A Theory of Salient Economic Fluctuations*

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February 2013

Abstract

The paper builds a model of investment in which investors have biased perceptions of the possible payoffs of a project and distort their expectations towards more salient payoffs. This can generate endogenous fluctuations. Booms are more likely when the project has a higher upside payoff or after the wealth of investors has increased more. Booms are followed by busts.

1 Introduction

Human perception tends to be biased towards elements that are unusual or that stand out. Whether we perceive light, weights, or lottery payoffs, experimental evidence suggests that perception is distorted towards more salient objects. For example, in a lottery that gives the chance to earn a million dollars, individuals may tend to overweight the possibility of earning this million and even otherwise risk-averse individuals may end up buying the lottery ticket despite its negative expected value.

In this paper we study the implications of such a perception bias on investment. We find that the overweighting of salient payoffs can lead to endogenous cycles of investment. More specifically, investors decide how much to invest in a risky project. When the upside of the project is more salient, investors tend to overestimate the expected value of the project and become too optimistic. They make losses as a result. As losses accumulate, investors become more pessimistic and end up under-investing.

*We would like to thank Philippe Bacchetta, Lorenz Goette, Pascal Saint-Amour, Luis Santos-Pinto for useful discussions. We gratefully acknowledge financial support from the National Centre of Competence in Research "Financial Valuation and Risk Management" (NCCR FINRISK).

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The paper thus offers a theory of economic fluctuations that is not based on economic fundamentals but on the perception of investors. This is reminiscent of the animal spirits hypothesis put forward by Keynes (2006). This approach can help reconcile movements in economic activity that do not seem to be in line with fundamentals. Furthermore, endogenizing recessions makes it possible to generate predictions on the likelihood of a future crisis.

In the model, investors can hire workers whose productivity is unknown. When deciding how many workers to hire, investors *perceive* an expected productivity of these workers. If the payoff associated with high productivity stands out compared to its downside, investors will tend to distort the expected productivity upwards and they will hire too many workers. The demand for workers is thus too high and investors pay their workers too much. They thus make a lower profit than they expected. By contrast, if the downside payoff is more salient, the demand for workers will be too low, so will be the equilibrium wage and investors will make a higher profit than they expected.

A delicate issue is to define what payoffs investors look at. Experimental evidence suggests that they do not consider the possible states of their final wealth but focus instead on changes in wealth. Furthermore, these perceived changes may be affected by previous losses or gains. For example, consider a lottery that can pay off 10 in case of success, 0 otherwise. When comparing such a lottery to an alternative safe lottery that pays off 5, most decision makers would opt for the safe choice. If, however, they just made a gain of 100 and considered the same lottery, experimental evidence suggests that the same decision makers would be wiling to take more risk. This is referred to as the house money effect. By contrast, following (large enough) losses, decision makers tend to become more risk-averse (Thaler and Johnson, 1990).[1]

When computing the salience of payoffs, we assume that the previous gains or losses of investors are reflected in the payoffs considered by investors. This assumption implies that we can have boom-bust episodes. A salient upside payoff will make investors over-invest. They will make a negative profit as a result. When integrating these losses to

[1]The implications of the break-even effect will be discussed more in depth in the paper.

their perceived payoffs, the downside payoff will become more salient and investors will underinvest as a result.

One advantage of endogenizing recessions is that it makes it possible to derive testable implications on the likelihood of a crisis. A rising wealth of investors, for example, suggests that optimism will rise. Projects with salient upside payoffs will also tend to foster optimism. As suggested above, optimism makes investors overinvest and plants the seed for the next crisis.

The mechanism we focus on is based on experimental evidence that documents anomalies with respect to the expected utility paradigm and that have proven successful to explain other types of behavior in economics. This includes the works of Kahneman and Tversky (1979) and Thaler and Johnson (1990). However, the present work is more closely related to Bordalo et al. (2012) who provides an alternative theory based on salience to explain many of these anomalies.

As mentioned above, the idea that the state of the economy may at times be disconnected from fundamentals is not new. This dates back at least to Keynes (2006). Related theories that focus on the role of finance include Kindleberger and Aliber (2011), Minsky (1992), and Shiller (2006). This paper shows instead that such exuberant episodes can occur in a real model.

Importantly, the economy can experience recessions without resorting to negative productivity shocks as in the RBC paradigm (King and Rebelo, 1999). Furthermore, unlike in the news shock literature where recessions occur following overoptimistic signals, recessions are not caused by an exogenous shock (Beaudry and Portier, 2004).

