



Department of Economics and Finance

Advanced Macroeconomics

STAGNATION ECONOMICS

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1 INTRODUCTION

Is it possible for economic recessions to have long-lasting effects? Can a deviation from the full employment equilibrium, due to a either supply-side or demand-side shock, and the consequent output gap, impede to get back to the pre-shock situation? Examining this possibility and the mechanisms through which it may happen is the focus of this work. It is a central pillar of both classical models and Keynesian models that it is all about fluctuations: fluctuations around the given mean, and that what economic analysis should focus on, and policy-makers aim to, is understanding and limiting the sources of volatility. In our opinion this point of view ignores some realistic and dangerous scenarios. We will argue that there are two main channels of persistence: the economy cannot escape a depressed state after an initial shock pushes it there, resulting in a prolonged stagnation; the economy suffers from a reduction in its future potential due to the present recession, a phenomenon known as hysteresis.

This thesis is divided in two main sections. The first investigates what a stagnation is, why is an economic trap, how an economy may fall into one and what are the consequences in terms of policies. A stagnation is a depression of indefinite duration, not strictly in terms of time, but more in the sense that the economy will not tend to return to its full potential, but will rather stay there in equilibrium. Some features are necessary in order for an economy to fall in a state of stagnation. The most important one is probably the zero lower bound on the nominal interest rates, which prevents the monetary policy adjustment to a depression. The other type of adjustment, which would come from the labor market, may also not come through because of rigidities in the wages level. Constraints on private indebtedness, if they become more binding when the economic performance gets worse, may lead to depressed and even stagnating conditions: while any kind of economic shock could push the economy in the depression that will become a stagnation, episodes of forced deleveraging in a short period of time are particularly dangerous because of the immediate consequences they have on real interest rates. Based on this features, two formal models that generate a below potential equilibrium are presented: the first explores the implications of deleveraging shocks; the second links demand weaknesses to long-run growth. The effectiveness of

monetary policy in those situation is partial at best, limited to higher inflation targeting; expansionary fiscal policy however is very effective, especially if debt-financed, while the effects of growth-enhancing policies is ambiguous. The second main section of the thesis deals with the other way depressions have long-lasting effects, which is hysteresis. High unemployment and low aggregate demand, other than not being desirable in the immediate, may damage some structural aspects of an economic system. Unemployment becomes persistent and output loses part of its potential because of some combinations of labor market imperfections and reduced investments in research and capital formation. We performed an empirical analysis on these issues that suggests that the last recession has indeed had long-run repercussions, and that the reduction in capital investments due to the crisis is at least partially responsible for it. This consideration should change the way we usually think of fiscal stimulus: other than stimulating current demand, such policies prevent hysteresis, and therefore they can be as much long-term as they are short-term oriented. The arithmetic of debt-financed fiscal expansions shows that, even for a country like Italy deeply in (public) debt and with low growth expectations, those measures may plausibly be beneficial to public finances.

From an academic point of view, the most general lesson that this work wishes to give is that the stark separation, typical of textbook macroeconomics, between the analysis of short-run fluctuations and long-run growth models is inadequate. From a more practical standpoint, we think that the theories presented here fit well the current economic scenario, especially in Europe and Japan, and the United States to a lesser degree. Understanding the nature of a problem is always the first step to hope to fix it.

2 STAGNATION TRAPS

What happens to an economic system, supposedly in equilibrium, in the aftermath of a negative shock? This question seems to be quite trivial to those with some understanding of economic theory, and not only to them. Whether is coming from the demand-side or the supply-side of things, we would expect output to decline from its pre-shock level: in other words, a recession. Now out of its steady state, the system would no longer be stable, but it would go through an adjustment period, so that, thanks to some stabilizing policies or simply to market mechanisms, a new steady state equilibrium is reached. While the first part of the story is hardly controversial, the second is more open to challenges. In particular, there are scenarios where the adjustment process could no longer work. In this case, a recession, or more precisely a sub-optimal output level, could become persistent, if not permanent. The presence of output gaps i.e. a shortcoming of the output, and therefore employment level, with respect to its potential, at that point is not simply the symptom of upcoming adjustments, but instead a feature of the new steady state. We refer to such equilibrium as a stagnation equilibrium, and the breaking down of the stabilization tools as a stagnation trap.

The last financial crisis and the recession it propelled have put in serious doubt the conventional wisdom, and the idea of a protracted stagnation has come back into the economic debate, especially since Lawrence Summers in 2013, during a consequential speech at the IMF, talked about the dangers of a secular stagnation. The phrase secular stagnation was first introduced by Hansen (1939). He argued that, since population growth and technological innovation were slowing down, firms would not have had much incentive to invest in new capital goods and innovation. Insufficient investment spending and reduced consumption by households would then prevent from reaching full employment for a long period of time. Hansen's prediction proved to be wrong: after World War II most economies experienced a period of exceptional expansion, with both strong population growth and rapid technological progress. Nevertheless, while in the '40s the world did not go through a secular stagnation, this does not mean that the idea must be ultimately dismissed. What led Summers to bring it back was the weak recovery

of the U.S. economy after the Great Recession. Several years removed from the crisis, the economy has not recovered the lost ground, even if by conventional wisdom we would expect a lot of catch-up once the factors that triggered the recession have disappeared. If the whole problem was the financial unrest, it becomes very hard to explain the continued slow growth in the following years. Moreover, if an asset bubble was happening before the crisis, as many believe, why there was no evidence of abnormal GDP growth? Both those facts would become much easier to accept if, during the last decade or so, the real interest rate consistent with full employment had fallen to negative. If that was the case, then even with artificial stimulus to demand coming from the early '00s financial imprudence, there would not have been any excess demand, and the resumption of normal credit conditions would not be enough to restore full employment. Conventional macroeconomic policy would not offer much of an answer, because while exceptional monetary measures may have been effective in stopping the recession, they are not considered feasible over a longer period of time, but the underlying problem may be there forever. The same thing goes for fiscal considerations, since the idea that deficits are needed only until the crisis is over breaks down if adequate aggregate demand and equilibrium interest rates cannot be achieved given the prevailing rate of inflation. This last point rings true also looking outside the U.S., maybe even more so. Japan's low inflation, low interest rates and low growth environment has been a reality for almost twenty years; and while the European experience with the recession is very different than the American one, mainly because of the fiscal consolidation experiments and their consequences, monetary policies have had minor impact on output and subpar growth and deflation seem to be a new normal. The possibility of a secular stagnation has therefore become a main topic of discussion over the last few years, and many efforts have been done to include it in a formal economic model. We will first see the main features that may lead an economy in a state of stagnation; then we will explore two approaches that generate such a result, one based on the persistence of deleveraging shocks in an overlapping generations environment, the other centered around the link between trend-growth and current consumption.

2.1 Common features of stagnation models

While, as we said, there are different kinds of models consistent with a stagnation equilibrium, some features tend to be present in all of those models. In order to avoid repetitions and over-exposition later, and to give a first feel of what could lead to a stagnation trap, we will first list and analyze these features.

2.1.1 *The zero lower bound on nominal interest rates and the liquidity trap*

In the last decades monetary policy has been considered the main tool of economic policy, given the achievement made in the field of monetary economics and the skepticism surrounding the role of fiscal policy (see for example Taylor (2000)). This situation raises a question: is monetary policy effective under any circumstances? In very simple terms, we expect monetary policy-makers to set the interest rate in such a way that the cyclical fluctuations are limited, and the economic system stays on the track of full employment and sustainable growth. The issue of the liquidity trap emerges when the real interest rate consistent with full employment would be negative, but the central bank, which deals in nominal rates, cannot reach it since it is constrained by the zero lower bound.

The first exposition of the liquidity trap comes from the Hicksian formulation of Keynes: the IS-LM model. The theory lost popularity after the Friedman-Schwartz reinterpretation of the Great Depression, which disregarded the existence of the liquidity trap as a problem in itself, but rather linked it to some structural, supply-side dynamic. However the Japanese experience from the '90s on inspired a new interest for the topic, and a modern theory of the liquidity trap emerged. The building block of this new formulation is in Krugman (1998). Krugman cited a couple of reasons that made IS-LM inadequate for the purpose of understanding the issue of the liquidity trap: among others, the developments in rational expectations theory and intertemporal macroeconomics.

A liquidity trap can be defined as a situation in which conventional monetary policy is powerless, since the central bank faces the zero lower bound. At that level of nominal

rates in fact, bonds and money are viewed as perfect substitutes, and therefore the opportunity cost of holding additional money is zero: further expanding the money supply does not alter economic agents' preferences. A mind experiment may show why the liquidity trap is a separate issue from supply-side, structural ones. If money are (roughly) neutral, monetary expansion raises price level, while in presence of some stickiness it also raises output. Structural, supply-side problems can affect the level of output for any level of monetary base, but they cannot explain the lack of reaction of prices and (or) output, given a change in the monetary base. Moreover, while a temporary increase in monetary base does not have full, if any, impact on prices or output, an increase repeated indefinitely for every period should translate to prices. This price effect is what the policy-makers need to escape the liquidity trap: while the negative real rate cannot be reached directly via nominal rates, rising inflation is the way to achieve the target real rate. The liquidity trap is therefore, at its core, a credibility-based problem: since usually part of the job of policy-makers is to convince agents of their commitment to price stability, they have a hard time convincing of a long-lasting commitment to stimulating inflation. Generating inflationary expectations is key to achieve actual inflation, but it is problematic when the usual conduct of policy makers is to reverse their policies immediately after the first signs of inflation kick in.

What are the implications of the zero lower bound for monetary policy? The first is a deflationary black hole. As we said, hitting the bound prevents the central bank from having any power through conventional policy tools. Thus, if at the bound the economy is in a deflationary situation, we would find it very difficult to reverse it. The answer would be generating inflationary expectations, so that the negative equilibrium rate may be reached even with positive nominal rates. But in such a scenario it would be natural to have deflationary expectations, making things even worse. Escaping deflation through other means, like purchases of long-run government bonds or other assets, could be considered an option, even if is not contemplated by the traditional view on monetary policy, as expressed by Taylor (1993). Using a full dynamic model, Eggertson Woodford (2003), try to answer the question of whether inflation targeting or asset purchases are effective to escape the liquidity trap. On the front of the effectiveness of

inflation targeting at the zero lower bound, the answer is that yes, higher expected inflation may help closing the output gap, because of the fall in real interest rate: with fixed (at zero) nominal rates, inflation accommodates the negative real rate. It is important to stress again the issue of the credibility of such a measure: it is crucial that the central bank does not revert to a purely forward-looking optimal inflation target once the zero lower bound no longer binds: why otherwise would agent believe on a policy of increased inflation target during the trap? Regarding asset purchases, their conclusion is that the rational expectation equilibrium is independent from the size of monetary base, and hence that strategies that provide additional money balances, such quantitative easing or targeted asset acquisitions, do not offer any liquidity service after the satiation level of money balances is reached. Quantitative easing and asset purchases could have effects, but more plausibly through the expectation channel.

In conclusion, it is clear how a liquidity trap could be a major factor in protracting economic downturns, since it stops monetary policy from restoring a full employment condition, or at least makes it significantly harder to do.

2.1.2 Wages (downward) rigidity

Wages rigidity is the friction with the longest tradition in the literature, dating all the way back to Keynes (1936), who puts it at the center of his explanation of the Great Depression. It is in fact one of the most consequential market rigidity: the basic market correction we anticipate after a rise in unemployment is for the wages to go down, so that labor demand can be always consistent with full employment. However, if wages are downwardly rigid it may cause output to fall permanently below the full employment level. More realistically, wages are downward sticky, not totally rigid; still, this could make the adjustment period very long, contributing to the persistence of economic downturns. Some level of stickiness is not just possible, but likely, and the role it played in the weak recovery of employment from the Great Recession has been gaining increasing attention in the last years.

It is not controversial to include wage rigidity in economic models, but it is interesting to discuss the ways this feature is modeled. Depending on the way the idea is formalized, more focus is put on a different aspect of labor market rigidities. Schmitt-Grohè Uribe (2012) model nominal downward wage rigidity assuming that in any given period nominal wages can at most fall by a factor proportional to the aggregate rate of unemployment: this allows nominal wages to become more flexible as unemployment increases. This captures that, as the number of unemployed people increases, so does the pressure they put on the labor market. In Schmitt-Grohè Uribe (2013), the source of wage rigidity is not an aggregate dynamic, but the reservation wage of the households. They derive a disutility working for wages that are lower than their wage in the previous period. The more the aversion of the representative households for wage reductions is high, the more rigid the wages will be.

As we will also point out later, the possibility to simply reduce this rigidity could be ineffective in preventing the harm it creates if it cannot be completely eliminated, an unrealistic task.

2.1.3 Constraints on private indebtedness

Is there a limit on the level of debt households and firms can hold? Is this level somewhat tied to the business cycles? The fact the only a certain level of debt is deemed acceptable intuitively makes sense. This threshold could be determined by regulators, in the case of large financial institutions for example, or simply by risk aversion reasons. This second possibility in particular has interesting implications. As argued by Minsky (1986), the attitude toward risk, especially in the financial markets, changes with the position in the economic cycle: expansion periods embolden agents, that become more incline to assume additional risk and make further use of leverage. A more technical and less psychological reason for this is related to the way risk is measured. Adair Turner, chairman of the British Financial Services Authority, in its 2009 report to British Government about the causes of the financial crisis, expanded on this point. He argued that poor, pro-cyclical risk assessment methods have been a major factor to the

collapse: most risk measures, based as they are on historical standard deviation, underestimate it after years of good market performances, when systemic risk and the likelihood of a sudden crash is actually at its peak. The realization of this asymmetry is what has been called a “Minsky moment”, where agents suddenly deleverage to conform to a new acceptable debt limit. Those deleveraging moments play a key role in pushing the economy into a liquidity trap, or even a stagnation.

2.2 Deleveraging driven slumps

The first kind of stagnation we will analyze can be summarized as follows: debt-constrained agents are suddenly forced to deleverage, pushing the real interest rate into the negatives and the economy into a liquidity trap. The central bank is unable to restore full employment with conventional monetary policy. The addition of an overlapping generations dynamic could both further push the real rate down and make the slump persistent.

We will first describe a model of deleveraging and liquidity trap (Eggertsson Krugman (2012)); then we will go to the work of Eggertsson Mehrotra (2014), that builds on Eggertsson Krugman (2012) to show how the liquidity trap could become permanent, and the economy could be in a secular stagnation equilibrium.

2.2.1 Debt deleveraging and liquidity trap

For this model we will consider the exogenous output case only: a full, endogenous output model will be the object of the next paragraph. What we wish to do now is characterize a deleveraging shock and show how it may lead into a liquidity trap.

This is a “quasi representative” agent model: there are two classes of agents, which we will call the patient (or savers s) and impatient agents (or borrowers b). They split the output equally and maximize the utility function:

$$E_t \sum_{t=0}^{\infty} \beta(i)^t \log C_t(i) \text{ with } i = b \text{ or } s,$$

subject to the budget constraint:

$$D_t(i) = (1 + r_{t-1})D_{t-1}(i) - \frac{1}{2}Y + C_{t-1}(i) \text{ with } i = s \text{ or } b$$

The only difference between the two types of agents is the rate of time preference, which implies an higher discount factor for the more patient ones: $\beta(s) = \beta > \beta(b)$. Both groups face a debt limit, $D^{High} \geq (1 + r_t)D_t(i)$, but it is only binding for the borrowers, which would happily borrow more if it were allowed (for $i = b$ the debt limit becomes an equality). What is the steady state in this endowment economy? We can describe it with three main equations:

$$C(b) = \frac{1}{2}Y - \frac{r}{1+r}D^{high} \quad (2.1)$$

$$C(s) = \frac{1}{2}Y + \frac{r}{1+r}D^{high} \quad (2.2)$$

$$\frac{1}{C_t(s)} = (1 + r_t)\beta E_t \left\{ \frac{1}{C_{t+1}(s)} \right\} \quad (2.3)$$

Equation (2.1) is the steady state consumption of the borrowers, while equation (2.2) is the steady state consumption of the savers: in the long-run the savers will consume more, while the borrowers will have to pay the debt back. Equation (2.3) is the savers' Euler equation, which regulates the intertemporal distribution of their consumption. Note that borrowers do not have an Euler equation: since they are debt constrained in the first period, they will simply consume the entire extent of their debt now, and consumes what they have left after they repay the debt later. In steady state, (2.3) gives us the equilibrium real interest rate, $= \frac{1-\beta}{\beta}$. Assuming $\beta < 1$, which is the natural assumption, the real rate in steady state is positive.

