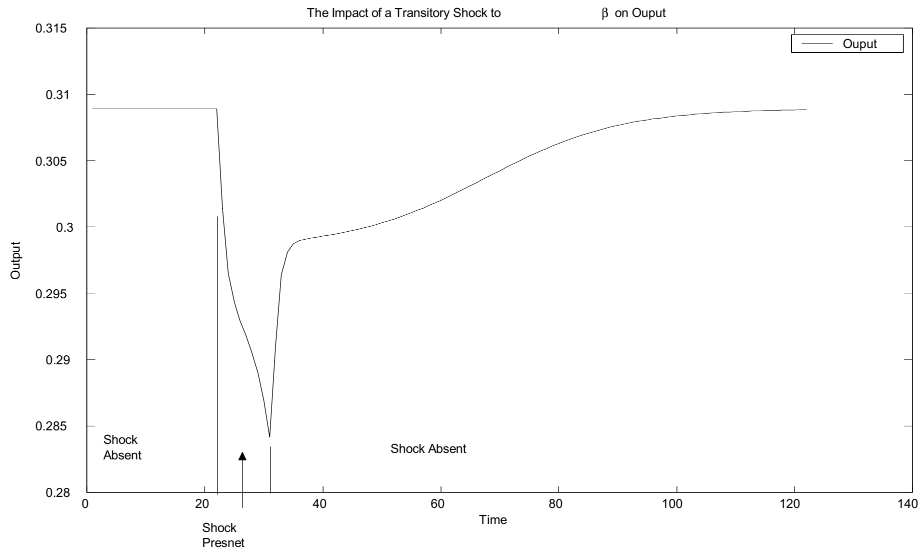

Figure 2: The Evolution of Output.

uncertainty and lead to a fall in the informational capital stock. The fall in the informational capital stock implies a lower level of output in future periods as factor of production are utilized less efficiently. Figure (2) presents samples dynamics induced by an increase in the marginal propensity to save β.

A rise in β affects the economy both when the shock is present and when the value of β returns to its normal value. For a given level of capital stock a rise in β leads to a fall in output. A fall in demand, a rise in β, lowers equilibrium profits, lower profits lead to a lower output, lower output leads to a lower demand. The process terminates and in equilibrium the level of output is lower. Moreover, when the shock occurs the economy responds along an extensive margin. Lower expected profits lead to suspensions of a greater number of projects. Hence, the level of activity and equilibrium profits become smaller and in turn the level of output falls even more. Naturally, the reaction of the economy along the extensive margin magnifies the reaction of the economy to shocks. Moreover, in the following period there is actually more physical capital. A higher value of β implies that agents saved more the period before. However, the level of output is smaller and keeps on falling. This is due to the fact that a fall in expected profits leads to suspensions of a greater number of projects. Therefore, there is less uncertainty resolution and the quality of projects becomes smaller in future periods. Naturally, there is more physical capital, but the information sets are of lesser qualities and in equilibrium it can turn out that a higher capital stock is utilized less efficiently and the overall output falls. Finally, when the shock ceases to be present the level of output does not immediately return to its normal value. The process of recovery takes time as the level of informational capital is lower and it needs to be rebuilt before the economy can reach its pre-crisis potential. It is worth noting that during the recovery phase the level of physical capital is higher than it is in the long run and yet the destruction of informational capital stock caused by the shock to β makes efficient usage of the physical capital stock impossible and as a result the level of output is lower[4].

Summarizing, the presence of informational capital enriches the dynamics. Moreover, the presence of informational capital introduces inertia to the economy. Specifically, a negative shock to demand for consumption good, a rise in β, leads to smaller expected profits and increases the number of suspended units. A greater number of suspended productive units inhibits uncertainty resolution and hampers the decision making process in the future periods. In other words, a reduction in the level of demand leads to a fall of informativeness of economic variables. The fall of informativeness implies less information in the future. Less information in turn implies to less efficient factor usage and in turn to lower level of output. The process leads to downturns in economic activity that are too deep and too long. Alternatively, assuming that informational capital is a sense constitutes a factor of production it can be said that the model shows that even temporary disturbances affect the potential level of output.

5.2 Cleansing During Recessions

The underlying assumptions imply that managerial decisions take the form of a cutoff rule. In particular, a manager who faces a project of type q^i decides to engage in production if her idiosyncratic utility cost is below the cutoff

[4]It is fairly straight forward to obtain dynamics in which informational capital is relatively unimportant compared to physical capital. In such a situation, increases in β have only temporary negative impact on output. However, the fact that physical capital stock rises with a rise in β is technically due to the assumption that labor supply is inelastic and to the assumption that physical capital is the only saving instrument.

level given by (18.) Agents who face unfavorable idiosyncratic shocks choose not to engage in economic activity and remain idle and agents whose shocks are favorable decide to explore economic opportunities.