Finally, we are not the first to build models in which fluctuations are endogenous (Grandmont, 1985; Benhabib and Farmer, 1994; Aghion et al., 1999; Caplin and Leahy, 1994; Zeira, 1999; Chamley and Gale, 1994). However, their mechanisms are completely different and do not involve endogenous waves of pessimism and optimism.

There are limits to our work, however. So far, this is only a model of investment. In contrast to the previous literature on business cycles, it lacks many of the ingredients that have made it successful such as the introduction of consumption-saving and labor-leisure decisions. It also lacks its quantitative realism. This paper should thus be thought of as a first step with the objective to highlight a mechanism that can generate endogenous fluctuations. Future research, however, should aim to address the above issues.

The paper is organized as follows. Section 1 introduces the model. Section 2 solves the model under rational expectations. Section 3 solves the model under salient expectations. Section 4 concludes.

2 Model

We consider an economy populated with representative investors who live for T periods $t = 0, 1, \ldots, T$ and who are endowed with an initial level of wealth ω_0.

There is a technology that transforms labor l into the final good y

$$y = al \tag{1}$$

where a is a productivity parameter that can be high ($a = A$) with probability π or low ($a = 0$) with probability $1 - \pi$.

Investors can also allocate their wealth to a storage technology that delivers a return of 1 on their wealth.

The expected profit p of investors is given by the difference between expected production and the cost of labor.

$$p = (E(a) - w)l, \tag{2}$$

The supply of labor is $S(w)$, with $S' \geq 0$.

Finally, the wealth of investors is equal to their past profit in addition to their previous wealth. Then, wealth evolves according to

$$\omega_{t+1} = p_t + \omega_t, \quad \text{with } t = 0, 1, \ldots, T - 1. \tag{3}$$

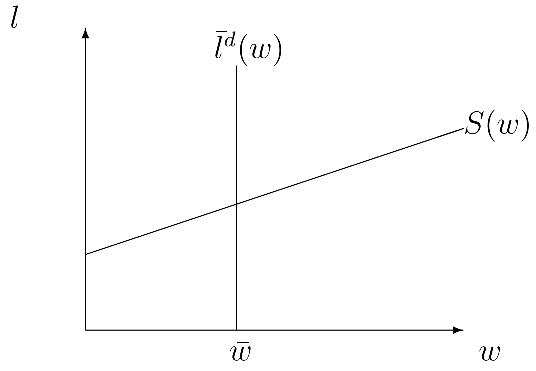

Figure 1: The demand for labor with rational expectations

3 Benchmark

We first solve our model using the rational expectation operator, that is, $E(a) = \bar{A} = \pi A$. Investors solve Equation (2). The resulting demand for capital is given by

$$\bar{l}^d(w) = \begin{cases} 0 & \text{if } w > \bar{A}, \\ l \in [0, +\infty[& \text{if } w = \bar{A}, \\ +\infty & \text{if } w < \bar{A}, \end{cases} \tag{4}$$

This demand as well as the supply of labor are represented in Figure 1.

Then, the equilibrium wage is

$$\bar{w} = \bar{A}, \tag{5}$$

and the equilibrium stock of labor is

$$\bar{l} = S(\bar{A}). \tag{6}$$

At periods $t = 0, 1$, the production of the economy is given by

$$\bar{y}_t = \bar{A}\bar{l}. \tag{7}$$

The profits of investors are equal to 0 and their wealth is thus constant and equal to ω_0.

Result 1 (Benchmark) *With rational expectations, the economy does not fluctuate.*

4 Salience

4.1 Background

Investors can now have biased perceptions of payoffs. They distort the expected value of a project towards the most salient states of nature.

Let us define the salient expectation operator as follows

$$E(A) = \begin{cases} \tilde{A} \leq \bar{A} & \text{if } \sigma_h \leq \sigma_l, \\ \tilde{A} > \bar{A} & \text{if } \sigma_h > \sigma_l, \end{cases} \tag{8}$$

where σ_i refers to the salience of state $i = h, l$.

Following Bordalo et al. (2012), the salience σ_i of state i is defined by the following function:

$$\sigma_i = \frac{|P_i - P_0|}{|P_i| + |P_0|} \tag{9}$$

where P_i is the perceived payoff of investors when state i has occurred and P_0 is a reference payoff that we assume consists in storing previous wealth. Thus the salience of state i is increasing in the difference between P_i and P_0 (ordering). Furthermore, it is decreasing in the sum of P_i and P_0 (diminishing sensitivity).