What happens when a deleveraging shock hits this economy? Suppose there is a new, lower debt limit, and consider the consequences in both the short and the long-run. In the short-run, the borrowers are forced to deleverage to adjust to the new limit, while the savers' consumption is determined by market-clearing ($Y = C(b) + C(s)$). The short-run consumption, for borrowers and savers, is:

$$C_{s.r.}(b) = \frac{1}{2}Y + \frac{D^{low}}{1+r_{s.r.}} - D^{high} \quad (2.4)$$

$$C_{s.r.}(s) = \frac{1}{2}Y - \frac{D^{low}}{1+r_{s.r.}} + D^{high} \quad (2.5)$$

The size of deleveraging determines short-run levels of consumption. Borrowers will consume less than before, and savers compensate this lost consumption. The long-run equilibrium will look like the pre-shock one described by (1) and (2), but with the new D^{low} instead of D^{high} . The relation between short and long-run is captured by rewriting the savers' Euler equation:

$$C_{l.r.}(s) = (1 + r_{s.r.})\beta C_{s.r.}(s) \quad (2.6)$$

Combining the last three equations we find the equilibrium gross real rate in the short-run:

$$1 + r_{s.r.} = \frac{\frac{1}{2}Y + D^{low}}{\beta(\frac{1}{2}Y + D^{high})} \quad (2.7)$$

If the gross real rate is smaller than one, the equilibrium real rate is negative: the economy is pushed into a liquidity trap. (2.7) can be rearranged then into a liquidity trap condition, as a function of the size of deleveraging:

$$\beta D^{high} - D^{low} > \frac{1-\beta}{2} Y \quad (2.8)$$

If the debt overhang, the left hand side of (2.8), is large enough, $r_{s.r.}$ becomes negative. The larger the deleveraging imposed on the borrowers, the larger is their reduction in spending power that has to be compensated by increased present day consumption by savers: this requires the real rate to go down.

Money (and prices) are included in the model by introducing one-period nominal debt, denominated in money, whose return is set by the government (the nominal interest rate). The saver has now another investment option, and Euler equation attached: when we combine the two Euler equations we get the traditional Fisher equation, the relation between nominal and real rates:

$$1 + r_{s.r.} = (1 + i_{s.r.}) \frac{P_{s.r.}}{P_{l.r.}} \text{ with } i_{s.r.} \geq 0 \quad (2.9)$$

(2.9) needs to be positive because the existence of money precludes the possibility of a negative nominal rate: this is the zero lower bound. We also denominate the debt limit in nominal terms, so $D^{high} = \frac{B^{high}}{P_{s.r.}}$, where B^{high} is the monetary value of debt. Using this definition, combining (2.7) and (2.9) and making the zero lower bound binding, we get:

$$1 + r_{s.r.} = \frac{P_{s.r.}}{P_{l.r.}} = \frac{\frac{1}{2}Y + D^{low}}{\beta(\frac{1}{2}Y + \frac{B^{high}}{P_{s.r.}})} < 1 \quad (2.10)$$

This equation tells us that when the a deleveraging shock is big enough to push the real rate into negative territory, where the nominal rate cannot go, a deflationary process will also be triggered, which in turn makes the real burden of the debt even worse. This spiral mechanism had been already described by Fisher (1933), and it is indeed known as Fisherian debt deflation. When the debt limit goes down the real rate will follow, and if the forced deleveraging is big to the point where the nominal rate cannot adjust because of the zero lower bound, deflation will kick in. Since the debt limit is defined in nominal terms, deflation will lower it even more, adding further downward pressure on the real rate and prices, in a vicious spiral.

While this model is effective in showing the link between indebtedness and liquidity trap, does not however directly address the problem of stagnation: the consequences of deleveraging hit the economy in the short-run, but are neutral in the long-run. The steady state of the economy is not altered by the deleveraging shock, only the distribution of consumption between the different agents is. The liquidity trap is only a short-run problem, since in steady state the real rate will revert to its (positive) equilibrium level of $\frac{1-\beta}{\beta}$.

2.2.2 A model of secular stagnation

Is it possible that an economy falls into a liquidity trap, and that trap becomes an intrinsic characteristic of its new steady state? To address this possibility we move away from a quasi-representative agent model to an overlapping generations one: in particular, in any period we have young, middle aged and old people. We will very quickly go through the endowment economy case, to spend time then on the more interesting endogenous output scenario.

Each passing generation the population grows at a rate g_t . Only the middle and old generations receive any income in the form of an endowment Y_t^m and Y_t^o . In this case, the young will borrow from the middle-aged households, which in turn will save for retirement when old, when they spend all their remaining income and assets. The three population groups lend and borrow to each other, without any aggregate saving. The young people essentially assume the role of the borrowers in Eggertsson Krugman (2012): they are the ones constrained by the debt limit D_t , since they would happily subscribe even more debt in the absence of the limit.

In the world describe above, the equilibrium would be determined on the loans market. Eggertsson Mehrotra (2014) describe this equilibrium building the demand for loans function and the supply of loans function:

$$L_t^d = \frac{1+g_t}{1+r_t} D_t \quad (2.11)$$

$$L_t^s = \frac{\beta}{1+\beta} (Y_t^m - D_{t-1}) - \frac{1}{1+\beta} \frac{Y_{t+1}^o}{1+r_t} \quad (2.12)$$

The interpretation of (2.11) is straightforward: the demand for loans goes up with the debt limit, the growth rate of the population (there are more young borrowers compared to middle aged lenders), but goes down with the interest rate. (2.12) on the other hand shows how the supply increases with the middle aged income, who are the indeed the savers of this economy; it is affected negatively however by the debt limit in the previous period. The reason is that if middle aged had more room to borrow when young, because of a higher limit, they will spend more of their resources to repay the debt, and therefore have less possibility to lend. The generational connection alters the

way deleveraging shocks impact the economy, from what we have seen in the previous paragraph. Figure 2.1 shows the equilibrium in the loans market and the effect on it of a reduction in the debt limit or a population growth slowdown. The equilibrium is reached at the level of real interest rate that allows the intersection between supply and demand, given by:

$$1 + r_t = \frac{1 + \beta}{\beta} \frac{(1 + g_t) D_t}{Y_t^m - D_{t-1}} + \frac{1}{\beta} \frac{Y_{t+1}^o}{Y_t^m - D_{t-1}} \quad (2.13)$$

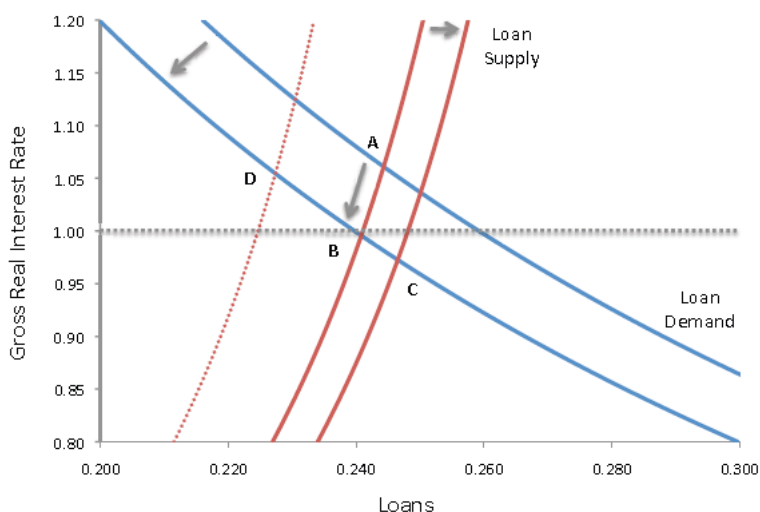


Figure 2.1: Equilibrium in the asset market, before and after a deleveraging shock or a population growth slowdown. Source: Eggertsson Mehrotra (2014)

The first consequence of a reduction of D_t or g_t is a shift downward of the loan demand, and the equilibrium goes from point A to point B: this is the short-run mechanism in Eggertsson Krugman (2012). Relative to the original equilibrium, the young are now spending less at a given interest rate, while the middle aged and old are spending the same. Since all the endowment has to be consumed in our economy, this fall in spending by the young then needs to be made up by inducing some agents to spend more. The adjustment takes place via reduction in the real interest rate. The drop in the real interest rate stimulates spending via two channels: a fall in the real interest rate makes consumption today more attractive to the middle aged, thus increasing their spending, while at the same time relaxes the borrowing constraint for the credit-constrained young generation, since a lower interest rate allows them to take on more debt. That is

because at any given D_t , the borrowing of the young is limited by their ability to repay in the next period, and that payment depends on the interest rate. Observe that the spending of the old is unaffected by the real interest rate of the time: their consumption is the result of the saving decisions they take as middle-aged.

What is more interesting is what happens in the period following the shock. In Eggertsson Krugman (2012) the loan supply would decrease, because deleveraging reduces interest income accruing to savers, which implies that their supply of savings falls in equilibrium: we reach Point D, where the real rate is back at its long-run equilibrium level. In the overlapping generation case however the loan supply increases after the deleveraging, because the middle aged would have contracted less debt when young and therefore have more income to lend. The equilibrium is reached in Point C, where the real rate has fallen even more. In this framework is then more likely that the size of deleveraging is large enough to push the real rate into negative territory, since the loans market undergoes two subsequent negative events: a reduction in loan demand in t and an increase in the loan supply in $+1$. The other difference compared with what happens in the previous model is that the lower real rate is an equilibrium result. This is a much more consequential distinction. If to satisfy (2.13) the real rate must be negative the resulting liquidity trap is not temporary, but permanent. It is not just the variation in the debt limit that has an impact on the level of interest rates. In that case, like in Eggerston Krugman (2012), when the economy gets to the steady state (where by definition there is no variation), the rate is always at the same level: only one equilibrium real rate is possible, the one function on the subjective discount factor. The overlapping generations case however makes the real rate not a function of the debt variation, but of the level of indebtedness of the economy. The generational dynamic serves as a powerful and persistent propagation mechanism for the original deleveraging shock, and expands the range of possible equilibrium real rates.

Money is introduced the same way we described in Eggertsson Krugman (2012), implying the standard Fisher equation:

$$1 + r_t = (1 + i_t) \frac{P_t}{P_{t+1}} \text{ with } i_t \geq 0 \quad (2.14)$$

(2.14) gives us an interesting insight: in a flexible prices environment, if the real interest rate is negative in equilibrium, as we saw it may happen, a price stable steady state is ruled out, because of the zero lower bound. In general, for an equilibrium with constant inflation to exist, there is a bound on the inflation rate given by $\geq \frac{1}{1+r}$, which while not of great significance for a positive real rate, it becomes an actual constraint when the rate is negative. It implies in fact that steady state inflation needs to be permanently above zero (possibly well above zero) depending on the value of the steady state real interest rate. For example, if the real rate were -2%, constant inflation would need to be higher than 2.04%.

We assume that the central bank sets the nominal rate following a Taylor rule of the following type:

$$1 + i_t = \max \left\{ 1; (1 + i^*) \frac{\Pi_t^{\varphi_{\Pi}}}{\Pi^*} \right\} \quad (2.15)$$

with φ_{Π} as a parameter of the policy rule that we hold constant, and Π^* and i^* as respectively the inflation and the nominal interest rate target. The central bank tries to stabilize inflation around the target unless it is constrained by the zero lower bound. Additionally, assumption is that $\varphi_{\Pi} > 1$: the central bank responds to deviation of inflation from the target changing the interest rate more than proportionally. We also define $\Gamma^* = (1 + i^*)^{-1}(\Pi^*)^{\varphi_{\Pi}}$ as the policy parameter given in the policy reaction function.

The next step is making the output endogenous. The assumptions are for the production technology to be labor only: $Y_t = L_t^{\alpha}$. The middle generation is the only provider of labor, supplying it all inelastically at \bar{L} . Firms' profits maximization in each period gives the labor demand condition:

$$\frac{W_t}{P_t} = \alpha L_t^{\alpha-1} \quad (2.16)$$

In a frictionless production side, output would be at potential at any time: $Y^f = \bar{L}$. However output can fall below potential if, in a more realistic world where households are not willing to accept every wage, the production side has some level of wages

rigidity. The assumption is that households' decision to accept or not a certain wage level is based also on the wage they received the previous period, and it is modeled followed Schmitt-Grohè Uribe (2013). We first define a wage norm:

$$W_t^{norm} = \gamma W_{t-1} + (1 - \gamma) P_t \alpha \bar{L}^{\alpha-1} \quad (2.17)$$

where the parameter γ measures households' willingness to accept a wage lower than what they received the previous period (W_{t-1}), because it is closer to the efficient wage level that would guarantee full employment ($P_t \alpha \bar{L}^{\alpha-1}$, coming from (2.16) with labor demand equal to the total supply). Therefore, $\gamma = 1$ implies a perfectly downwardly rigid wage, $\gamma = 0$ corresponds to the flexible wage case considered earlier. The wage level is then:

$$W_t = \max\{W_t^{norm}, P_t \alpha L^{\alpha-1}\} \quad (2.18)$$

The wage can never fall below the norm. If the labor market-clearing wage is above the norm, there will be no unemployment and the output will be at potential; if labor market-clearing requires a wage lower than the norm, some people will not be hired and output will fall below potential.

What is the steady state of this economy? We look at steady state aggregate supply and aggregate demand, that summarize the model, to show how such an economy could have output below potential in equilibrium. If the central bank is unwilling to let inflation be high enough to prevent this opportunity, it will have to tolerate some level of unemployment. The aggregate supply has two regimes, depending on whether the prevalent real wage is equal to the market-clearing one or higher, or equivalently on whether the market-clearing real wage exceeds the wage norm. This turns out to be a condition on steady state inflation: in fact, if we evaluate (2.17) in steady state and define the real wage as $\omega = \frac{W}{P}$ we get:

$$\omega \geq \gamma \omega \Pi^{-1} + (1 - \gamma) \alpha L^{\alpha-1} \quad (2.19)$$

which is satisfied as long as $\Pi \geq 1$. The aggregate supply function then is:

$$Y = L^\alpha = Y^f \text{ for } \Pi \geq 1 \quad (2.20)$$

$$\frac{\gamma}{\Pi} = 1 - (1 - \gamma) \left(\frac{Y}{Y_f} \right)^{\frac{1-\alpha}{\alpha}} \text{ for } \Pi < 1 \quad (2.21)$$

While (2.20) is simply the full employment potential output, (2.21) is a nonlinear Phillips curve: a positive relation between output and inflation. The intuition is that as inflation increases, real wages decrease (since wages are rigid) and hence firms hire more labor. The relation is steeper the more flexible the economy is, the lower is the parameter γ , to the point that for $\gamma = 0$ the curve would be vertical. As we mentioned this is a steady state function, which means that wages are rigid even in the long-run. Since the source of wage rigidity is the relative unwillingness to accept a wage reduction, and not some general mechanisms in the labor market that could progressively disappear.

We now turn to aggregate demand. As in the case of aggregate supply, the demand-side consists of two regimes: one when the nominal interest rate is positive and the zero lower bound is not binding, the other when the nominal rate is zero because the zero lower bound binds :

$$Y = D + \frac{(1+\beta)(1+g)D\Gamma^*}{\beta} \frac{1}{\Pi^{\varphi_{\Pi}-1}} \text{ for } i > 0 \quad (2.22)$$

$$Y = D + \frac{(1+\beta)(1+g)D}{\beta} \Pi \text{ for } i = 0 \quad (2.23)$$

In the case of a positive nominal rate, demand is obtained by summing up the consumption of the three generations and substituting the nominal interest rate with the policy reaction function. (2.22) is a negative output-inflation relation, and that is because as inflation increases, the central bank tightens its policy and increases the nominal interest rate, in more than offsetting fashion (since $\varphi_{\Pi} > 1$). The real rate rises as well, with negative effects on consumption and ultimately output. However, when we hit the zero lower bound and fall into a liquidity trap, the relation becomes positive, as shown by (2.23). As inflation increases and the nominal rate stays constant, the real rate falls, stimulating consumption. It is important to note the role of population growth in stimulating aggregate demand. The Hansen (1939) idea that slowing population growth was one of the reasons for secular stagnation is somewhat captured then by this model, and it is important that it does: looking at the European and Japanese

experiences in fact is hard not to think that population dynamics have something to do with the persistently weak demand.

Equilibrium output and inflation is determined at the intersection of the aggregate demand and aggregate supply curves. The following figures show the two curves in an output-inflation space, and the resulting equilibrium. Potential output is normalized at $Y^f = 1$. To discuss the properties of the two equilibria it is useful to define the natural rate of interest r_t^f , which is the real interest rate consistent with full employment. The natural rate can be obtained by evaluating equation (3) at $Y_t = Y^f$:

$$1 + r_t^f = \frac{1 + \beta}{\beta} \frac{(1 + g_t) D_t}{Y^f - D_{t-1}} \quad (2.24)$$

The equilibria showed in the figures below can be separated based on the natural rate of interest. Figure 2.2 shows a full employment equilibrium, which corresponds to a positive natural rate of interest; figure 2.3 depicts a secular stagnation equilibrium, characterized by a negative natural rate of interest.