At any point in time the cutoff value θ_c^i depends on the level of demand in a given period and on the type of a given project. Recall that times when economic agents save a higher fractions of their incomes are times when output and demand are low, i.e., these are times of recessions. Clearly, the deeper a given recession is the lower the cutoff value. This indicates that a chance that a given project is operated becomes smaller. The mass of actually operated projects of type q^i in a given point in time, given by,

$$\eta_t^i = (1 - z_t^i) n_t^i = \frac{\theta_c^i - \underline{\theta}}{\overline{\theta} - \underline{\theta}} n_t^i \tag{22}$$

is lower during recessions, when θ_c^i is low, than expansions. Moreover, the mass is the higher the higher the type of a given project.

Two observations become apparent. First of all the higher the type of a given project the larger the suspension margin. Clearly, this indicates that the higher the type of a given project the higher the chance that the project is actually operated. Moreover, for any project type the cutoff level is higher during expansions than recessions. Therefore, during expansions more projects are operated than during recessions. Alternatively, during recessions more projects are suspended than during expansions. Moreover, the cutoff level is always smaller for projects of lower types and closer to the minimum value of $\underline{\theta}$. Thus during recessions projects of lower types are proportionately more affected than projects of higher types (as long as $\underline{\theta} > 0$). In other words, during recessions projects of lower types are eliminated first and the project of higher types bear a relatively smaller burden. Consequently, fluctuations in aggregate demand lead to a change in the composition of the pool or projects being operated. The quality of projects being operated actually rises when negative shocks to demand occur. Therefore, the model implies, as argued by Caballero and Hammour [20], that recessions are times of cleansing as the least productive units are suspended and only those of highest quality, highest type, are operated. However, it must be kept in mind that the implication that only projects of the highest qualities are operated during recession is conditional on the distribution of projects that are actually available.

5.3 Sullying during Recessions

The stark prediction of Caballero and Hammour [20] that recessions are times of cleansing has not remained without controversy despite some empirical support. A recent contribution by Barlevy [9] makes the opposite claim. Barlevy identifies in the context of labor market frictions a countervailing effect that may overcome the cleansing effect and asserts that recessions are in fact times of sullying rather than cleansing.

The model presented in this paper remains in broad agreement with Barlevy's assertion despite the fact that it does not explore channels identified by Barlevy. As argued in the preceding section recessions lead to the suspension of least productive projects, i.e., recessions can be viewed as times of cleansing. However, an increase of the average quality of projects being operated in recessions does not lead to a permanent increase in the average quality of available projects. Quite the contrary during recessions economic agents, by suspending the least productive projects, reduce the amount of information, demands become unobservable, that can be extracted from economic variables. Moreover, the reduced amount of information leads to a fall in the average quality of all available projects in future periods. In other words recessions bias the average quality of all available projects downward. Therefore, recessions can be also interpreted as times of sullying. The presence of sullying during recessions is due in the context of this paper to the presence of informational imperfections and to the fact that those imperfections are exacerbated during recessions.

The descriptive arguments presented in the preceding paragraph can be established in more technical terms. Recall that at any point in time a manager facing a project of quality q^i follows a cutoff rule and decides to engage in production if her idiosyncratic shock does not exceed the value given by equation (18.) The higher the demand the higher the cutoff level and the more projects actually operated. An engagement in productive activity, in particular, leads to uncertainty resolution regarding the status of a given demand. On the other hand a decision not to explore an economic opportunity precludes the demand on a given market from being observed. As a consequence, in the following period there is higher uncertainty pertaining to the status of the demand. Moreover, a fall in demand leads to a suspension of a higher number of project. This implies that the distribution of available projects will be different in the following period. Analytically, a fall in demand rises the values of z_t^i's, more projects are suspended, which implies that the values of n_{t+1}^i will be different than they would be otherwise. Technically, an increase in z_t^j by the amount of Δz_t^j with all other z_t^j's unchanged[5] lowers the value of n_{t+1}^1 by the amount of $q^j \Delta z_t^j n_t^j$, increases the value of n_{t+1}^{j+1} by the amount of $\Delta z_t^j n_t^j$ and lowers the value of n_{t+1}^k by the amount of $(1-q^j)\,\Delta z_t^j n_t^j$, and leaves all other values of n_{t+1}^i's unchanged. The average quality of available projects, defined as $\Sigma_{i=1}^k q^i n_{t+1}^i$ changes by $-qq^j \Delta z_t^j n_t^j + q^{j+1} \Delta z_t^j n_t^j - q^k (1-q^j)\,\Delta z_t^j n_t^j = -q^k (1-q^j)\,\Delta z_t^j n_t^j$. In other words, the average quality of available projects becomes smaller or alternatively the pool of available projects becomes downgraded. This phenomenon can be interpreted as sullying.

Shocks that adversely affect the distribution of available projects can lead to serious changes in macroeconomic variables. Specifically, a fall in the average quality of available projects implies that there a projects of high quality, which are not regarded as such and are utilized less often than they should be. On the other hand there are projects, which are of no economic value, but are not recognized as such (many suspended projects and their type is not observable) and are utilized too often. Such over-usage of unproductive units and under-usage of the highest quality units leads to improper factor engagement and in equilibrium can lower output and welfare.