What is the perceived payoff? Following Thaler and Johnson (1990) and Barberis et al. (2001), we assume that investors may be affected by previous changes in their wealth when making decisions. Here, we will focus on the money of the house effect according to which agents who have just made some gains tend to be more risk-seeking by integrating the previous gains. For the moment, we assume that investors only integrate previous gains and discard previous losses. Below, we show how the analysis is modified when losses are integrated.

Thus, we assume $P_i = p_i + X$ and $P_0 = X$, where X refers to the profit of the previous period if it was positive. If the profit of the previous period was negative, $X = 0$. Then, we can rewrite the salience functions as follows:

$$\sigma_h = \frac{(A-w)l}{(A-w)l + 2X}, \tag{10}$$

$$\sigma_l = \begin{cases} \frac{wl}{-wl+2X} & \text{if } -wl + X > 0, \\ 1 & \text{if } -wl + X \leq 0. \end{cases} \tag{11}$$

Analyzing the function $\sigma_h - \sigma_l$ is key to understand the salient expectation operator given by Equation (8). We show a first result:

Result 2 *If $X > 0$, there exists a threshold l^* above (below) which the low state becomes more (less) salient than the high state. At $l = 0$ and $l = l^*$, both states are equally salient. If $X = 0$, we have $\sigma_h = \sigma_l = 1$ for all l.*

From Equations (10) and (11), $l = 0$ and

$$l^* = X\left(\frac{1}{w} - \frac{1}{A-w}\right). \tag{12}$$

are solutions to $\sigma_l = \sigma_h$ in the case $-wl + X > 0$. The function $\sigma_h - \sigma_l$ is represented in Figure 2 as a function of l. It shows that it is a hump-shaped function of l and crosses the x-axis at the points 0 and l^*. For $l < l^*$, the prospect of making a positive profit is salient. However, for $l > l^*$, the prospect of the large loss becomes more salient. It is easy to show that the case $-wl + X \leq 0$ does not affect the result.

Another useful result is:

Result 3 *The threshold l^* is increasing in A and X.*

This result can be derived from Equation (12).

4.2 Decision Problem

We now turn to the maximization programme of the investor. For each l, the investor computes the salience of the two states and chooses the level of l that maximizes the

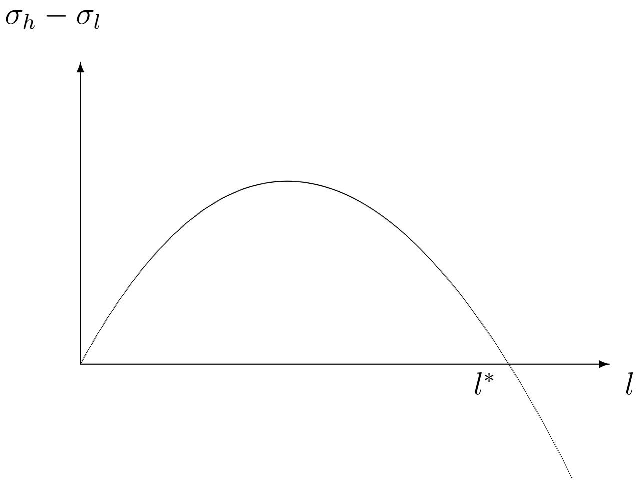

Figure 2: Relative salience and labor

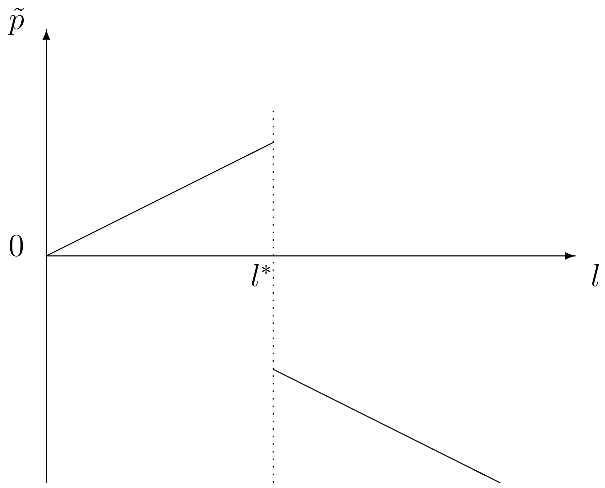

Figure 3: Profits and labor

resulting salient expected profit function, which we call $\tilde{p}$.