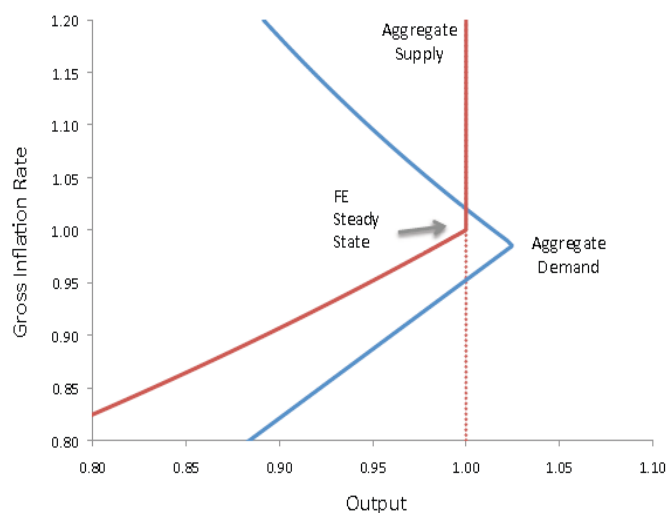


Figure 2.2: Steady state aggregate demand (AD) and aggregate supply (AS) curves, full employment (FE) equilibrium. Source: Eggertsson Mehrotra (2014)

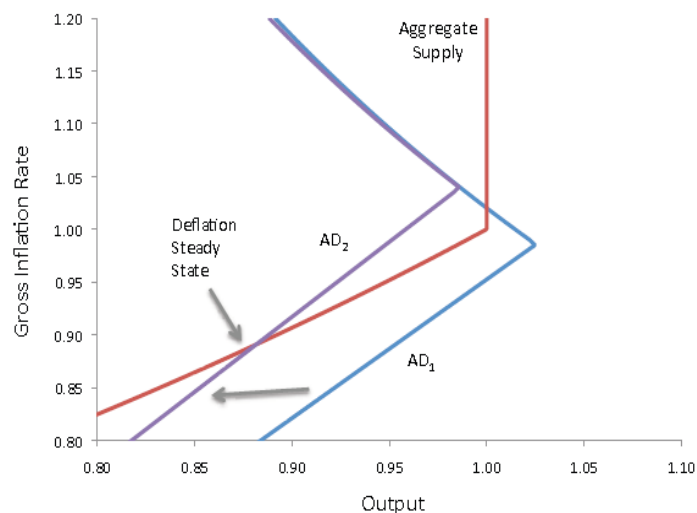


Figure 2.3: Steady state aggregate demand (AD) and aggregate supply (AS) curves, deflation equilibrium.

Source: Eggertsson Mehrotra (2014)

If $r^f > 0$, the aggregate demand curve intersects the aggregate supply curve in its vertical section: the steady state of the economy has full employment and positive inflation. Demand-side shocks, like reductions of D_t or g_t , could hit the system, but as long as they are not large enough so that the natural rate becomes negative, the equilibrium is actually unaltered: the central bank will fully offset these shocks via cuts in the nominal interest rate.

However, if the shock is large enough to push $r^f < 0$, the curves no longer intercept in the traditionally shaped sections of the aggregate supply and the aggregate demand. The new outcome is a long-run high unemployment, deflationary liquidity trap: a secular stagnation. Considering a deleveraging shock, reduction in the debt capacity reduces output for any given inflation rate, since younger households' consumption declines: they cannot borrow as much as before to finance their spending in the early stages of their lives. In the normal equilibrium, to this drop in spending would correspond a drop in the interest rate, which restores spending back to where it was before the shock. The zero lower bound, however, makes monetary policy ineffective and prevents the adjustment. Hence, the shock moves the economy off the full employment segment of the supply curve and in a deflationary equilibrium where the nominal interest rate is

zero. Here, steady state deflation raises steady state real wages, thus depressing demand for labor and contracting output. It is important to note that not only there is actual deflation, but also that inflation is below the inflation rate targeted by the central bank in its policy rule.

The distinction between the two equilibria based on the natural real rate makes us understanding, and give a model-based explanation, to the point made by Summers (2013): the essential problem of secular stagnation is that the natural real rate of interest has become negative.

2.2.3 Keynesian paradoxes and policy implications

The repercussions of the particular form of the aggregate demand (and by a lesser extent of the aggregate supply) are deep and interesting. In particular, liquidity trap economics has produced several paradoxical results, exposed in various analyses (as in Eggertsson (2010) and Eggertsson Krugman (2012)). This framework by Eggertsson Mehrotra (2014) delivers all those paradoxes, and provides an easy graphical display of them. These paradoxes are referred to as Keynesian paradoxes, because they are the result of an economy where the traditional Keynesian frictions are present.

The paradox of toil, in its first illustration by Eggertsson (2010), states that if all households try to supply more labor, there will be less labor in equilibrium. We can generalize this idea: any force that increases the overall productive capacity of the economy, so not only an increased labor supply, but also a positive technology shock, can have contractionary effects. As shown by figure 2.4, a positive technology shock shifts the aggregate supply on the right, and the new intersection with the demand is at a lower output, lower inflation level. That is because an increase in aggregate supply, demand fixed, triggers deflationary pressure, making the real rate rising and further depressing demand. The result holds only if the economy is in the portion of the demand that is actually increasing in inflation, due to the zero bound that stops the central bank from offsetting a drop in inflation by cutting the nominal rate, leading to higher real interest rates.

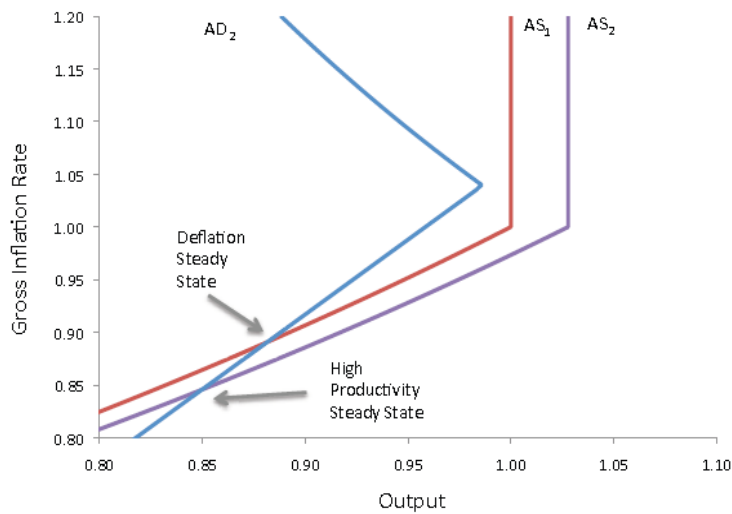


Figure 2.4: Paradox of toil. Source: Eggertsson Mehrotra (2014)

Another interesting result is the paradox of flexibility: as prices, and wages, become more flexible, unemployment rises and output actually contracts. This is considered a paradox because if prices and wages were completely flexible, there would never be an output contraction, since wages would always adjust to ensure full employment. In our world, however, there are price rigidities, and they cannot be eliminated, only reduced. We can see in figure 2.5 that as the parameter γ decreases, meaning wages become more flexible, the slope of the aggregate supply curve steepens, and the system is indeed worse off. For any given deflation steady state, a decrease in γ will shift the steady state along the demand curve, decreasing the rate of inflation, raising real wages, and therefore further increasing the output gap. This result emerges because an increase in price and wage flexibility triggers a drop in expected inflation and therefore, since nominal rates cannot adjust at the zero bound, the real rate increases. If achieving perfect flexibility were a possibility, if $\gamma = 0$ was actually feasible, the supply curve would be vertical over all its domain, and the two curves would have only one intersection. The paradox of flexibility in fact does not deny that in a flexible wage environment involuntary unemployment should not exist: this premise is still true; it questions that it implies that more flexibility is always beneficial.

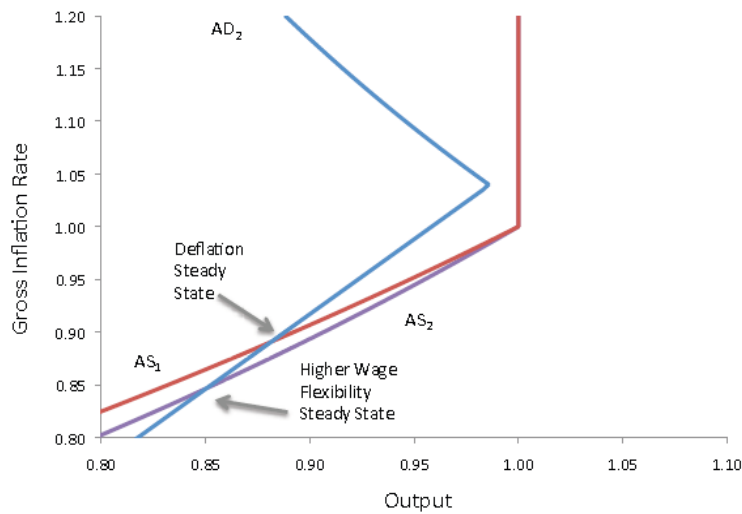


Figure 2.5: Paradox of flexibility. Source: Eggertsson Mehrotra (2014)

Finally, for the sake of completeness, we briefly touch on the paradox of thrift, which is actually already present in the old Keynesian literature. It is the notion that, if all households try to save more, aggregate savings will actually drop. The logic behind the result is simple: if the propensity to consume of the households decreases, aggregate demand will fall, and income with it. All households then will have less income from which to save, and the overall savings will decrease.

What can policy makers do to escape from a stagnation equilibrium? Let us start with monetary policy. We established the idea that a secular stagnation is a particularly vicious form of a liquidity trap. As we discussed earlier in 2.1.1, the traditional solution for a liquidity trap problem is a credible commitment to higher future inflation that reduces real interest rates and stimulates spending. This is also the solution of a stagnation problem, but as we will see with an additional caveat. A commitment to higher inflation is in the terms of the model an increase of the targeted inflation π^* , which raises the monetary policy parameter Γ^* and shifts then the negatively shaped section of the aggregate demand. Depending on how much the inflation target is raised, the policy could produce two different outcomes. The first possibility is that the higher inflation target moves the demand from AD_1 to AD_2 : the increase in the inflation target

is too modest, not enough to push the demand to the point where it would intersect the full employment line, and the economy stays stuck in the secular stagnation steady state. This is a case of what Krugman (2014) referred to as the timidity trap: while a policy measure is effective in principle, it could lose its practical impact because it is not carried out aggressively enough.

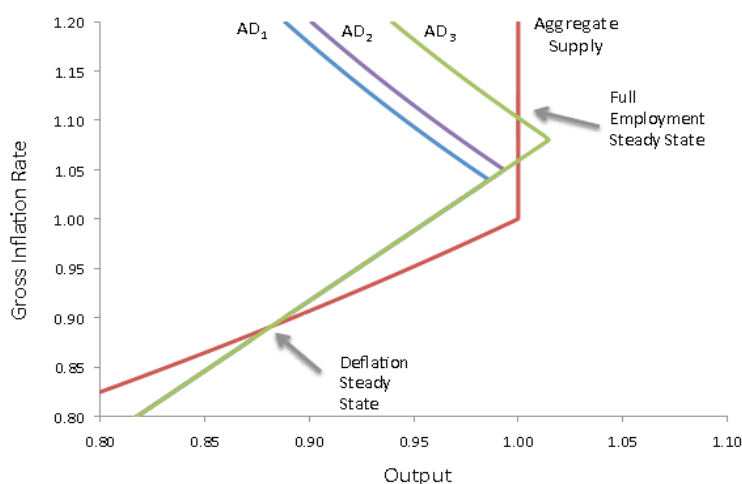


Figure 2.6: Effects of rising inflation targets. Source: Eggertsson Mehrotra (2014)

But if the new inflation target is big enough, we have the situation where the demand goes from AD_1 to AD_3 : the demand now intersects the supply in its vertical, full employment section. Now out of the liquidity trap, the nominal interest rate is positive because the inflation target is large enough to accommodate whichever negative shock pushed the economy into stagnation in the first place. The demand curve intersects the full employment line twice because there are two positive rates of inflation that ensure the real interest rate is equal to the natural rate of interest. But while the increase in the inflation target makes possible two new equilibria with full employment, it does not eliminate the original secular stagnation equilibrium. Stagnation is still a possibility, consistent even with a more aggressive policy rule. In this model, where the generational factor makes the slump persistent if not permanent, monetary policy is less

effective than in a simple, temporary liquidity trap environment, where, as we already said, such a commitment definitely restores full employment. As a quantitative note, for the inflation commitment to be high enough to overcome the timidity trap, we need a target such that $(1 + r^f)\Pi^* \geq 1$.

While monetary policy's power is somewhat limited, fiscal policy could be very effective in dealing with a stagnation. A public sector in this economy is included adding, for each period, taxes to each generation of households (T_t^y , T_t^m and T_t^o), government debt (B_t^g) and government spending (G_t). When we consider the demand of loans by the government and the reduction in loan supply because of less available income after taxes, equation (1) and (2), evaluated in steady state, become:

$$L^d = \frac{1+g}{1+r} D + B^g \quad (2.25)$$

$$L^s = \frac{\beta}{1+\beta} (Y^m - D - T^m) - \frac{1}{1+\beta} \frac{Y^o - T^o}{1+r} \quad (2.26)$$

The government budget constraint is (again in steady state):

$$T^m + B^g + \frac{1}{1+g} T^o + (1 + g)T^y = G + \frac{1+r}{1+g} B^g \quad (2.27)$$

A fiscal policy regime corresponds to a choice of the level and distribution of taxation and government spending subject to the government's budget constraint. Now that a public sector is present, the real interest rate can be affected by fiscal policy, shifting the loan supply and loan demand curves. This can be achieved with the different fiscal variables, so with both taxation, tax distribution, financing method and spending. The overall effect of fiscal policy on the real interest rate then depends on the contribution of all the fiscal variables. In particular, an increase in public debt B^g directly increases the demand for funds in (15), thus shifting out the demand for debt and raising the natural rate. In this respect, increasing government debt is a logical tool to avoiding a secular stagnation, because it offsets the tendency of the natural real rate to go in the negatives. Also, as we said before, this is an economy where the equilibrium real rate depends on the absolute level of debt hold by the agents. The issue of the real rate being negative can be seen then as the economy not being indebted enough. Since this is a

closed economy, the last point is not to be interpreted as net indebtedness, that is always zero, but as gross indebtedness. For an economy that needs more debt, public debt emissions are the optimal policy measure, since it has direct benefits aside from the stimulus to the demand that the funds raised can provide. To see the effects of this stimulus, we add public expenditures to the elements of the aggregate demand. Those effects are different whether the economy is at a positive interest rate level or not. In our economy labor is supplied inelastically, and once all workers are employed and the output is at potential, which is the case at positive interest rates, government purchases will reduce private consumption one to one without any effect on output: the fiscal multiplier is zero. The effects however when the real rate is negative and output below potential, emerge when we generalize (13) with (15) and (16), to get a new equation for the demand in steady state at the zero lower bound:

$$Y = D + T^m + \frac{1+\beta}{\beta} B^g + \left[\frac{(1+\beta)(1+g)}{\beta} D - \frac{1}{\beta} T^o \right] \Pi \quad (2.28)$$

This equation shows the way fiscal instruments directly affect aggregate demand at a zero interest rate.

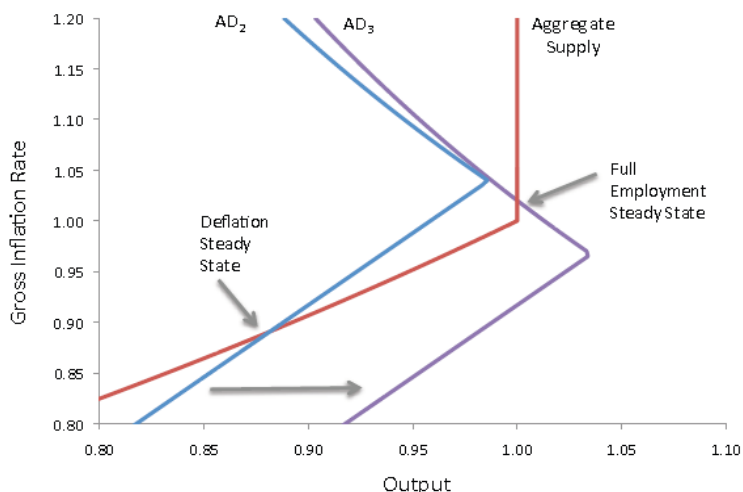


Figure 2.7: Effects of expansionary fiscal policy. Source: Eggertsson Mehrotra (2014)

The fiscal multiplier is now generally greater than zero. Looking at the figure above, we observe the main advantage of fiscal policy in this context. In the case of monetary policy in fact, an increase in the inflation target only allowed for the possibility of reaching the full employment equilibrium, but without actually ruling out remaining in secular stagnation. On the contrary, in the case of fiscal policy the secular stagnation equilibrium can be eliminated, since fiscal policy shifts the entire aggregate demand curve, not just the negatively shaped section. Spending financed by issuing new debt has the highest possible multiplier, for the positive implications of more public debt above discussed.