Overall, the model predicts that indeed recessions can be viewed both as times of cleansing and times of sullying. The apparent contradiction in terms can be easily reconciled. Indeed, during recessions only projects of the highest qualities are utilized and projects of lesser qualities are suspended, i.e., recessions are times of cleansing. However, this assertion is made with reference to the pool of all available projects, i.e., it is asserted that conditional on a given pool of available projects only project of the highest quality are most likely to be utilized. However, recessions impose informational burden on the economy and, in particular, lead to a deterioration of the qualities of the pool of all available projects. Therefore, recessions are also times of sullying. In summary, during recessions the average quality of projects that are actually operated is higher relative to the quality of all available projects. However, at the same time the average quality of all available projects decreases as the composition of available projects changes. Naturally, on net the latter effect dominates and recessions impose negative burden on the economy leading to

[5] In equilibrium, in fact, z_t^i's are interrelated. However, all either increase or decrease simultaneously. Taking the equilibrium relations into account would actually strengthen the argument at hand.

persistent effects of temporary shocks on output.

6 Macroeconomic Policy

Economic downturns are a key characteristic of rich macroeconomic dynamics. Recessions appear on average every eight years and are routinely perceived as periods of substantial welfare losses. Accordingly, policy makers implement measures designed to stimulate the economy and return the level of output to its potential. However, macroeconomic theory neither explicitly implies, albeit a recent contribution by Gali, Gertler, and J.D. Lopez-Salido [25], that sizeable welfare losses should be associated with recessions nor it takes a clear position on the role of policy. The goal of this section is to provide a sound rationale for the shape of policy routinely implemented during recessions.

During recessions government deficits increase beyond the magnitude implied by a fall in revenues resulting from a smaller tax base. Governments attempt to stimulate the economy by directly contributing to demand, increased government spending, or indirectly by adopting more favorable tax systems. Both approaches lead to public debt buildup. There is a rich literature that rationalizes the existence of public debt in the context of a tax burden redistribution, liquidity instrument, insurance tool, or political economy. However, there is no explanation for the presence of public debt that perceives bond issues solely as a demand stimulus. Moreover, the baseline explanations suggest that deficits and debt, if non-neutral at all, can at best increase current output, but only at a cost of lower potential in the future. This paper shows that it need not be the case, i.e., it argues that deficits can have positive impact on the economy both in the short and long run and indeed can be used as a stabilization tool to combat recessions.

The impact of public debt on equilibrium can be highlighted in a simple setup outlined below. Government spending on the consumption good in period t is equal to p_tG_t and is equal to zero in all future periods. The expenditures are financed through a bond issue in period t and the debt is repaid fully in period $t+1$. Taxes needed for debt repayment are levied on the wage earners at time $t+1$.

Under these assumptions the level of demand and the level of output in period t are given by

$$d_t = (1 - \beta (1 - \alpha))\phi_t^\sigma k_t^\alpha + \frac{1}{\gamma} G_t, \tag{23}$$

$$y_t = (1 - \beta (1 - \gamma) (1 - \alpha))\phi_t^\sigma k_t^\alpha + \sigma G_t. \tag{24}$$

Naturally, government expenditures contribute towards demand and towards output expressed in terms of the price of the consumption good. The result is due to the fact that spending on the consumption good increases equilibrium profits and in turn the equilibrium output. Moreover, bonds issued to finance government expenditures reduce the demand for the investment good and release resources from the investment good sector allowing in equilibrium the demand for the consumption good be satisfied.

The accumulation equation, assuming that bonds are denominated in units of physical capital, takes the form identical to that in the Diamond model

$$k_{t+1} = \beta (1 - \alpha) k_t^\alpha - b_{t+1}, \tag{25}$$

where b_{t+1} denotes the stock of bonds issued at time t and outstanding at time $t + 1$. Government expenditures are fully financed through debt. Therefore

$$p_t G_t = p_t^k b_{t+1}. \tag{26}$$

Finally, denoting the fraction of saving that takes the form of bonds by λ_t the accumulation equation can be expressed as

$$k_{t+1} = \beta (1 - \lambda_t) (1 - \alpha) k_t^\alpha. \tag{27}$$

Bond financed government expenditures affect the level of output the level of demand and alter the path of investment in physical capital. Moreover, the impact is not limited to period t and affects equilibrium variables in other periods via a number of channels. First of all, bonds issued at time t imply that there is debt to be repaid. The repayment, by assumption, is to take place in period $t + 1$ and is to be financed through taxes imposed on wage earners. Therefore, the process of repayment will amount to an effective transfer from wage earners to bond holders. However, bond holders and wage earners differ in regard of their propensities to save. Therefore, the process of debt repayment is non neutral for equilibrium outcomes in period $t+1$. The levels of disposable incomes of economic agents in period $t+1$ are given by