To sum the policy discussion up, we can say that in a stagnation, while traditional monetary policy is powerless because of the liquidity trap, an increase in the inflation target can be effective, if substantial and credible, because inflation is exactly what this economy needs to reach the natural real rate that is negative when the nominal rate is zero. By substantial we mean that it has to be high enough to break the timidity trap: monetary policy cannot get any traction in pushing the economy out of a stagnation liquidity trap by increasing the inflation target, if does not increase it enough. Even if that is the case, inflation targeting can only generate new possible full employment equilibria, but does not guarantee to get out of the secular stagnation. Fiscal policy on the other hand is extremely effective, because in this depressed setting Ricardian equivalence breaks down: since the output expansion that fiscal measure is able to generate are permanent, private agents do not need to compensate for it. Expansionary fiscal policy definitely moves the economy out of stagnation and closes the output gap. The fiscal multiplier is even larger if the stimulus is financed through public debt, since more debt could counteract the excessive loan supply and directly raise the natural rate.

2.3 Demand, growth and stagnation

We have seen a theory that explains how insufficient aggregate demand may lead to a protracted period of high unemployment and low interest rates. We now explore another approach to produce this result, exploiting a two-way relation between depressed demand and weak growth. The basic logic is the following: firms' investment

in innovation and in capital formation are negatively influenced by an economic environment with high unemployment and weak aggregate demand, because it reduces the expected return from those investments; this in turn has negative repercussions on long-term growth. On the other hand, low growth might further depress the real interest rates, push the economy in the liquidity trap and worsen the overall economic condition, in a dangerous spiral.

The logic above is at the heart of what is known as Keynesian growth literature. It is a field that melts two very different traditions. On the one hand, we have the endogenous growth literature, in particular vertical innovation theories a la Aghion Howitt (1992). In such models vertical innovations, generated by a competitive research sector, constitute the underlying source of growth, and both the average growth rate and its variance are increasing functions of the size of innovations. On the other hand, we have seen in the previous paragraphs how Keynesian frictions could exacerbate and prolong aggregate demand weaknesses. When those two intuitions are combined in one model, we get a mechanism where demand issues and growth issues reinforce each other, and this link could result in a steady state depression. Stagnation here is presented as a twin trap problem: a liquidity trap and a growth trap. When there is both an output and a growth gap, and the two reciprocally cause each other, different policy considerations are necessary.

We will present one model based on this logic, introduced in Benigno Furnaro (2015), and discuss its properties and policy implications, with a comparison with the results exposed before.

2.3.1 A model of Keynesian growth

A demand-side shock, in the model driven by negative expectations, produces output gap and lower growth rates in steady state. The shock lowers firms' profits today and more importantly the expected value of investing in innovation. That is because innovation in this setting means improving the quality of the different goods composing the consumption bundle; the investments in innovation, if successful, guarantee to the

firm a period of monopoly profits, since the firm would be the only supplier of a good of superior quality. The growth of the economy is the improvement in consumption quality, and then the reduction of those investments lowers the growth rate of the economy. When we add Keynesian frictions i.e. wage rigidity and the zero lower bound, the economy gets stuck in the low growth, high unemployment trap permanently.

We will not show the entirety of the model, but only its equilibrium properties: the full foundation of the following equations can be found in Benigno Furnaro (2015). To describe this economy we need four equations. The first is the Euler equation that captures the households' consumption decisions:

$$c_t^\sigma = \frac{\bar{\pi} g_{t+1}^{\sigma-1}}{\beta(1+i_t)E_t[c_{t+1}^{-\sigma}]} \quad (2.29)$$

c_t is the consumption for the period of every quality of consumption good (it is assumed that every good has the same weight in the consumption bundle); σ is the inverse of the elasticity of intertemporal substitution; $\bar{\pi}$ is an assumed, constant rate of inflation; g_{t+1} is the growth of the quality of the consumption bundle for the following period; β is the subjective discount factor and i_t is the nominal interest rate. As it is standard, the Euler equation provides a negative relationship between present consumption and (nominal, since there are price rigidities) interest rate. Also, the equation links present and expected future consumption: a rise in consumption expectations stimulates present consumption. The peculiar feature of (2.29) is the presence of the growth rate. The impact that productivity growth has on present demand is ambiguous, since it can be decomposed in two opposed effects: an income and a substitution effect. The income effect stems from the fact that faster growth generates higher lifetime utility from consumption, leading households to increase their demand for current consumption after a rise in the growth rate of the economy. However, faster growth means that the quality of future consumption goods, compared to present goods, is superior, creating an incentive to postpone present consumption: this is the substitution effect. Which of the two effects dominates depends on the elasticity of intertemporal substitution. For $\sigma > 1$, the elasticity is low, the relationship between growth and demand for consumption is positive: the income effect dominates. For $\sigma < 1$ instead, there is a high

incentive for intertemporal substitution, therefore the relationship between growth and demand for consumption is negative. Finally, for $\sigma = 1$ the two effects perfectly cancel out and the demand is independent from the growth rate. The conclusion of several empirical works is that the elasticity of intertemporal substitution is quite low, and very likely to be lower than one (Hall (1988), Ogaki Reinhart (1998), Basu Kimball (2002) among others). We will operate then under the assumption that $\sigma > 1$ and the income effects dominates: growth stimulates current consumption.

The second key equation describes the supply-side of the economy:

$$1 = \beta E_t \left[\left(\frac{c_t}{c_{t+1}} \right)^\sigma g_{t+1}^{1-\sigma} \left(\chi \frac{\gamma-1}{\gamma} y_{t+1} + 1 - \frac{\ln g_{t+2}}{\ln \gamma} \right) \right] \quad (2.30)$$

$\chi > 0$ is a parameter for the productivity of research, $\gamma > 1$ captures the distance in quality between the innovator and the followers, and y_{t+1} is the output of the economy for the following period: since output capacity at full employment is normalized at 1, it is also a measure of output gap. This is a growth equation. The equation comes from the firms' incentive to invest in innovation, and paints a positive relation between output and growth: rising output leads to higher monopoly profits, which in turn induce firms to invest more in research and this has a positive impact on the growth rate of the economy.

The third equation is a goods market-clearing condition, adjusted to account for the investments in innovation:

$$c_t = y_t - \frac{\ln g_{t+1}}{\chi \ln \gamma} \quad (2.31)$$

Since there is the possibility of investments, not all output is devoted to consumption. This equation tells us that in order to generate faster growth the economy needs to devote a larger share of its output to research and a smaller one to consumption: growth and consumption are negatively related.

Finally, we have monetary policy. Since it is assumed here that inflation is constant, the policy rule will not respond to inflation as in 2.2.2, but to output gap:

$$1 + i_t = \max\{1; (1 + i^*)y_t^\varphi\} \quad (2.32)$$

The central bank will adjust the nominal rate to try guaranteeing full employment, if it is not constrained by the zero lower bound.

From this system of equations, we can derive the steady states of the economy: in fact, there are two different solutions consistent with equations (2.29) to (2.32). First, there is a natural, full employment steady state. Evaluating equation (2.29) and (2.30) in steady state and recalling that at potential the output is one, we find the full employment growth rate and nominal interest rate. The growth rate g^f is such that:

$$\frac{g^f}{\beta} + \frac{\ln g^f}{\ln \gamma} = \chi \frac{\gamma-1}{\gamma} + 1 \quad (2.33)$$

While the nominal interest rate is:

$$i^f = \frac{\bar{\pi}(g^f)^{\sigma-1}}{\beta} - 1 \quad (2.34)$$

Making some assumptions on monetary policy parameters to impose that inflation and growth rate in the full employment steady state are high enough that the zero lower bound on the nominal interest rate is not binding, it can be shown that the full employment steady state exists and it is unique. However, the same economy could find itself in another steady state, where output operates below capacity and therefore there is unemployment. If we again evaluate equation (2.29) and (2.30) in steady state, but in a liquidity trap situation ($i = 0$), we find that both growth and output are below potential:

$$g^u = \left(\frac{\beta}{\pi}\right)^{\frac{1}{\sigma-1}} < g^f \quad (2.35)$$

$$y^u = \left[\frac{(g^u)^{\sigma-1}}{\beta} + \frac{\ln g^u}{\ln \gamma} - 1 \right] \frac{\gamma}{\chi(\gamma-1)} < 1 \quad (2.36)$$

Benigno Furnaro (2015) describe this second steady state as a stagnation trap: the combination of a growth trap and a liquidity trap. As far as the growth trap, (2.35) depicts a situation where investments in innovation are depressed because of the demand weakness, resulting in untapped growth potential in the economy ($g^u < g^f$).

The liquidity trap works as usual: the central bank does not have the ability to restore full employment and the economy permanently operates below potential ($y^u < 1$).

Figure 2.8 describes the economy with two curves in an output-growth space. The GG curve is the steady state growth equation, while the AD curve combines the Euler equation with the policy regime. The intersections between the two curves are the equilibria of this economic system.

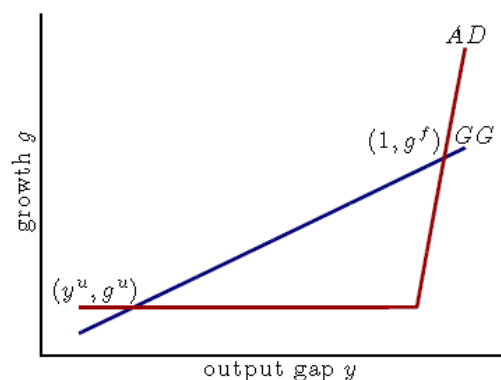


Figure 2.8: Full employment steady state and stagnation trap. Source: Benigno Furnaro (2015)

The GG curve is positive because, as already said, more production increases the firms' profits and hence the expected return of investing in innovation, leading to more growth. The AD curve has two sections, one upward sloping and the other flat. The positive relation between growth and output is where the zero lower bound is not binding, therefore as output rises the central bank increases the nominal rate; since inflation is constant the real rate rises as well, and this stimulates investments and growth. Because of the low elasticity of intertemporal substitution, higher growth also means higher demand for consumption. The flat portion of the AD curve is the liquidity trap section. The nominal rate is stuck at $i = 0$ and, as (2.35) shows, growth is lower and independent from output. Expectations on growth are what drive the economy toward one equilibrium or the other. If the expectations are positive, expected growth will sustain aggregate demand because of the income effect, and investments will actually be high because of the expected profits. But if growth expectations are weak, the economy falls in the liquidity trap: low expectations about growth and future income

depress aggregate demand, while the central cannot sustain full employment due to the zero bound; the economy operates below capacity, firms and investment in innovation are low and the initial expectations of weak growth are justified. Both equilibria are examples of self-fulfilling prophecies.

The results do not change when the model allows inflation to be variable, and function of the state of the economy. The source of price variations is the wages dynamic. Wages downward rigidity is modeled following Schmitt-Grohè Uribe (2012): $W_t \geq \psi(y_t)W_{t-1}$ with $\psi'(\cdot) > 0$ and $\psi(1) = \bar{\pi}$. This formulation of wages rigidity is very general, and allows wages to fall at a rate that depends on unemployment: wages become more flexible the more output is below its potential. Since prices are proportional to wages, the wage setting process produces a Phillips curve. The steady state Phillips curve is:

$$\pi = \psi(y) \quad (2.37)$$

Just as aggregate demand, the Phillips curve has two different regimes. If inflation is greater than $\bar{\pi}$, output is fixed at potential. For lower inflation levels however, the relation between output and inflation is positive, as the standard Phillips curves imply. This should suggest that the full employment steady state is unaffected by the presence of the Phillips curve, which flattens at that point. The unemployment equilibrium growth rate on the other hand becomes, plugging (2.37) in (2.35):

$$g^u = \left(\frac{\beta}{\psi(y^u)} \right)^{\frac{1}{\sigma-1}} \quad (2.38)$$

This equation shows a negative relation between growth and output in a liquidity trap environment. As output increases wages and prices rise, generating higher inflation (due to the Phillips curve). Since the nominal rate is fixed, the real rate goes down, lowering productivity growth.

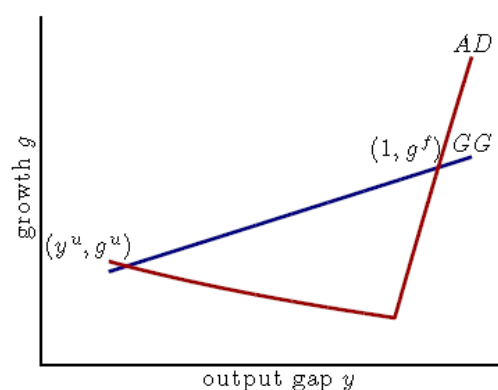


Figure 2.9: Steady states with flexible inflation. Source: Benigno Furnaro (2015)

This explains why the constrained portion of the aggregate demand is not just flat in the liquidity trap portion, as in the fixed inflation case, but negatively shaped. Inflation does stimulate output, but puts a burden on growth. This is visualized in figure 2.9, which represents the model once we include the Phillips curve.

2.3.2 Growth policies

Subsidies to innovation policies have been extensively studied in the context of endogenous growth models as a tool to overcome inefficiencies in the innovation process, but are not usually thought as a way to address aggregate demand problems. In this framework however, one of the roots of the reasons that the economy falls into stagnation is the limited incentive for firms to invest in innovation. It is natural then to consider public subsidies to investments as a way to get out of the trap. Since the unemployment steady state is characterized by low growth, and the lack of growth contributes to the shortcomings in aggregate demand, public subsidies to growth can effectively get the economy out of stagnation because of the twofold advantages they provide. We should in fact keep in mind the income effect that higher growth has on current consumption, and therefore aggregate demand. To be effective, the subsidy should loosen the link between profits and investment, incentivizing firms to invest even when their cost-benefit analysis would not call for it, and ensuring a minimum level of

growth regardless of the outside conditions. For simplicity, consider the fixed inflation case, where unemployment steady state growth is, as given in (2.35), $g^u = \left(\frac{\beta}{\pi}\right)^{\frac{1}{\sigma-1}}$, and we know there is another feasible, higher growth rate, g^f . The conclusions are not different if inflation is flexible. What the subsidy needs to do is ruling out the possibility of the low growth equilibrium: if investments are high enough to guarantee that growth is always relatively strong, the economy will converge to the full employment steady state. If the size of the subsidy is fixed and independent of the outside conditions, there could be inefficiently high investments in innovation at full employment; but if the subsidy is designed to be anticyclical, so that it kicks in only when output operates below capacity and growth is weak, the policy avoids inefficiently high investment when they are not needed. When the measure is set this way, it accomplishes the goal of avoiding a low growth stagnation without affecting the output level at full employment steady state. Figure 2.10 shows the economy before and after an anticyclical subsidy is implemented.

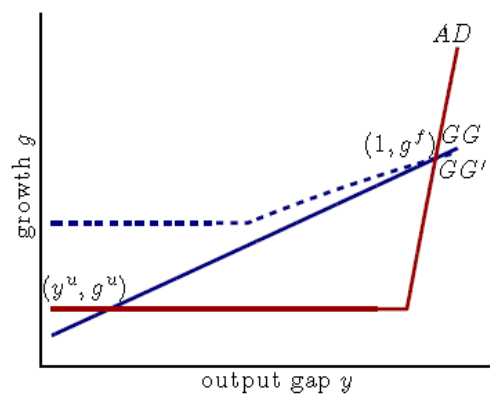


Figure 2.10: Effects of a countercyclical subsidy policy. Source: Benigno Furnaro (2015)

It is interesting to note how a typical supply-side policy, like subsidies to growth-enhancing investment, can play a role in stimulating aggregate demand and ruling out liquidity traps driven by expectations of weak future growth. In turn, the stimulus to aggregate demand has a positive impact on employment. In some regards then, we could say that this model offers a supply-side way out of stagnation. In the previous

stagnation model, however, we have seen the effects of supply-side policies when they are implemented during a period of economic underperformance. In that context in fact the paradox of toil holds: measures that increase the potential output actually decrease real output. Supply-side policies in a stagnating economy have opposite effects in these two frameworks: which result should we trust more? The reason behind this difference is the lack, in deleveraging models, of an incentive to the demand coming from the increase in potential supply. Eggertsson Mehrotra (2014) do not have in their model an endogenous mechanism responsible for growth, that is present and central in Benigno Furnaro (2015). From this perspective, the latter model is more complete and should be kept in higher regard. However, there are reasons to argue in favor of the former. First, we explained the importance of the assumption that $\sigma > 1$, that ultimately makes the growth-consumption relation positive. While we said that empirical estimations are consistent with this assumption, the actual size of the parameter is less clear. While Hall (1988) argues that the elasticity of intertemporal substitution may be around zero, Vissing-Jorgensen (2002) shows that for some households, especially those with higher asset holdings, the elasticity is higher, meaning that σ may be close to one, where the income and substitution effects cancel out. While the income effect is still likely to edge the substitution effect out, the incentive of growth on consumption may be of little practical significance. Secondly, the conclusion that technology improvements could have contractionary effects has some empirical evidence behind it. Basu Fernald Kinball (2004) indeed find that the paradox of toil holds in the short run: when technology improves, input use and investment demand and output itself fall. But it does not seem to be a steady state result, since they also see that, even if several years later, eventually investments return to normal and the expected output growth arrives. Our conclusion is therefore that supply-side measures should still not be considered the primary tool against a stagnation, because while they may stimulate demand, this effect could initially be not strong enough to offset contractionary pressures coming from deflation. However over a longer horizon, growth policies should show their effectiveness in sustaining investments, stimulating aggregate demand and employment during a liquidity trap and expanding output.

3 HYSTERESIS

Macroeconomic analysis is having a hard time explaining the slow recovery from the financial crisis. As we have seen so far, the deleveraging process was likely strong enough to push the economy in a territory where monetary policy was no longer effective: the zero lower bound on the nominal interest rate limited the ability of policy-makers to stimulate the economy. Practical constraints have also been present on the other main tool of economic policy, at least as far as the European situation goes. It appears clear that several European economies have gone and are going through a period of political and financial tensions over the ceilings and the sustainability of their public debts, and this has been a constraint on the will of governments to engage in expansionary fiscal policy as source of stimulus. While these demand-side factors have undoubtedly played a central role, it is unlikely that they alone can account for the extraordinarily sluggish movement of the economy back to the pre-crisis trend, and even less so can explain the damages that the trend itself seems to have suffered looking at the data. This leads to explore the contribution of supply-side factors, and especially the links between demand and supply issues. This is the basic, most general idea behind the theory of hysteresis: in the words of Krugman (2016), hysteresis means that “demand-side weakness now breeds supply-side weakness later”.

This chapter is divided in three paragraphs. The first one deals with the theoretical definition of hysteresis: the history of the concept, the different formulations it has had and the economic mechanisms that could be responsible for it. In the second paragraph, we go through some of the most recent empirical studies on hysteresis. The most recent financial crisis in fact caused a renewed interest for the subject and has provided new data to test the existence of hysteresis and try to quantify it. Then we present an original empirical work that, using data from the last ten years, tries not only to find evidences of hysteresis effects, but also to shed some lights on which channels seem to be relevant and which do not. Finally, the last paragraph is a policy discussion that links hysteresis with the liquidity trap and stagnation economics exposed in the second chapter. In particular, when we include the possibility of hysteresis the case for expansionary fiscal

measures becomes strong not only from an aggregate demand standpoint, but also from a supply-side and a public finance one.

3.1 Theory of hysteresis

While Phelps (1972) has been the first to point out that there are reasons for believing that recessions impose costs even after they end, the term hysteresis in the economic discussion is linked with Blanchard Summers (1986). They introduced the idea in the economic discussion when analyzing the issue of persistently high unemployment in Europe from the '70s on.

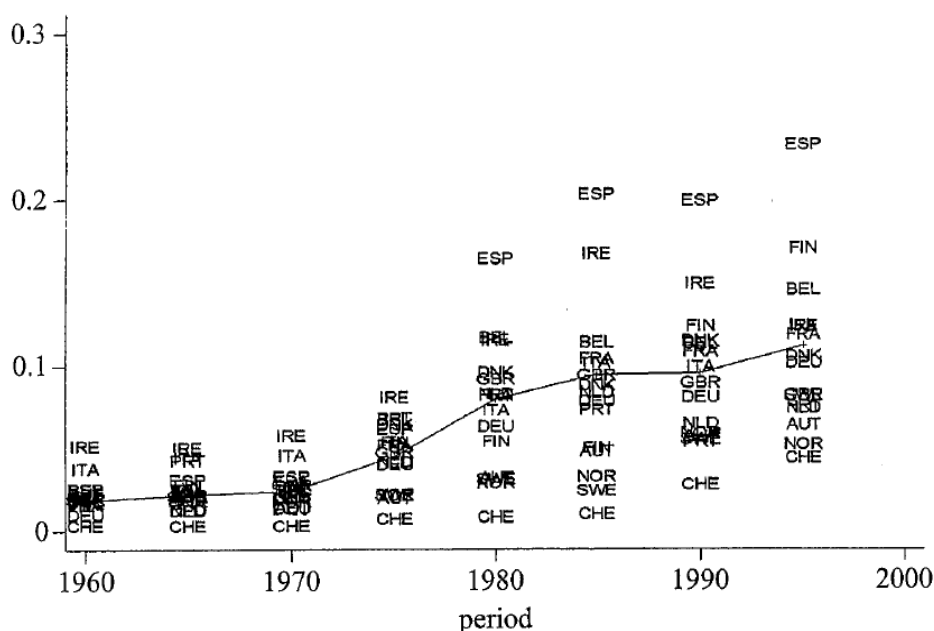


Figure 3.1: Unemployment rates over time for each Euro15 country and average. Source: Blanchard Wolfers (2000)

The rising unemployment in the '70s can be explained in standard terms, as the results of shocks hitting the economy from both the demand and the supply-side. Blanchard Wolfers (2000) identify three different negative phenomenon the most European economies had to go through in that period: real interest rates rose, total factor productivity growth slowed down, the labor share declined. All these factors can explain

why unemployment went up, but not why it has not gone down since. This persistence suggests that the past levels of unemployment have some reverberations on the present performances of the labor market, and of the economy in general. If this was true, it should not only hold for the European experiences after the '70s, but more generally for a more diverse group of economies. Indeed, considering the period from 1980 to 2005, all the major advanced economies show that unemployment is correlated with its past levels:

COUNTRY	1-YEAR AUTOCORRELATION	3-YEARS AUTOCORRELATION
Canada	0.7889	0.5080
France	0.8827	0.4950
Germany	0.8641	0.1443
Italy	0.8974	0.4302
Japan	0.9674	0.8248
United Kingdom	0.9155	0.5714
United States	0.8439	0.4133
Average	0.8800	0.4839

Fig. 3.2: 1 and 3-years autocorrelation coefficients of unemployment rate in the G7 countries, 1980-2005.

Data from April 2016 IMF WEO Database (own calculations)

These correlation results may very well not be an indication of persistence in unemployment. A very strong 1-year correlation is to be expected, since it is unreasonable to think that shocks that rise unemployment may be recovered in only 12 months. In 3 years the shock should have done its course, and the Germany result is the one we would generally expect; however, while the correlation is in fact lower, it is still on average substantial. Even if the autocorrelation is strong, it does not mean causality: we cannot say that past unemployment causes present one. To take a step further, we should understand what drives the autocorrelation.

What we would expect when a negative shock hits the labor market is not just that unemployment goes up, but more precisely that it moves away from the natural rate of unemployment, i.e. the rate of unemployment consistent with non-accelerating inflation. The effect of a transitory shock show on unemployment rate, but should leave the natural rate untouched. But if the natural rate of unemployment were not only a function of the structural, supply-side characteristics of the economy, but in some ways

of the actual unemployment as well, this may be the reason behind the observed persistence of unemployment rate. This is the first definition of hysteresis: when the actual unemployment rate increases, the natural unemployment rate moves up as well. This would explain the persistence without renouncing the idea that unemployment in excess of the natural one cannot live indefinitely without adjusting thanks to deflation. Let us call total unemployment in the short-run $u_{s.r.}$ is made of its natural component $u_{s.r.}^n$, plus the excess unemployment due to cyclical fluctuations. We decompose actual unemployment in its two component adding and subtracting the natural rate $u_{s.r.}^n$, so we get: $u_{s.r.} = (u_{s.r.} - u_{s.r.}^n) + u_{s.r.}^n$. Suppose that excess unemployment disappears eventually, in the long-run. However a fraction α of that excess unemployment adds to the natural part. By our assumptions then:

$$u_{l.r.} = u_{l.r.}^n = u_{s.r.}^n + \alpha(u_{s.r.} - u_{s.r.}^n) = (1 - \alpha)u_{s.r.}^n + \alpha u_{s.r.}$$

This very simple and generic framework highlights how the correlation between unemployment in the short and the long run may arise even if cyclical factors disappear. Instead of cyclical unemployment never adjusting back, a very troubling notion, we have a situation where cyclical fluctuation still have only temporary direct effects, but leave a mark on what we consider structural aspects of the system. While correlated, $u_{s.r.}$ and $u_{l.r.}$ are essentially different, because the short-run was characterized by low natural and high non-natural unemployment, while the long-run has high natural and low non-natural unemployment. In a deeper sense, the existence of hysteresis implies that a truly natural rate of unemployment does not even exist: since it can be altered, while not directly, by temporary shocks hitting the economic system, the natural rate is not the byproduct of core, supply-side aspects of the economy, but has a random element to it.

Why, and through which channels, should natural unemployment be affected by actual unemployment? The logical starting point is investigating labor market mechanisms. The argument Blanchard Summers (1986) considered most promising to explain the persistent unemployment relied on a combination of the role of insiders on the wage setting process and human capital deterioration.

The insiders argument lies on the premise that not all members of the labor force are equal in status. Some, the insiders, have input on the level of wages; the others, the outsiders, have to take the results of the wage setting process as a given instead. Who are the insiders? The simplest example are employed workers, while the outsiders are those literally out of a job. The problem of this situation is that insiders have a say on their wages. Suppose that all wages are set by bargaining between employed workers and firms, with outsiders playing no role in the process. How will insiders approach bargaining? They will be concerned with maintaining their jobs, and once that is safe, maximizing their income. Insiders are simply not concerned with expanding the employment base and helping outsiders get a job: they could actually jeopardize their chances. Suppose the bargaining works as a two stages game. First, insiders set the wage; then, firms decide how many people to employ. The insiders then just set the highest wage as long as the firms' best response is to hire all of them. The wage resulting from this process will be higher than the labor market-clearing one; it is the hypothetical market-clearing wage if the labor supply was made just of the insiders. The implications are interesting in both the absence and the presence of shocks. In the absence of shocks, any level of employment of insiders is self-sustaining, because they can always set the wage they desire. In the presence of shocks, employment would show the autocorrelation we discussed above: after an adverse shock, which reduces employment, some workers lose their insider status and the new smaller group of insiders sets the wage to maintain this new lower level of employment. The insiders bargaining process would imply that employment and unemployment show no tendency to return to their pre-shock value, but are instead determined by the history of shocks. While this example is simplistic and extreme, it highlights the underlying logic: if wage bargaining is a prevalent feature of the labor market, the dynamic interactions between employment and the size of the group of insiders may generate substantial persistence in employment and unemployment levels. Blanchard Summers (1986) developed a formal model that generate this results, even in a more general and realistic framework that allows for some outsiders to be hired in the aftermath of a positive shock. While we talked of the antagonism between employed and unemployed, the

most important example of insiders-outsiders dynamic in the labor market comes from the presence of unions, especially when we consider that the true importance of insiders is in their bargaining power.

Essentially, the human capital argument holds that those who become unemployed lose the opportunity to maintain and update their skills by working. This issue gets worse and worse the longer the unemployment period lasts, and the atrophy of skills makes the job profile of the unemployed progressively less attractive for the employers, in a vicious spiral. Ultimately, both disaffection from the labor force due to the inability to find a job and the reduced attractiveness of the skills of the unemployed could reduce the effective supply of labor, and the outside pressure that unemployment has on the labor market. This last point is essential, since the outside pressure is crucial to ensure that wages adjust: if the pool of people considered employable keeps shrinking, the long-term effect of a negative shock would be a reduction of the employment rate. Wages will adjust to a negative shock, whose first effect on the labor market is a reduction of the demand, only if the labor supply stays fixed. This argument has some similarities to the insiders-outsiders one, but the distinction between the groups here is skill-based. The main problem with this theory is how troublesome it is to gauge it quantitatively.

If we slightly change focus, we could talk about hysteresis not in terms of unemployment, but in terms of output; persistent actual unemployment means persistent output gaps. We theorized that the persistence in unemployment was actually due to the natural rate of unemployment going up, which would mean that present output causes future potential output to decrease from what could have been. From this perspective, the issue of explaining hysteresis becomes how the supply-side potential can suffer from demand weaknesses that open temporary output gaps. The link between the shortcomings in aggregate demand and diminished growth of the aggregate supply comes from the investment channel. Two different types of investments could be responsible: R&D expenditures and physical capital formation.

The reason why we think of R&D investments is the theoretical ground offered by the Keynesian growth literature, illustrated in the previous chapter. When the demand falls,

firms not only react employing less people, but also cutting down on the investments on innovation, for a couple of reasons: they have less resources to put into it because of lower present profits; the expected value of those investments is lower because of weaker prospects on the demand and therefore lower expected profits. In turn, lower investments in innovation should depress growth. While there are theoretical reasons to consider this channel plausible, the evidences are mixed. In line with the Keynesian growth framework, Bianchi Kung (2014) argue that the return on adopting existing technology varies significantly in response to changes in market conditions. However, they add that transitory disturbances are mostly absorbed by diffusion rates of new technology, not by changes on R&D because of the high adjustment costs attached to it. The optimal response by firms to cyclical fluctuations that impact the marginal return of technology would be adjusting technology adoption rates, not changing R&D expenditures, at least in the medium-run. Only if the depression has been, and it is perceived to be, lasting over a longer period of time, R&D would eventually go down.

The physical capital story simply holds that adverse shocks reduce investments in capital formation, for the same reasons described to explain why R&D expenditures should go down after a shock. The reduction in the overall capital stock of the economy has negative consequences on its productive potential. The main difference between a reduction in R&D and in capital formation is how those investments affect potential output. Assume the economy productive technology is given by a generic Cobb-Douglas function: $Y = AL^\alpha K^\beta$. The effects of reduction in R&D should mainly be encapsulated by the parameter A , while a reduction in capital formation should translate in a lower value of the variable K . While evidences for the link between cycle fluctuations and R&D are mixed, this link is clearer in the case of investments in physical capital, as we will see in the next paragraph.

3.2 Empirical evidences of hysteresis effects

As we have seen so far, there are solid economic arguments in favor of hysteresis being a real issue. While some of these arguments can be formally modeled, hysteresis is still

not part of a general equilibrium model yet. The reason that keeps the concept relevant in the academic discussion are the very strong empirical evidences behind it.

The following paragraph will show some of the empirical works on the matter, especially, but not only, from the experience of the last recession. In addition, we will present the methodology and the results of an original study we performed on the matter. We find further evidence of hysteresis effects while also testing a couple of possible channels responsible for it.

3.2.1 *The long shadow of the financial crisis*

An often cited study on the long-run harm of the financial crisis is Ball (2014). He showed that the Great Recession not only pushed the economy out of its pre-crisis trend, but shifted the trend as well. He takes OECD data on 23 countries: annual data on actual output and estimates of potential output made in 2014 against estimates of the levels that potential output would have attained if not for the recession extending the pre-crisis potential output series with log-linear extrapolation. The results show strong evidence of hysteresis: the weighted average of the loss in potential output, for the entire countries sample is 7.2% in 2013 and rises to 8.4% in 2015.

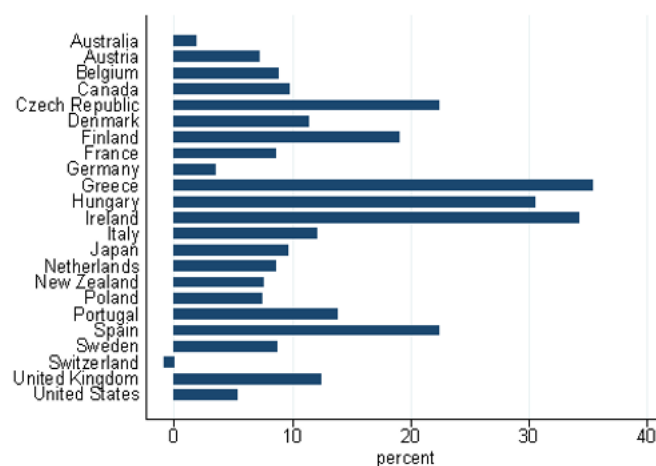


Fig. 3.3: Loss in 2015 potential output after the recession. Source: Ball (2014)

Those losses are proportional to how strong the countries were hit by the recession, with the countries that most suffered from the effects of the financial crisis also having the worst long-term repercussions. In some countries, while potential output has fallen significantly below its pre-crisis path, the current growth rate of potential is not far from its old normal: pre and post-crisis trends are roughly parallel. However, there are countries where the current growth rates of potential output are much lower than pre-crisis growth rates. Ball (2014) calls this phenomenon super-hysteresis. Countries damaged most by the Great Recession will do worse and worse over time relative to other countries and to their own pre-crisis trajectories. In his calculations in average growth rate of potential has gone down by 0.7%. Super-hysteresis makes even more urgent to revert the negative effects of a recession, since if potential growth rates remain at current depressed levels, then the losses of potential output relative to pre-crisis trends will continuously grow over time.