$$y_{1,t+1} = w_{t+1} - \tau_{t+1} w_{t+1}, \tag{28}$$

$$y_{2,t+1} = r_{t+1}k_{t+1} + r_{t+1}b_{t+1}, \tag{29}$$

$$y_{m,t+1} = \pi_{t+1}. \tag{30}$$

Naturally, the government budget constraint assumes the form

$$r_{t+1}b_{t+1} = \tau_{t+1}w_{t+1}. \tag{31}$$

In equilibrium the level of demand and the level of output can be expressed as

$$d_{t+1} = (1 - \beta(1-\alpha)(1-\tau_{t+1}))\phi_{t+1}^{\sigma}k_{t+1}^{\alpha}, \tag{32}$$

$$y_{t+1} = (1 - \beta(1-\gamma)(1-\alpha)(1-\tau_{t+1}))\phi_{t+1}^{\sigma}k_{t+1}^{\alpha}. \tag{33}$$

Obviously, both are affected by the size of the government debt τ_{t+1}. An effective transfer from savers to consumers increases the level of output and the level of demand. Moreover, the accumulation equation is also affected and takes the form

$$k_{t+2} = \beta(1-\tau_{t+1})(1-\alpha)k_{t+1}^{\alpha}. \tag{34}$$

Finally, in equilibrium the level of taxation τ_{t+1} in period $t+1$ is related to the size of debt λ_t issued at time t through the following model specific identity

$$\tau_{t+1} = \frac{\alpha}{1-\alpha}\frac{\lambda_t}{1-\lambda_t}. \tag{35}$$

In all future periods there is no government or government debt. Therefore, the equilibrium level of demand, output, and the accumulation equation take the standard form of

$$d_{t+i} = (1 - \beta(1-\alpha))\phi_{t+i}^{\sigma}k_{t+i}^{\alpha}, \tag{36}$$

$$y_{t+i} = (1 - \beta(1-\gamma)(1-\alpha))\phi_{t+i}^{\sigma}k_{t+i}^{\alpha}, \tag{37}$$

$$k_{t+i+1} = \beta(1-\alpha)k_{t+i}^{\alpha}. \tag{38}$$

Naturally, bond financed government expenditures affect the path of physical capital accumulation. In period t the introduction of bonds crowds out physical capital. The capital stock at time $t+1$ is lower than would be with no government presence by the amount of debt issued at time t. Moreover, at time $t+1$ debt repayment effectively shifts a fraction of income from savers towards consumers and as a result adversely affects the process of physical capital formation. Starting from period $t+2$ onwards the process of physical capital accumulation is not affected. However, the process of physical capital buildup starts from a lower base and the overall trajectory of physical capital accumulation is always below the path it would take with no government intervention at time t. In summary, government debt introduced in period t lowers the level of capital stock in all future periods.

The intervention at time t not only influences the process of physical capital buildup, but it also directly affects the equilibrium outcomes in periods t and $t+1$. Bond financed government spending contributes to the demand in period t and due to the presence of aggregate demand externality increases overall output in period t. Similarly, taxes imposed on wage earners in period $t+1$ are transferred to old agents, the bond holders, at time $t+1$. The marginal propensity to consume is higher for the old agents than for the young agents and hence again government action at time $t+1$ contributes to an increase in demand and through the aggregate demand externality to a higher level of output[6]. There is no direct effect in periods $t+2$ or beyond.

Moreover, government spending at time t and government debt repayment at time $t+1$ influence the equilibrium indirectly. Recall that the level of aggregate demand for the consumption good constitutes a key incentive for managers to engage in productive activities. Managers follow a cutoff rule. The higher the level of deficit the higher the level of spending the higher the level of demand and the cutoff level and the more projects are undertaken. Therefore, deficit financed government spending at time t generates a higher level of demand and as a result encourages entry by managers, which further increases, through its equilibrium impact on ϕ_t, equilibrium output and equilibrium demand. Moreover, an increase in demand makes managers operate more enterprises, which reveals additional information about the actual demands for different intermediates goods. This process facilitates learning and enhances the information sets of economic agents, i.e., a higher demand leads to faster informational capital buildup. More information revelation at time t implies a larger informational capital stock in period $t+1$. This in turn implies that decisions made at time $t+1$ will be sounder and will ultimately result in better resources allocation and a higher level of output. A similar situation takes place in period $t+1$. An effective transfer from the young to

[6] For a given level of physical capital stock k_{t+1}.

the old increases demand and in equilibrium higher profits. Higher profits encourage entry and increase the equilibrium value of ϕ_{t+1} effectively leading to a higher level of output. A higher number of projects operated increases profits and in turn equilibrium output and demand. Moreover, a higher number of projects being operated leads to more information revelation and to a faster informational capital buildup. Therefore, information sets in periods $t+2$ and beyond are richer and allow for better resource allocation and a higher output. Starting from period $t+2$ there are no direct or indirect effects of government activity. Moreover, the process of informational capital formation is the same as it would be with no government presence at all[7]. However, the stock of informational capital is higher at time $t+2$ than it would be otherwise, which implies that in all future periods will be higher than it would otherwise be. A higher level of informational capital leads to a higher level of output.