Hall (2014) has argued that the huge contraction in economic activity induced by the crisis produced lasting harms and led to an endogenous decline in capacity growth. The focus of his work is to assess the different components that account for the lost potential i.e. the relative importance of the channels of hysteresis. In his calculations the shortfall in output during the recession cumulated to 11.3 percent. He identified four main factors: lost total factor productivity; lost investment resulting in a lower capital stock; unemployment lingering after job creation incentives have returned to normal; persistent decline in labor force participation. Higher unemployment and a correspondingly lower employment rate accounted for 2.3 percentage points, lower factor productivity for 3.0 percentage points, the reduction in the capital contribution on account of the collapse of investment for 2.5 percentage points, while declining labor force participation and declining weekly hours of work respectively for 1.2 and 1.6 percentage points. These are the factors we would expect to be relevant from our theoretical discussion. In fact declining employment and participation rate can be explained by human capital deterioration and insiders-outsiders theories; the reduction in capital investment is expected after a recession and as a way to prolong its effects; total factor productivity growth could be a consequence of a drop in R&D expenditures.

An issue when discussing the topic of persistence in economic downturn is that while the data may fit the idea of hysteresis, the origin of the persistence may go the other way. The correlation between recessions and subsequent poor economic performance is consistent with two directions of causality. The causality may directly run from the recession to lower output later: hysteresis or super-hysteresis is in play. However, it may reflect reverse causality: supply-side shocks or the anticipation of lower output or lower growth in the future may lead in fact to a decrease in current consumption and investment spending. Blanchard Cerutti Summers (2015) try to assess whether is possible to distinguish between the two directions of causality, looking at a wider sample of recessions. First, they find that the correlation is not limited to the last recession: about two-thirds of recessions are followed by lower output relative to the pre-recession trend even after the economy has recovered and about one-half of them are followed by lower output growth relative to the previous trend. Regarding the direction of causality, the reverse causality case is not consistent with a recession triggered by a demand-side shock. If the initial shock was a supply-side one, we would naturally expect a present to future output correlation, but if the correlation is there also after a demand shock is much more likely that hysteresis is the reason. They find that, while recessions associated with supply-side shocks are more likely to be followed by lower output later, downturns triggered by demand shocks too tend to be followed by lower output or even lower output growth. Intentional deflations, the clearest example of demand shocks are still associated with lower output and lower growth nearly two-thirds of the times.

3.2.2 Empirical research: are the investments responsible for hysteresis?

What we wish to test on the data is the role that the investments channel plays in provoking hysteresis. The general mechanism would be the following: the initial shock on output reduces the investments, because of lower profits today, and hence less resources to invest, and of the lower future profits' expectations; less investments would then cause lower future potential output. In particular, we would like to identify if a particular class of investments is responsible for hysteresis. The two that have some

theoretical ground to be considered responsible, as we argued earlier, are investments in R&D and investments in capital formation. The econometric methodology and data treatment we will use is based on Fatas Summers (2015). We will use a two stages regression to capture the effects on potential output that the decline of investments have, for the component of that decline actually explained by the initial shock.

We take two time-series data on real output: the one from the IMF World Economic Outlook Database of April 2007 (the closest version of it before the crisis) and the one from the IMF World Economic Outlook Database of October 2015 (the latest version available). Because of data revisions, changes in base year and in national accounting rules, the two series are no immediately comparable. To solve this problem we rebase the 2007 series, so that Real GDP in 2006 is equal in both series. We do so by multiplying each element of the series from the 2007 database by 2006 GDP in 2015 data and dividing by 2006 GDP in 2007 data. Since the 2007 database does not provide GDP data beyond 2008, we computed the average growth rate of GDP in the period 1998-2008 to get GDP forecasts until 2020 through linear extrapolation.

We identify the shock of the Great Recession as the unanticipated reduction in real output in 2009. As a measure of it, we use the forecast error made in 2007 for the 2009 GDP: the difference between the actual output in 2009 and the forecast made in 2007,

as a percentage of the forecast: $F.E. GDP_i^{09} = \frac{GDP_{09,i}^{15} - GDP_{09,i}^{07}}{GDP_{09,i}^{07}}$.

Data on output gap, provided by the IMF, allow us to derive the implied potential output. For the comparison reasons explained above, potential output in the 2007 data are derived applying the output gap measure on the rescaled series. Up to 2016, potential output forecast in 2015 are explicit for all countries, but only for G7 countries there are forecasts up to 2020. For the other countries, we compute the average growth rate of potential output during 2005-2016 and use it to get estimates up to 2020 through linear extrapolation. As measures of the change in potential output, we use the revision in the forecast of potential output: the difference between the potential estimated in 2015 and the potential estimated in 2007, as a percentage of the original forecast. In order to get stronger results, we compute the revision of potential output over different time

horizons: 2012, $F.R.Pot_i^{12} = \frac{Pot_{12,i}^{15} - Pot_{12,i}^{07}}{Pot_{12,i}^{07}}$, 2016 ($F.R.Pot_i^{16} = \frac{Pot_{16,i}^{15} - Pot_{16,i}^{07}}{Pot_{16,i}^{07}}$), and 2020, $F.R.Pot_i^{20} = \frac{Pot_{20,i}^{15} - Pot_{20,i}^{07}}{Pot_{20,i}^{07}}$. The 2020 results should go with a caveat, since the 2020 values from both the 2015 and the 2007 databases are not explicit forecasts, but are derived via extrapolation.

Data for investments in R&D and investments in capital formation come from the World Bank database. They define “expenditures for research and development are current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, including knowledge of humanity, culture, and society, and the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development”. By definition of the World Bank gross capital formation investments “consist of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and work in progress”.

The change in investments is calculated taking the 2009 (post-shock) percentage change with respect to the 2007 (pre-shock) level:

$$\Delta R\&D_i^{09-07} = \frac{R\&D_{09,i} - R\&D_{07,i}}{R\&D_{07,i}}, \Delta Cap_i^{09-07} = \frac{Cap_{09,i} - Cap_{07,i}}{Cap_{07,i}}.$$

We use a sample of 18 countries, those, in the major advanced economies group, for which we have the complete data both in the 2007 and the 2015 databases: Australia, Austria, Belgium, Canada, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom and United States.

We begin our analysis showing some summary statistics about the variables in play:

	Mean	Std. Deviation	Minimum	Maximum
<i>F. E. GDP_i⁰⁹</i>	-0.0778039	0.0327009	-0.1564137	-0.002599
<i>F. R. Pot_i¹²</i>	-0.0921664	0.0500352	-0.2255597	-0.0120568
<i>F. R. Pot_i¹⁶</i>	-0.1405999	0.0750033	-0.3278598	-0.0153418
<i>F. R. Pot_i²⁰</i>	-0.1802044	0.094704	-0.4152659	-0.0161121
<i>ΔR&D_i⁰⁹⁻⁰⁷</i>	0.0587274	0.1003293	-0.0932211	0.3659832
<i>ΔCap_i⁰⁹⁻⁰⁷</i>	-0.16564	0.0871734	-0.3583309	0.0449517

Fig. 3.4: Summary statistics for forecast error of '09 GDP, revisions of '12, '16, '20 Potential, change in R&D and change in capital formation between '09 and '07

There is a lot to take away from this table. First of all, unsurprisingly, we see the shock of the financial crisis hitting all the countries: the average unexpected decline in real output in the sample is 7.8%, ranging from over 15% in Ireland to almost zero in Australia. What is very interesting to look at are the forecast revisions in potential output. The size of the average loss of potential ranges from 9.2% by 2012 all the way to 18% in 2020. When we weight the average by the pre-crisis size of the economies, the lost potential becomes 5.68% by 2012, 9.42% by 2016 and 12.69% by 2020: these numbers are more in line with the weighted averages found by Ball (2014). Not only potential output has gone down in every country, and over all time horizons; but those damages are on average larger than the initial shock, and increasing over time. Such revisions on potential seem to suggest not just persistence, but permanence of the damages from the recession. The fact that those revisions are increasing over time may also be a clue of super-hysteresis. Looking at the investments, R&D does not seem to have suffered much of a common variation (standard deviation is almost twice the size of the mean), but the evolution of capital formation investments show an average reduction during the crisis of over 16%, with a peak of almost 36% in Ireland, with four more countries over 20% (Finland, Spain, UK and US).

We start the econometric analysis of the channels through which the output reduction may have impacted the future potential with the R&D expenditures. Based on the methodology described earlier, we use the following specification:

$$\Delta R\&D_i^{09-07} = \alpha + \beta F.E. GDP_i^{09} + \varepsilon_i$$

$$F.R. Pot_i^{12,16,20} = \alpha + \beta \widehat{\Delta R\&D}_i^{09-07} + \varepsilon_i$$

Here are the main results:

	$\Delta R\&D_i^{09-07}$
$F.E. GDP_i^{09}$	0.2089995 (0.788)
α	0.0749884 (0.261)

Fig. 3.4: Coefficients and p-values of the 1st stage regression of R&D expenditures on real output forecast errors

	$F.R. Pot_i^{12}$	$F.R. Pot_i^{16}$	$F.R. Pot_i^{20}$
$\widehat{\Delta R\&D}_i^{09-07}$	5.63822 (0.780)	8.032601 (0.781)	9.766312 (0.782)
α	-0.4232846 (0.723)	-0.612334 (0.720)	-0.7537549 (0.717)

Fig. 3.5: Coefficients and p-values of the 2nd stage regression of potential output revisions on predicted R&D expenditures

The coefficients are not significant over all the horizons. The reason is that R&D expenditures appear to be flat over the time period considered, and, more importantly, not reactive to economic shocks: the coefficient of the first stage regression in fact is non-significant. The results are in line with Bianchi Kung (2014): even if the shock has been strong, in the immediate aftermath of it R&D investments are unlikely to react. This does not mean that we can exclude variation in R&D as a channel of persistence, but it does not seem to have played a role yet. A longer period of depressed demand may be needed before observing reduction in R&D and evaluate its effects.

We repeat the exercise using capital formation investments. The econometric specification we test is:

$$\Delta Cap_i^{09-07} = \alpha + \beta F.E.GDP_i^{09} + \varepsilon_i$$

$$F.R.Pot_i^{12,16,20} = \alpha + \beta \widehat{\Delta Cap_i^{09-07}} + \varepsilon_i$$

The first stage regression gives the following results:

	ΔCap_i^{09-07}
$F.E.GDP_i^{09}$	2.325766*** (0.000)
α	0.0749884 (0.548)

Fig. 3.6: Coefficients and p-values of the 1st stage regression of capital formation investments on real output forecast errors

Differently from the previous case, the coefficient of the first stage regression is very significant: the fall in capital investments can, at least partially, be explained by the initial shock. For each percentage point of unanticipated decline in output should result in a fall of 2.33% in capital formation investment. This is consistent with our expectation of such investments being pro-cyclical, motivated by the theoretical reasons already explained. Once we have established this, we look at how capital formation variations have impacted future potential output; since we have found a significant relation in the first stage, we can isolate the component of this variation the recession can account for taking the fitted values of the variation in capital formation. The table shows the results of the second stage regression.

	$F.R.Pot_i^{12}$	$F.R.Pot_i^{16}$	$F.R.Pot_i^{20}$
$\widehat{\Delta Cap_i^{09-07}}$	0.5066654*** (0.000)	0.7218309*** (0.000)	0.8776267*** (0.000)
α	-0.0082424 (0.662)	-0.0210359 (0.504)	-0.0348343 (0.394)

Fig. 3.7: Coefficients and p-values of the 2nd stage regression of potential output revisions on predicted capital formation investments

The coefficients this time are extremely significant and increasing in size as we spread the horizon. This suggests not only that capital investments have some role in determining the growth of future potential output, but that current output recessions have a role as well through those investments. The result may represent an evidence of the existence of hysteresis and of one of the channels responsible for it. The increasing coefficients over time suggest that super-hysteresis could be in play: the recession has not just reduced the level of potential output, but also its growth rate. Finally, looking at first and second stage together we can try to quantify the long-run impact of the financial crisis. For a 1% unanticipated reduction in real output in 2009, due to the channel of capital investments, potential output estimates have been revised downward by an estimated 1.18% by 2012, 1.68% by 2016 and 2.04% by 2020. When we consider that on average the recession has reduced real output by 7.8%, the loss of potential output explained by the cycle-induced variation of capital formation amounts to 9.2% of its pre-crisis level by 2012, 13.1% by 2016 and 15.9% by 2020.

The result is consistent with both what we said in the theoretical paragraph and with other findings in the empirical literature. Hall (2014) for example emphasizes how the collapse in business investment during the recession brought about a non-trivial drop in the capital stock, and that this is a relevant factor in explaining the persistent decline of output after the crisis.

While the result clearly show the correlation between falling output, investments and potential output, they are not conclusive evidence for direct causality, an hysteresis mechanism, that goes from falling output to falling potential output through capital investments. On the data in fact we cannot exclude the possibility of reverse causality between falling potential and falling output and investments. What would it be the economic interpretation of the reverse causality? We tackled the issue in the previous paragraph: supply shocks may be behind both the recession and the lower output later, like an exogenous decrease in underlying potential growth leading households to reduce consumption and firms to reduce investments, and therefore causing both the fall in potential and the initial recession. However, while the interpretation of the reverse causality case is consistent with supply-side shocks, the hysteresis interpretation is the

one consistent with a demand shock. The effects of a demand shortcoming would be a reduction of the current, actual output, but it would not explain directly the fall in future potential, if not through hysteresis. Hence, if the 2009 shock comes from the demand-side, the reverse causality would be unlikely to be what really happened, because its interpretation is much harder to reconcile with standard economic intuition. While financial crises are usually thought as a supply shock, they may also lead to a very large initial decrease in demand and thus to a decrease in both output and inflation. This has indeed found to be the case for the last recession: while it is true that the Great Recession has been triggered by a financial crisis, we should not rule out the possibility the shock hitting the economies around the world was mainly a demand shock. Mian Sufi (2014) have shown that deterioration in household balance sheets played a significant role in the sharp decline in U.S. employment between 2007 and 2009, and the result is not driven by industry-specific, supply-side shocks.

We also check if the shock was demand-side ourselves using the same criterion used by Blanchard Cerutti Summers (2015) in order to separate demand-side from supply-side shocks. The distinction is based on how inflation responds after the recession hits. Recessions with increasing inflation are more likely to be associated with supply shocks, while recessions with declining inflation are more likely to be associated with demand shocks. We used two different measures of change in inflation for this purpose: percentage change in average inflation from 2008 to 2009; forecast error for 2009 average inflation. According to both criteria we find evidence of deflation: for 18 out of 18 countries with the first measure; 16 out of 18 with the second. Since it seems quite clear that the 2007-2009 shock was a demand-side one, the direct causality interpretation of our results is validated and the evidence for a hysteresis mechanism being in play gets even stronger.

3.3 Preventing hysteresis: the case for fiscal expansion

If hysteresis is a concern, it follows that damages from a recession are far greater than usually considered: it would not only cost a lower actual output during the period of

underperformance, but also a permanent reduction of the full employment potential. Therefore, reducing the size and the duration of output gaps has long-run benefits, and counter-cyclical policy interventions may be considered appropriate in light of their trend effects. When we consider that a depressed economy could find itself stuck into a liquidity trap, fiscal policy becomes the main tool to avoid those losses. When we discussed secular stagnation, we have seen that expansionary fiscal measures move the economy in a more efficient steady state, therefore are effective in stimulating output long-term. The result is quantitatively stronger when the policy is financed through new public debt, which makes sense when we recall that one of the interpretation of the stagnation problem is an insufficient level of debt in the economy. However, we did not consider explicitly hysteresis and public finances consequences in that analysis. To argue on these matters we will use a simple framework developed by DeLong Summers (2012), showing the logic behind the derivation and the using it to derive some results of our own. Before continuing, it is important to note that the following is not a full economic model, but more of an evaluation framework, and while several parameters are introduced, no ex ante hypothesis on their values is made. The formulas should not be considered equations, rather identities.