In summary, it can be said that debt financed government spending on the consumption good increases current output. Moreover, its impact on output in future periods depends on the relative magnitude of two competing effects. Debt decreases physical capital stock, which implies lower output in the future periods. On the other hand higher expected profits in the current period imply more enterprises being started up and as a consequence a higher informational capital stock in future periods. This in turn leads to better resource allocation in future periods and a higher output. Naturally, if the effect pertaining to the physical capital stock dominates then debt decreases output if the reverse is true then debt can actually increase output. The following figures (3), (4), (5) and (6) present a number of possibilities arising from the introduction of government debt.

Graph (3) depicts the paths of the level of output and the level of welfare in the case when informational capital stock channel dominates over the physical capital channel. Clearly, output is higher in all periods. Similarly, welfare measured in terms of utility of a representative young agent is higher[8] in all periods when government intervenes. This indicates that government intervention leads to a Pareto improvement in equilibrium allocations. Moreover, the relative gain in terms of welfare is the smallest for the generation that bears the burden of debt repayment. Recall that by assumption government spends only in one period. The expenditures are financed through

[7] Abstracting from any equilibrium impact resulting from changes in physical capital.
[8] The same is true for welfare of managers.

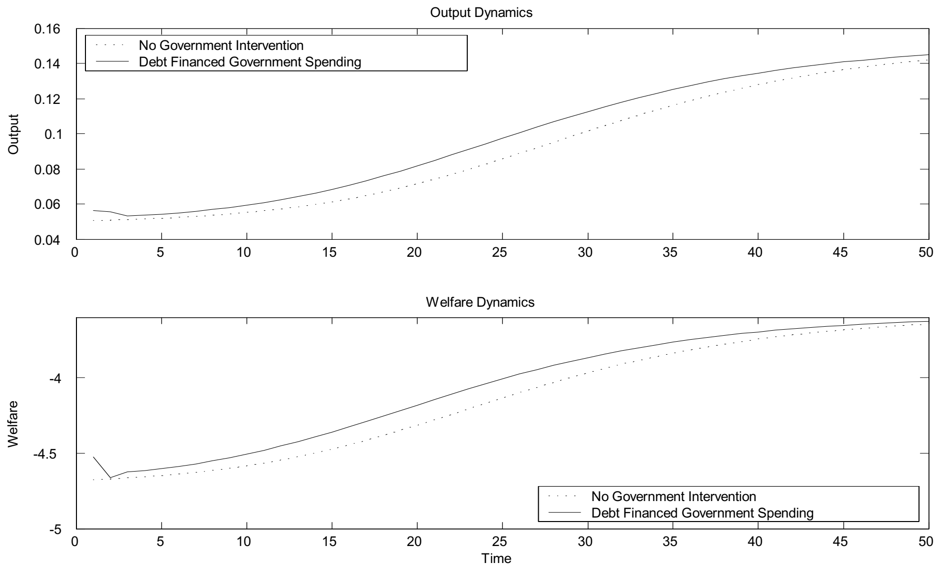

Figure 3: The Evolution of Output and Welfare with the Informational Capital Channel Dominant

bond issues and the debt is repaid in the following period. Hence the minimum in the path of welfare at the time of public debt repayment. The path of welfare could be smoothened out by allowing all future generations rather than just one to participate in the process of debt repayment.

Figure (4) presents the paths of physical and informational capital. The path of physical capital follows a very traditional route. Public debt displaces physical capital and the stock falls. The stock is slowly rebuilt after public debt repayment. Informational capital follows a path which is nearly a mirror image of the path of physical capital. Higher economic activity at the time of bond issue allows more individual market demands to be identified. This builds up informational capital in the following period. Afterwards the informational capital stock starting from a higher base converges to a steady state value.

It need not be the case that debt financed government spending leads to an improvement in output and welfare in Pareto terms. Government spending financed by bond issues leads to a higher economic activity when it takes place. However, it lowers investment in physical capital and reduces the productive potential in the future periods. Moreover, a spur in economic