We consider a depressed economy: one where the unemployment rate is higher than its natural rate ($u_t > u^f$), and therefore output is below potential ($y_t < y^f$). Let us add that the zero lower bound on nominal interest rates is binding, so monetary policy is not an option, and so the government decides for a fiscal expansion. When we evaluate the policy we should consider on the one hand the effects on output, both present and future, on the other the public finance implications.

The effects on present output of the fiscal expansions are:

$$\Delta y_t = \mu \Delta G \quad (3.1)$$

where μ is the fiscal multiplier and ΔG is the size of the fiscal stimulus. If hysteresis is a reality, the fiscal expansion has also future, permanent effects. Potential will be affected by present output gap by a hysteresis parameter η :

$$\Delta y^f = \eta \Delta y_t \quad (3.2)$$

Combining (3.1) and (3.2) and multiplying it by the tax rate τ , we get the long term tax increase due to the fiscal stimulus:

$$\tau\Delta y^f = \tau\eta\mu\Delta G \quad (3.3)$$

On the financing side of it, let us suppose that the government finances the stimulus by issuing new debt ΔD , equal to:

$$\Delta D = (1 - \mu\tau)\Delta G \quad (3.4)$$

The short-run effects of the stimulus on output allow financing part of it because of higher tax revenues. If the government does not want to increase its long-term debt-to-GDP ratio, the additional debt burden, given the economy's long-run growth rate g and the real government borrowing rate r , is:

$$\Delta D(r - g) = (r - g)(1 - \mu\tau)\Delta G \quad (3.5)$$

So, as long as the increase in tax revenues is higher than the additional tax burden, the fiscal expansion would be neutral from a public finance perspective. The saved hysteresis would make the stimulus self-funding. Comparing (3.3) to (3.5) and rearranging, we derive an interest rate condition for this to be the case:

$$r \leq g + \frac{\tau\eta\mu}{(1-\tau\mu)} \quad (3.6)$$

When (3.6) holds, a debt-financed fiscal expansion actually improves the prospective public balance sheets. This is the best possible result for a cost-benefit analysis of debt-financed spending, since there no costs at all. In this case, arguments that a depressed economy cannot afford fiscal expansion because the government dare not raise its debt completely lose ground. Arguments that curbing spending today is a good strategy during a depression, because demonstrating the credibility of their long-run fiscal strategy would have benefits due to increased confidence also fail, since cutting spending does not improve but rather worsens the long-run fiscal picture.

As we said, the condition expressed in (3.6) is neutral in a sense: we have said nothing about the value of the parameters, and, in turn, it may hold or not. A spending measure will be likelier to pass this test if the borrowing rate is lower, or the hysteresis and fiscal

multiplier parameters are higher. Regarding the interest rate, a depressed or stagnating economy could find itself with the nominal rate at zero. While the interest rates we dealt with discussing stagnation are not exactly what we are talking about here, the prevailing real rate of the economy and the nominal rate set by the central bank are clearly correlated with the rate at which the government finances its debt.

As far as hysteresis goes, the theoretical and empirical discussion in this chapter should convince that the parameter η is indeed higher than zero. However, it is not easy to quantify these hysteresis effects, and it is especially hard to encapsulate them in a single parameter: the factors that cause a downturn may continue to have an impact once the downturn has ended, which is difficult to disentangle from hysteresis itself. Surveying the literature, Blanchard Summers (1986) find evidences to argue for an η that goes from 0.065 all the way to an 0.34, and even this could be a conservative measure. Fatas Summers (2015) in fact measured the effects on potential output of fiscal consolidation policies, and consistently found, with different econometric specifications and over different time horizons, coefficients, which should be considered a reduced-form estimation of the parameter η , always higher than one. This same conclusion is reached by our study, presented in the previous paragraph: the product of the coefficients in the two stages can be interpreted as an estimated value for η , and it ranges from 1.18 to 2.04 depending on the time horizon considered to measure future potential output.

The size of fiscal multiplier is a long debated theme. A line of thinking going back to Taylor (2000) has been skeptical about the effects of discretionary fiscal policy, with the size of multiplier then being close to zero. Romey (2011) surveys the literature to identify the different methods utilized to calculate it and the different estimates. She concludes that “the range of plausible estimates for the multiplier in the case of a temporary increase in government spending that is deficit financed is probably 0.8 to 1.5 (...) If the increase is undertaken during a severe recession, the estimates are likely to be at the upper bound of this range.” (pp. 680-681). In another survey conducted by Romer (2011), the average multiplier found is around 1.5, while suggesting that econometric estimates are downward biased, since, in times of normal economic performance, the effects of a fiscal measure would be partially offset by monetary policy. This last point is

particularly important in the discussion about multiplier, and even more so in the context of this work. Our analysis of stagnation economics is consistent with the idea that multipliers would be larger in such context than in normal times, or equivalently that the magnitude of fiscal multipliers is anti-cyclical. First, because of the binding zero lower bound, central banks cannot offset the short-term effects on economic activity of a fiscal measure. Indeed, Eggertson Mehrotra (2014), giving to the parameters of their model standard values, find that multipliers are higher than two, for a debt-financed stimulus in a liquidity trap. Moreover, when output and income are lower, and agents are financially constrained, consumption may depend more on current income than on future income, leading to larger multipliers (Eggertsson Krugman (2012)). Blanchard Leigh (2012) performed an econometric analysis that corroborated these intuitions: they found that, the actual multiplier of fiscal consolidations during the recession was about one full point higher than estimated by the IMF, whose estimate of the multiplier were based on periods of good economic performance. Since the original IMF multiplier is around 0.5, this would mean an actual multiplier of 1.5.

Given all this, it is likely that, in a depressed economy, expansionary fiscal policy is actually self-funding, or equivalently that the parameters present in (3.6) are such that the condition is satisfied. In the following table we show critical borrowing rates for the government below which (3.6) holds and expansionary fiscal policy is self-financing, as a function of μ and η .

Hysteresis η	Fiscal Multiplier μ				
	0	0.5	1	1.5	2
0	0.90%	0.90%	0.90%	0.90%	0.90%
0.05	0.90%	2.31%	4.83%	10.61%	37.57%
0.1	0.90%	3.72%	8.76%	20.31%	74.23%
0.15	0.90%	5.13%	12.69%	30.02%	110.90%
0.2	0.90%	6.54%	16.61%	39.72%	147.57%
0.25	0.90%	7.95%	20.54%	49.43%	184.23%

Fig. 3.8: Critical borrowing rate for debt-financed fiscal expansion to be self-financing in Italy (own calculations)

We calibrated the other two parameters, the growth rate and the tax rate, on levels representative of the Italian situation. τ is set at 0.44, looking at the OECD data on tax revenues as a percentage of GDP; g is set 0.9%, in line with the IMF forecast of growth in their longest horizon available (2021), when the projected output gap is very close to zero. We consider only plausible values of all the parameters involved, and when in doubt, we opted to stay conservative, to avoid influencing the results. The results show that exist a wide range of entirely plausible values of fiscal and hysteresis multipliers consistent with a self-financing fiscal stimulus. For instance, if long-run damages from hysteresis are 10% of the current recession, and the fiscal multiplier is 1, the critical borrowing rate is 8.76%. In those conditions, the stimulus is self-financing if the real borrowing rate is below that threshold. We evaluate which of the critical rates fail the test (red cells) and which ones pass the test (green cells) looking at the latest emission of 30 years bonds by the Italian Treasury. The yearly coupon rate on those bonds is 2.70%, so we flagged as red where the critical rate is higher than that.

Even minor counter-hysteresis benefits from expansionary fiscal policy are sufficient not to impose additional financing burden on taxpayers. The government will borrow, spend to boost the economy and use the extra revenues from a healthier economy to repay, at least partially, its debt. The idea that fiscal stimulus can be self-financing thanks to higher revenues later for certain values of the parameters implies that it will pass a cost-benefit analysis for an even wider range of parameters. As before, the benefits from such a policy are a boost to aggregate demand that leads to higher current production and income, and an increase in future potential output, due to the smaller shadow cast on future growth by a shorter and less harsh recession. When not self-financed, there are costs to undertake: the reduction of future output caused by the higher taxes needed to amortize the debt incurred to finance the fiscal expansion. The conclusion that fiscal expansion may be self-financing is at least partially a point about how the markets value government bonds. It is crucial that the investors perceive public debt as a safe form of investments. This would not be possible if debt instruments were unattractive, or a default on the debt considered a true possibility: this would push the borrowing rate up, making it higher than the risk free, time discount rate. It is possible

to use a more general valuation framework for a cost-benefit analysis that includes the additional features described here: possible distortions of future potential output due to higher taxation and a spread on the interest rate to compensate for the country risk. The policy will pass the cost-benefit test if the sum of discounted effects on present and future GDP of transitory fiscal expansion outweighs the lost future output because of higher taxation and the debt amortization burden. The value of the policy is:

$$\Delta V = \left[\mu + \frac{\eta\mu}{r-g} + \frac{\xi\eta\mu\tau}{r-g} - \frac{\xi(r+\rho-g)(1-\mu\tau)}{r-g} \right] \Delta G \quad (3.7)$$

where ξ is the reduction in future potential output from raising an additional euro of tax revenues, and ρ is the spread between the real social rate of time discount and the government's real borrowing cost. Considering the right-hand side of (3.7), the first term is the multiplier μ . Then there is the hysteresis term, $\frac{\eta\mu}{r-g}$: the present value of the reduction in the long-term shadow cast by the recession. The last part is the impact on future potential output of the net burden of additional debt, equal to the net impact on government cash flow. This component is made of two terms, a positive and a negative one. The first, $\frac{\xi\eta\mu\tau}{r-g}$, is the effect on potential output from lower tax distortions made possible by the counter-hysteresis effects of the fiscal expansion ΔG . This is another positive consequence of a fiscal measure. The second and negative one is the burden of amortizing the extra debt needed to finance the fiscal expansion. When this term is equal to zero we go back to the previous case, where the policy is self-financing. Even if this term is negative, the expansion still can create value, if the positive terms are large enough to offset it, so that the overall multiplier of the stimulus ΔG is positive.

In conclusion, this paragraph should give the sense that fiscal expansion gains can be as much in the long-run as they are on the short-run. Of the terms in (3.7) in fact, only the first one in the brackets, μ , represents a short-run effect. The presence of hysteresis makes the arithmetic of fiscal expansion particularly attractive, since preventing hysteresis represents a long-run benefit of the measure. Still, the policy does not necessarily rely on huge hysteresis benefits to be considered successful: we showed how a relatively low η , smaller than several actual estimates, is enough to pass a self-

financing test. However, this does not want to be an argument in favor of fiscal spending, at all costs and conditions. If the economy is working at full capacity, or close to it, the multiplier is likely to be small, since μ takes into account the typical monetary policy reaction function: the central bank will not allow the interest rate and aggregate demand to deviate from its desired path, and will thus attempt to offset the stimulus. Only in a depressed or stagnating economy, with interest rates at the zero bound, the central bank may lack the power to manage aggregate demand, and higher multipliers are likely. Also, even in a depressed economy, discretionary fiscal policy may fail the cost-benefit test if there is a substantial spread between the borrowing rate for the government, which determines the burden of the debt, and the social rate of time discount. High ρ countries, that borrow at very taxing terms or that would receive a market reaction to new debt issues that forces them to such terms, will not find the arithmetic of expansionary fiscal policy favorable. While this is a concern for a country like Italy, the present situation, with borrowing rates driven down by the ECB policies, could present an opportunity to use fiscal tools to tackle on the issues of double digits unemployment rate and weak long-run growth: improvements on those fronts are also necessary for a credible debt reduction strategy.

4 CONCLUSIONS

This thesis tries to systematize, blend and offer evidences to a group of ideas with separate origins. The idea of secular stagnation has been around since the '40s, and has come back in the last years as an evolution of the liquidity trap economics; hysteresis is also a dated concept that the latest economic crisis has brought back into discussions. We think that those two theories share a common ground and complement each other, giving a comprehensive take of how stagnation economics works. The secular stagnation story is about inadequate aggregate demand, not aggregate supply. Even if the economy's potential output is growing, depressed investment and consumption spending will prevent the economy from reaching that potential. However, because of hysteresis, secular stagnation will ultimately reduce aggregate supply as well, since growth in the economy's productive capacity is restrained by reduced capital formation and by the loss of workers' skills caused by a long period of unemployment.

The question of whether this theoretical framework is the right one to understand the current economic reality remains partially open. At the core of the secular stagnation hypothesis, there is the assertion that the natural real rate of interest is negative. It is difficult to have an exact idea of what the real rate really is at any given moment, but the picture it emerges from looking at the current situation seems consistent with real rates being close or even below zero.

Country	10-Year Government Bond Yields	2016 Inflation Rate
Canada	1.11%	1.35%
France	0.41%	0.40%
Germany	-0.01%	0.48%
Italy	1.51%	0.16%
Japan	-0.18%	-0.18%
United Kingdom	1.13%	0.77%
United States	1.60%	0.81%

Fig. 4.1: 10-year government bond yields as of June 14th 2016 and 2016 inflation rate for the major advanced economies. Data from IMF, Bloomberg.com

However, secular stagnation is not the consensus interpretation of the economic conditions of the last years. Hamilton et al. (2015) examined the dynamics and the determinants of the equilibrium real interest rate in the U.S. economy, in order to find out if the rate has actually moved downward over the last years, and how much so. They find that changes over time in subjective discount rates, financial regulation, trends in inflation, bubbles and cyclical fluctuations have had important effects on the real rate over any given decade. They consider the secular stagnation hypothesis to be unpersuasive, arguing that it probably confuses a delayed recovery with chronically weak aggregate demand. The secular stagnation argument may not distinguish in fact between a medium-term post-crisis problem and a permanent damage. Their analysis suggests that the current cycle is not essentially different from the last two: the equilibrium rate may have fallen, but probably only slightly. They conclude that the economic mindset over the last decades may have shifted too dramatically, from the optimistic “Great Moderation” years to the much more pessimistic idea of secular stagnation. The truth may lie somewhere in between. Some of the growth periods were indeed the byproduct of asset bubbles, while some of the symptoms of stagnation may simply be due to cyclical fluctuation. They conclude that the weak economic recovery of the past five years is not enough to argue in favor of secular stagnation.

Bernanke (2015) also tries to explain the low interest rates, and does not agree with the stagnation hypothesis. First, he questions the economic sense of negative real interest rates. If real rates are expected to be negative indefinitely, literally every investment should be profitable. Moreover, a shortcoming of secular stagnation is that it focuses only on domestic factors, like capital formation and domestic household spending. But nowadays households and firms can also invest abroad, where factors such as slowing population growth may be less relevant: unless the whole world is in the midst of secular stagnation, attractive investments should exist somewhere. He proposes an alternative explanation of the low rates that posits the main reason for low interest rates in many countries was a global excess of desired saving over desired investment, emanating for the most part from Asian emerging economies and oil-producing countries. He refers to this situation as a global savings glut. The secular stagnation and the global saving glut

ideas agree that there is an excess of savings over investment, implying substantial downward pressure on market rates. However, Bernanke prefers the latter because of the global perspective, while stagnation usually refers to domestic issues. It is more likely to him that the excess of desired saving is caused by international political decisions, like the ones taken by the emerging economies to reduce borrowing and build international reserves, than by fundamental factors like low capital needs and especially like slow population growth.

While all those points have validity, they are not enough to disprove the idea of secular stagnation. If this last recession was the result of a normal business cycle, we would expect the strength of the recovery to be proportional to the size of the collapse, but this has clearly not been the case. In the U.S. there has been some growth but the real test will be how growth progresses from now on: if the recent growth continues, if it creates a full recovery in employment and if the economy is able to withstand higher interest rates, the fear of secular stagnation can be legitimately reduced.

The argument that real interest rates cannot be negative in the long-run because it does not have economic sense has several counterarguments. Credit risk, credit constraints and uncertainty over returns are just some of the factors that may generate negative returns in an economic model; even if those particular mechanisms were not considered convincing, the interest and inflation rates we have seen above give enough reason to believe that negative real rates are at least a practical possibility.

The interpretation of secular stagnation as a purely domestic problem, inconsistent with open economy considerations, does not seem to be so definitive. Responding to Bernanke, Summers (2015) argues that in order to really understand stagnation, a global perspective is actually necessary. Currently, many major economies are in cyclically weak positions, so that foreign investment opportunities for households and firms are somewhat limited. The lower level of rates, the greater tendency towards deflation, and inferior output performance in Europe and Japan suggests that the specter of secular stagnation is greater for them than for the United States. In fact, many of the points

made by Hamilton et al. (2015), while valid for the U.S., lose traction when looking at the evolution in those other countries.