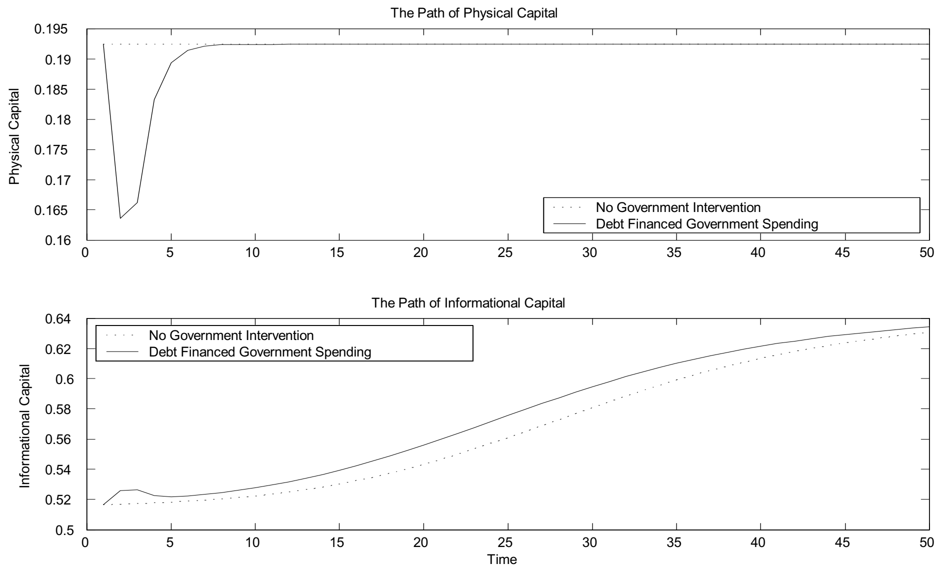

Figure 4: The Evolution of Physical and Informational Capital with the Informational Capital Channel Dominant

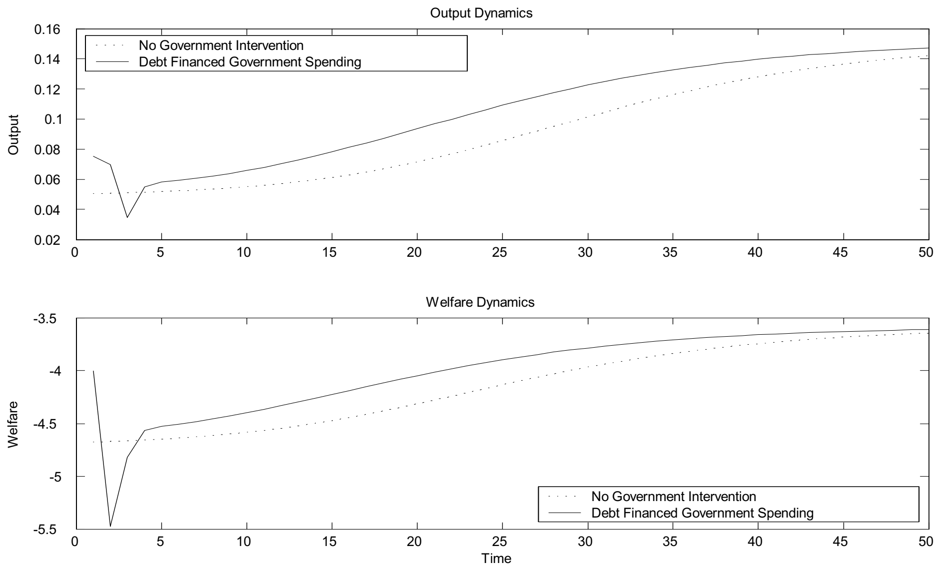

Figure 5: The Evolution of Output and Welfare with the Physical Capital Channel Dominant

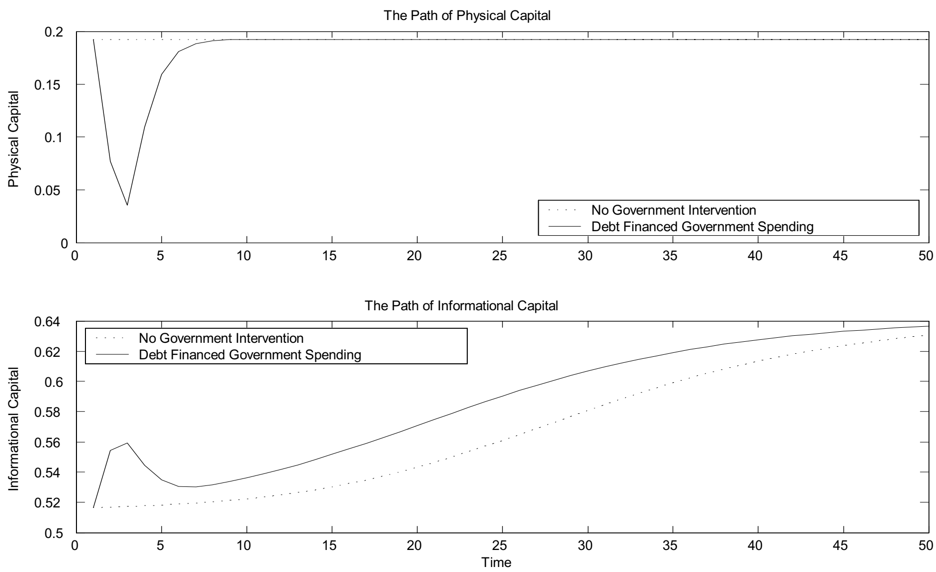

Figure 6: The Evolution of Physical and Informational Capital with the Physical Capital Channel Dominant

activity triggered by government spending allows for faster informational capital build up, which in turn increases the productive potential in the future periods. The net effect depends on the relative strength of the two effects. Figure (5) presents the paths of output and welfare in the case when physical capital channel is relatively stronger. Clearly, both output and welfare rise when government spending takes place and then fall below the values they would take without any government intervention. The fall is due to the fact that the faster informational capital buildup is insufficient to compensate for the fall in potential resulting from a smaller physical capital stock.