The distrust in fundamental factors problems when explaining the low rates does not seem justified. Population growth, one of those core aspects of an economic system considered a determinant of secular stagnation, is at levels that fit the theory:

Country	Population Growth Rate in 2015	Average population growth rate 2016-2021
Canada	0.92%	0.92%
France	0.46%	0.63%
Germany	0.86%	0.30%
Italy	0.02%	0.37%
Japan	-0.15%	-0.40%
United Kingdom	0.77%	0.68%
United States	0.77%	0.86%

Fig. 4.2: Population growth rate for the major advanced economies in 2015 and average estimated population growth rate from 2016 to 2021. Data from April 2016 IMF WEO Database

Weaknesses in many countries' demographics are indeed a reality. This does not mean that secular stagnation is ultimately a valid theory, but it should not be dismissed arguing that the fundamental factors are solid.

Overall, we believe that the lenses of stagnation economics are the most appropriate to capture what plagues, with different degrees, most advanced economies. But, even if secular stagnation were not what is going on right now, this does not diminish the importance of having a unified theory of stagnation economics, since it provides a scheme to identify its symptoms and a rulebook of the appropriate policy responses.

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STAGNATION ECONOMICS

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Advanced Macroeconomics

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Is it possible for economic recessions to have long-lasting effects? Can a deviation from the full employment equilibrium due to a (either supply-side or demand-side) shock, and the consequent output gap, become permanent and/or irretrievably damage the structural aspects of the economy, so that the pre-shock situation is never restored? Examining this possibility and the mechanisms through which it may happen is the focus of this work. We will argue that there are two main channels of persistence: the economy cannot escape a depressed state after an initial shock pushes it there, resulting in a persistent stagnation; the economy suffers from a reduction in its future potential due to the present recession, a phenomenon known as hysteresis. This thesis shall show the inadequacy of the stark separation, in textbook macroeconomics, between the analysis of short-run fluctuations and long-run growth models. Policy implications on how to deal with, and possibly prevent, long-lasting depressions are then drawn.

We will start examining stagnation. When a shock pushes the economy into a recession, we would expect some adjustment processes (both stabilizing policies and market forces) to kick in and get the economy back to full-employment in a rather short period of time. If those mechanisms do not work, the economy is not simply pushed away from its original steady state temporarily, but the new situation characterized by output gaps could be the new steady state. The phrase secular stagnation was first introduced by Hansen (1939), that argued that, since population growth and technological innovation were slowing down, insufficient investment spending and reduced consumption by households would then prevent from reaching full employment for a long period of time. The weak recovery of the U.S. economy after the Great Recession led Summers (2013) to bring it back into discussion. It would be easier to understand it if, during the last decade or so, the real interest rate consistent with full employment had fallen to negative. If that was the case, the artificial stimulus to demand coming from the early

'00s financial imprudence would not have caused excess demand, and the resumption of normal credit conditions after the financial collapse would not be enough to restore full employment. We will see two approaches that generate such a result, one based on the persistence of deleveraging shocks in an overlapping generations environment, the other on the link between trend-growth and current consumption. They both rely to some extent on the presence of some features of the economic environment, that appear to be necessary conditions in order for a stagnation to happen.

The first of those features is the zero lower bound on nominal interest rates, which creates the problem of the liquidity trap. This is a truly essential feature, since it prevents monetary offset, the main policy tool to stabilize the economy during cyclical fluctuations, from being effective. While the first formulations of the theoretical idea of a liquidity trap comes from in Keynes and Hicks, the theory behind it has then evolved, and our understanding of the liquidity trap now is that it is fundamentally a credibility problem faced by the central bank. Since usually part of the job of policy-makers is to convince agents of their commitment to price stability, they have a hard time convincing of a long-lasting commitment to stimulating inflation. Generating inflationary expectations is key to achieve actual inflation, but it is problematic when the usual conduct of policy makers is to reverse their policies immediately after the first signs of inflation kick in.

Wages rigidity is another consequential aspect of an economy. The basic market correction we could anticipate after a rise in unemployment is for the wages to go down, so that labor demand can be always consistent with full employment. In presence of frictions, this correction may not happen and the unemployment may remain high. Frictions in this regard are not just possible, but likely, hence making this assumption a reasonable one to include. As we will also point out later, the possibility to simply reduce this rigidity, without eliminating it, could be ineffective in preventing the harm it creates.

Lastly, another area of focus are constraints in private indebtedness. Is there a limit on the level of debt households and firms can hold? Is this level somewhat tied to the business cycles? The fact the only a certain level of debt is deemed acceptable, for risk-

aversion or even regulatory reasons, makes sense. As shown by Minsky, the attitude toward risk seems to be pro-cyclical, and “Minsky moments”, where agents are forced to deleverage to conform to a reduced debt limit, are not uncommon. This was indeed the case during the recent financial crisis.

Now that we have the most crucial hypothesis all set, let us expose how a deleveraging shock can drive an economy in a recession, based on a model present in Eggertsson Krugman (2012) and then expand on this idea to see how this recession could become a, possibly secular, stagnation. Consider a group of households, who only differ in their rate of time preference. Leverage constraint binds only borrowers, so they are forced to deleverage in the short-run when an exogenous shock lowers the maximum acceptable indebtedness. If the shock is such to push the equilibrium real interest rate below zero, where the zero lower bound prevents the central bank to go, it is impossible to maneuver nominal interest rates as it would be optimal to do. Fisherian debt deflation further increases deleveraging and the downward pressure on real rates. Sticky prices and wage rigidities are such that real effects on output happen. Still, this is a model of short-run effects: in the long-run, the real rate is always at the level implied by the rate of time preference.

Eggertsson Mehrotra (2014) add an overlapping generations dynamics to the previous setting, and this could crystalize the economy in a deflationary, high-unemployment steady state. Now young people are responsible for the loans demand, middle-aged provide the funds for the loan supply, while old people simply consume all their resources. The deleveraging shock not only reduces the loan demand of the young, it also increases in the following period the loan supply: middle-aged have now more resources, because they have less debt to pay back from their young days. Both aggregate demand and supply specifications have two regimes in an inflation-output space. Aggregate demand is downward sloping for positive nominal rates because the central bank more than proportionally offsets inflation, but becomes upward sloping when the zero lower bound binds, because inflation reduces the real rate, thus increasing consumption. Aggregate supply is fixed at potential when wage downward rigidity does not bind, but when deflation is such that the real wage is not consistent

anymore with full employment, a positive relationship between inflation and output arises. In such conditions, two equilibria are possible, based on the natural real rate of interest determined on the loans market. If the real rate is positive, the aggregate demand curve intersects the aggregate supply curve in its vertical section: the steady state of the economy has full employment and positive inflation. Demand-side shocks could hit the system, but as long as they are not large enough so that the natural rate becomes negative, the equilibrium is actually unaltered: the central bank will fully offset these shocks via cuts in the nominal interest rate.

However, if the shock is large enough to push the real rate in the negatives, the curves no longer intersect in the traditionally shaped sections of the aggregate supply and the aggregate demand. The new outcome is a long-run high unemployment, deflationary liquidity trap: a secular stagnation. Considering a deleveraging shock, reduction in the debt capacity reduces output for any given inflation rate, since younger households' consumption declines: they cannot borrow as much as before to finance their spending in the early stages of their lives. In the normal equilibrium, to this drop in spending would correspond a drop in the interest rate, which restores spending back to where it was before the shock. The zero lower bound, however, makes monetary policy ineffective and prevents the adjustment. Hence, the shock moves the economy off the full employment segment of the supply curve and in a deflationary equilibrium where the nominal interest rate is zero. Here, steady state deflation raises steady state real wages, thus depressing demand for labor and contracting output. It is important to note that not only there is actual deflation, but also that inflation is below the inflation rate targeted by the central bank in its policy rule.

The particular shape (and the economics behind) the aggregate demand and supply curves described give rise to several results that seem to contradict mainstream economics. Those results can be thought as "Keynesian paradoxes", and they have massive policy implications. The paradox of toil states an increase in potential output decreases actual output, because increases deflationary pressures in a depressed environment. Another is the paradox of flexibility: increasing prices/wages flexibility does not help the adjustment toward full employment, but actually worsen things off

due to added deflation now possible. The paradox of thrift means that increased desired savings actually decreases aggregate savings, because it would further reduce real rates, therefore reducing output/income from which to save. An economy like the one described is also victim of the so-called timidity trap: monetary policy cannot get any traction in pushing the economy out of a stagnation liquidity trap by increasing the inflation target, if does not increase it enough. While traditional monetary policy is powerless because of the liquidity trap, an increase in the inflation target can be effective, if substantial and credible, because inflation is exactly what this economy needs. Fiscal policy on the other hand is extremely effective: Ricardian equivalence breaks down in this depressed setting and the expansionary effect is even stronger if the stimulus is financed through public debt, since more debt could counteract the excessive loan supply.

Another approach to explain stagnation focuses on the link between present consumption and productivity growth. While the reasoning behind it is different from the previous model, the result is still a high unemployment steady state. The model, presented in Benigno Furnaro (2015), which produces this result is an endogenous growth model of vertical innovation, where the Keynesian rigidities described above, wage rigidities and zero lower bound, are added. The interaction between aggregate demand and productivity growth is such that an equilibrium with high unemployment and low growth is possible: lower demand results in lower firms' profits and thus investments. This in turn reduces productivity growth, which, since it is a key determinant of future income, reduces current consumption as well: if we assume a fairly low level of elasticity of intertemporal substitution, in line with empirical measures, an income effect creates a positive relation between current and future consumption. The liquidity trap prevents the central bank from sustaining aggregate demand.

How do we get out of such a stagnation trap? Since the steady state is characterized by low growth, and the lack of growth contributes to the shortcomings in aggregate demand, public subsidies to growth can effectively rule out the stagnation steady state. A typical supply-side policy, like subsidies to growth-enhancing investment, can play a

role in stimulating aggregate demand and ruling out liquidity traps driven by expectations of weak future growth. In turn, the stimulus to aggregate demand has a positive impact on employment. In some regards then, we could say that this model offers a supply-side way out of stagnation. This result apparently contradicts the “paradox of toil” described above, where measures to expand potential output have negative effects on actual output. Is it possible to reconcile those opposite results? The difference is probably in medium and long-run effects of growth policies. They may stimulate demand, but this effect could initially be not strong enough to offset contractionary pressures coming from deflation. However over a longer horizon, growth policies should show their effectiveness in sustaining investments and stimulating aggregate demand.

Moving on to the other major channel through which the effects of cycle fluctuations can become persistent, if not permanent, we get to hysteresis, the idea that demand-side weakness now breeds supply-side weakness later. The idea of hysteresis was first brought up in the ‘80s to explain the long period of high unemployment in Europe. Recession could cast a long shadow on future employment dynamics, and the economy could not get back on the pre-shock trend. Why should this be the case? One mechanism could be the role that unions play in the wage-setting process, and more in general on collective bargaining. Since unions prioritize the interests of insiders, like the employed ones, over reaching full employment, they do what they can to keep wages from falling in response to rising unemployment; preventing the wage adjustment could cause long periods of high unemployment. Another explanation could be that being unemployed for a long period of time makes the skills less and less valuable, and unemployed people become more disenfranchised from the labor force: the longer one is unemployed, the less likely it becomes for him to get a job. Finally, the link described above between current demand and growth productivity can explain why the potential output, not just the actual one, could be harmed by a recession. We can look at hysteresis not only as increased natural unemployment, but as reduced potential output. The issue of explaining hysteresis then becomes how the supply-side potential can suffer from demand weaknesses that open temporary output gaps. The link between the

shortcomings in aggregate demand and diminished growth of the aggregate supply comes from the investment channel. Two different types of investments could be responsible: R&D expenditures and physical capital formation.

An empirical literature has grown, especially after the financial crisis, trying to find evidence of hysteresis. A big challenge is the nature of potential output, which is an estimation and not something directly measurable. Revisions in output forecasts are used as proxy of change in potential output. In the aftermath of the crisis, there are evidences of hysteresis in almost every country and even super-hysteresis (reduction not only in potential, but also in the growth rate of potential) in those countries that were hit the worst. Looking at a wider range of recessions, the vast majority of them are followed by hysteresis. To distinguish between “true” hysteresis and the reverse causality case, where agents’ realization that potential output will be lower causes actual output to fall because of income effect, only demand-side, deflationary recessions are considered: even in those scenarios hysteresis effects are observed most of the times.

We performed an original empirical analysis, wishing to test on the data the role that the investments channel plays in provoking hysteresis. The general mechanism would be the following: the initial shock on output reduces the investments, because of lower profits today, and hence less resources to invest, and of the lower future profits’ expectations; less investments would then cause lower future potential output. In particular, we would like to identify if a particular class of investments is responsible for hysteresis. The two that have some theoretical ground to be considered responsible, as we argued earlier, are investments in R&D and investments in capital formation. The econometric methodology and data treatment we will use is based on Fatas Summers (2015). We will use a two stages regression to capture the effects on potential output that the decline of investments have, for the component of that decline actually explained by the initial shock. We use a sample of 18 countries, those, in the major advanced economies group, for which we have complete data on real output and potential output both in the 2007 and the 2015 databases. The econometric results depend on the types of investments we consider. When the relevant measure of

investments are the R&D, the coefficients are not significant for all the time horizons of future potential. The reason is that R&D expenditures appear to be flat over the time period considered, and, more importantly, not reactive to economic shocks: the coefficient of the first stage regression in fact is non-significant. However, when we consider the investments in capital formation the results change. Differently from the previous case, the coefficient of the first stage regression is very significant: the fall in capital investments can, at least partially, be explained by the initial shock. For each percentage point of unanticipated decline in output should result in a fall of 2.33% in capital formation investment. This is consistent with our expectation of such investments being pro-cyclical. In the second stage regression, the coefficients are extremely significant and increasing in size as we spread the horizon. This suggests not only that capital investments have some role in determining the growth of future potential output, but that current output recessions have a role as well through those investments. The result may represent an evidence of the existence of hysteresis and of one of the channels responsible for it. While the result clearly show the correlation between falling output, capital formation and potential output, they are not conclusive evidence for direct causality, an hysteresis mechanism, that goes from falling output to falling potential output through capital investments. On the data in fact we cannot exclude the possibility of reverse causality between falling potential and falling output and investments. However, while the interpretation of the reverse causality case is consistent with supply-side shocks, the hysteresis interpretation is the one consistent with a demand shock. The last recession by all accounts qualifies as a demand shock, looking at both the literature on it and the inflation response.

If hysteresis is a concern, it follows that damages from output gap are far greater than usually considered. The cost of a recession would not only be the actual losses, but the permanent reduction of the full employment potential. When we consider also that a depressed economy could find itself stuck into a liquidity trap, fiscal policy becomes the main tool to avoid those losses. Taking into account these factors, a cost-benefit analysis on the sustainability of debt-financed fiscal stimulus becomes much more favorable, even more so after considering the solid theoretical reasons and empirical works that

suggest that fiscal multipliers are higher in a depressed environment. This should give the sense that fiscal expansion gains can be as much in the long-run as they are on the short-run. Even in a depressed economy, discretionary fiscal policy may fail the cost-benefit test if there is a substantial spread between the borrowing rate for the government, which determines the burden of the debt, and the social rate of time discount. While this is a concern for a country like Italy, the present situation, with borrowing rates driven down by the ECB policies, could present an opportunity to use fiscal tools to tackle on the issues of double digits unemployment rate and weak long-run growth: improvements on those fronts are also necessary for a credible debt reduction strategy.

This work focuses on the economics of depression, meaning an environment with high output gap, high unemployment and very low interest rates. In particular, it tries to systematize a theory on how a negative shock that pushes the economy into recession could cast a long shadow on future economic performances. On the one hand we have the possibility of secular stagnation, on the other hand there is hysteresis. The secular stagnation story is about inadequate aggregate demand, not aggregate supply. Even if the economy's potential output is growing, depressed investment and consumption spending will prevent the economy from reaching that potential. However, because of hysteresis, secular stagnation will ultimately reduce aggregate supply as well, since growth in the economy's productive capacity is restrained by reduced capital formation and by the loss of workers' skills caused by a long period of unemployment. At the core of the secular stagnation hypothesis, there is the assertion that the natural real rate of interest is negative. It is difficult to have an exact idea of what the real rate really is at any given moment, but the picture it emerges from looking at the current situation seems consistent with real rates being close or even below zero. The aftermath of the financial crisis seems to give new validity of the presence of hysteresis effects on future potential output, but there is still work to do on the subject, like producing a sound and testable theory on why hysteresis occurs, in order to have a framework to quantify its entity. Overall, we believe that the lenses of stagnation economics are the most appropriate to capture what plagues, with different degrees, most advanced economies.

But, even if secular stagnation were not what is going on right now, this does not diminish the importance of having a unified theory of stagnation economics, since it provides a scheme to identify its symptoms and a rulebook of the appropriate policy responses.