Graph (6) shows the paths of physical capital and informational capital when the physical capital channel is relatively stronger. The two paths show that debt financed government spending leads to a fall in physical capital stock and a rise in the informational capital stock. However, the fall in physical capital stock is not outweighed by the rise in the informational capital stock. Hence, this particular form of government intervention does not imply Pareto improvement in welfare.

7 Conclusions

The paper contributes to the extensive literature on macroeconomic fluctuations. The paper is written in a very specific context, yet the results it delivers are robust. It combines several important contributions and presents new results in a unified intertemporal general equilibrium model. Specifically, the model incorporates the concepts of aggregate demand externality of Blanchard and Kiyotaki [15], the OLG model of Diamond[24], informational imperfections at the micro level and nonlinearity in the form of fixed costs. The model developed in the paper is characterized by several new features. The model predicts that shifts in aggregate demand can influence economic activity in the short run while in the long run the supply side determines the equilibrium. Broadly speaking the model constitutes an example of a unified, general equilibrium, reconciliation of the neoclassical approach with an intuitively appealing approach allowing for short run demand side output determination.

Specifically, the paper studies in a general equilibrium framework the impact of demand side shocks on macroeconomic variables. In particular, the paper establishes that demand side disturbances can have persistent effects and consequently impose significant welfare loses even if their nature is transitory. The mechanism that allows transitory shocks to influence aggregate activity beyond periods when the shocks are present is due to the existence of informational imperfections. It is shown that transitory negative demand side shocks limit uncertainty resolution when they are present, i.e., recessions are times when informational imperfections are exacerbated. As a result economic agents face information sets of lesser qualities when the shocks disappear. This leads to less efficient resource allocation and in turn to lower output.

In addition the paper shows that government spending on the consumption good, even when it is financed through debt displacing physical capital, can increase welfare at all horizons. The intuition for this result is straight forward. Debt displaces physical capital and leads to lower future output. However, increased spending increases contemporaneous output, due to the presence of aggregate demand externality, increases equilibrium profits, encourages entrepreneurial activity and leads to more uncertainty resolution as a greater number of individual markets demands is identified. As a result increased spending enhances the quality of information available to economic agents in future periods. This allows economic agents to make more informed decisions and generate higher output. The overall effect depends on the relative strengths of the impact on the physical capital stock and of the impact on the quality of information. Naturally, when the latter dominates the overall effect of debt financed government spending is positive even though debt inhibits physical capital formation.

Finally the paper touches on the issue of productivity at different stages of business cycles. It is shown that during recessions only the most reliable projects are operated. Therefore, recessions can be viewed as times of cleansing. However, this statement is conditional on the quality of the pool of all available projects. It is shown that during recessions the pool of available projects is also affected. Specifically, the paper establishes that the quality of the pool of available projects deteriorates during recessions. Therefore, recessions can be viewed also as times of sullying. Consequently, the paper resolves apparently contradictory observations and shows that recessions are simultaneously times of cleansing and sullying.

A Appendix: Steady State Distribution of Project Types

Recall that whenever a given demand is not observed its presence cannot be identified. Specifically, if the chance that the demand on a given market is not zero in period t is equal to q^i then if sale is attempted on that market then in the following period the demand is non zero with chance q and zero with chance $1-q$ or does not exits with chance 1. In other words, production and sales allow the demand to be identified. If the demand is positive then it remains positive in the following period with chance q and turns to zero with chance $1-q$. On the other hand if the demand does not exist in the current period it will not exist in the following period either. Therefore, markets with no demand, given that a manager can operate at most on a single market, are abandoned in favor of new markets where the demand is non zero with chance q^k. Moreover, when the chance that the demand on a given market is positive is equal to q^i and no sale attempt is undertaken then the demand is not observed. This implies that the chance that the demand will be non zero in the following period is given by q^{i+1}. This follows from the Bayes rule and is due to the fact that the demand will positive only if it is positive in the current period and will not turn to zero in the next period, i.e., the chance that it is not zero in the next period is given by $q^i q = q^{i+1}$.

Denoting the fraction of suspended units of type q^i in a given period by z_t^i it is possible to establish that the distributions of project types in two consecutive periods are related through the following system of equations

$$
\begin{aligned}
n_{t+1}^1 &= \sum_{i=1}^{k} q^i \left(1 - z_t^i\right) n_t^i \\
n_{t+1}^2 &= z_t^1 n_t^1 \\
&\vdots \\
n_{t+1}^{k-1} &= z_t^{k-2} n_t^{k-2} \\
n_{t+1}^k &= z_t^{k-1} n_t^{k-1} + z_t^k n_t^k + \sum_{i=1}^{k} \left(1 - q^i\right) \left(1 - z_t^i\right) n_t^i.
\end{aligned}
\tag{39}
$$

For fixed values of z_t^i's the system is characterized by the fixed point property. Moreover, the ergodic distribution can be found analytically and is given by

$$
\begin{aligned}
n_*^1 &= \frac{q^k \left(1 - z^k\right)}{1 - \Sigma_{j=1}^{k-1} q^j \left(1 - z^j\right) \omega_j + q^k \left(1 - z^k\right) \left(\Sigma_{j=1}^{k-1} \omega_j\right)} \\
n_*^2 &= \frac{q^k \left(1 - z^k\right)}{1 - \Sigma_{j=1}^{k-1} q^j \left(1 - z^j\right) \omega_j + q^k \left(1 - z^k\right) \left(\Sigma_{j=1}^{k-1} \omega_j\right)} \omega_2 \\
n_*^3 &= \frac{q^k \left(1 - z^k\right)}{1 - \Sigma_{j=1}^{k-1} q^j \left(1 - z^j\right) \omega_j + q^k \left(1 - z^k\right) \left(\Sigma_{j=1}^{k-1} \omega_j\right)} \omega_3 \\
&\vdots \\
n_*^{k-1} &= \frac{q^k \left(1 - z^k\right)}{1 - \Sigma_{j=1}^{k-1} q^j \left(1 - z^j\right) \omega_j + q^k \left(1 - z^k\right) \left(\Sigma_{j=1}^{k-1} \omega_j\right)} \omega_{k-1} \\
n_*^k &= \frac{1 - \Sigma_{j=1}^{k-1} q^j \left(1 - z^j\right) \omega_j}{1 - \Sigma_{j=1}^{k-1} q^j \left(1 - z^j\right) \omega_j + q^k \left(1 - z^k\right) \left(\Sigma_{j=1}^{k-1} \omega_j\right)},
\end{aligned}
$$

where $\omega_0 = 1$ and $\omega_j = \Pi_{i=1}^{j-1} z^i$. In a special case when z^i's are monotone, the case in equilibrium, there are two classes of ergodic distributions. One class of $z^1 = 0$ and the other for $z^1 > 0$. For z^k large enough $(z^1 > 0)$ there are increasing returns of the average quality of an operated unit with respect to $1 - z^k$. This is due to the fact that a fall in z^k actually decreases all z^i's and releases more projects of each type eventually contributing to the rise of the

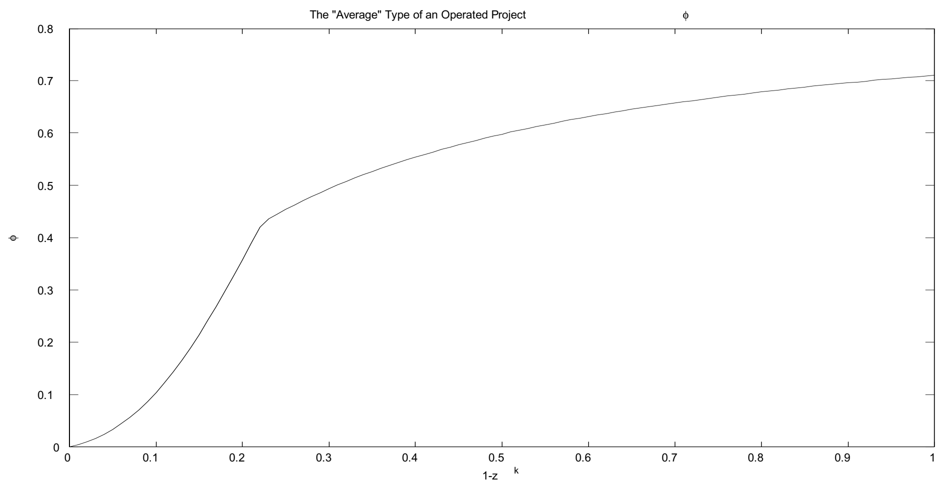

Figure 7: The Steady State Value of the "Average" Quality of an Operated Project as a Function of the Percentage of Projects of the Lowest Quality Utilized $1 - z^k$.

average quality more than one for one. On the other hand if z^k is small then $z^1 = 0$, i.e., all project of the highest type are operated. In such a situation a fall in z^k does not affect the fraction of projects of the highest type being operated hence its impact on the equilibrium average quality of an operated unit is less than one for one.

Moreover, it is naturally the case that the smaller z^k the larger the average type available and the larger the type operated in the steady state. Therefore, periods that lead to high values of z^k lead to destruction of informational capital.

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