To make our point in the simplest way, let us take the following functional form for the salient expectation operator:

$$\tilde{A} = \begin{cases} 0 & \text{if } \sigma_h \leq \sigma_l, \\ A & \text{if } \sigma_h > \sigma_l. \end{cases} \tag{13}$$

Note that this functional form is without much loss of generality. A more elaborate form would have $\tilde{A}$ as a continuous function of relative salience. However, as will become clear below, this would not affect dramatically the results.

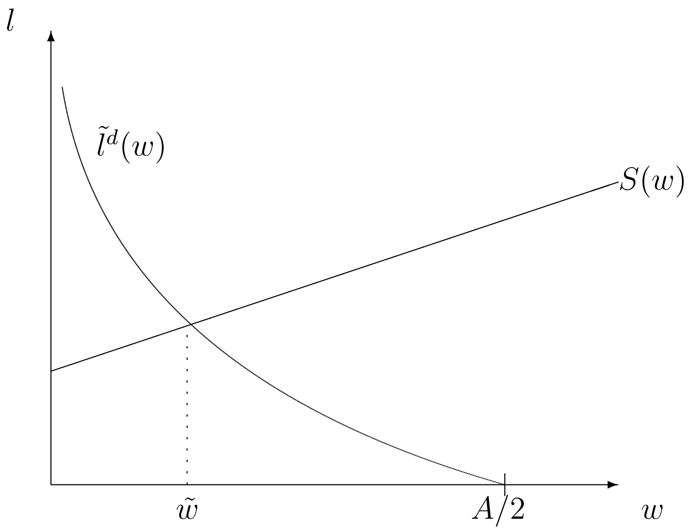

Figure 4: The equilibrium on the labor market with salient expectations

The function $\tilde{p}$ is represented in Figure 3. The investor chooses the level of l that maximizes $\tilde{p}$. The solution is given in the following result.

Result 4 *The demand for labor* $\tilde{l}^d$ *is given by* $\tilde{l}^d = \max(0, l^*)$.

For $l < l^*$, the upside of the lottery is more salient and in this region investors want to hire as many workers as possible because of the constants returns. For $l > l^*$, the downside is more salient and investors want to hire as few workers as possible. Overall, investors thus want to hire l^* workers.

The demand for workers as a function of the wage w is given by Equation (12). It is a standard decreasing function and is represented in Figure 4.

To find the equilibrium labor $\tilde{l}$, we need to compute the equilibrium wage $\tilde{w}$. It is the solution to

$$S(w) = l^*(w). \tag{14}$$

Then, the equilibrium stock of labor is given by

$$\tilde{l} = l^*(\tilde{w}). \tag{15}$$

The aggregate production is then given by

$$\tilde{y} = \bar{A}\tilde{l}. \tag{16}$$

We can now easily compare the cases with and without salience.

Result 5 *Compared to the no salience case, production is higher if $\tilde{l} > \bar{l}$ (boom), lower otherwise (bust).*

A first implication that will be useful once we study the dynamics concerns the profits of investors

Result 6 *p is positive if $\tilde{l} > \bar{l}$, negative otherwise.*

If $\tilde{l} < \bar{l}$, the investor underestimates his productivity. Because the demand for labor is lower as a result, individuals underpay their workers. They make a larger profit than in the no salience case and their wealth thus increases more. If $\tilde{l} > \bar{l}$, investors overpay their workers. They end up with a negative profit and their wealth decreases.

Result 3 is useful to study how the parameters of the model help generate booms or busts. A higher A and a higher X increase $\tilde{l}$ and thus increase the likelihood of having a boom.

4.3 Dynamics

One of the key variable to understand the dynamics of the economy is X which is itself a function of the past profit. Let us study how p depends on X:

$$\frac{dp}{dX} = -\frac{d\tilde{w}}{dX}\tilde{l} + (\bar{A} - \tilde{w})\frac{d\tilde{l}}{dX}. \tag{17}$$

We now assume that each investor invests in a large number of projects and consider each of them individually when computing salience. This enables us to keep a representative investor.

From Results 3 and 4, we know that $\tilde{l}$ is strictly increasing in X. Thus there exists at most one $\bar{X}$ such that $\tilde{l} = \bar{l}$ and $\tilde{w} = \bar{A}$. Starting from $X = \bar{X}$, the profit is zero as in the no salience case. Furthermore, using Result 6 the profit is positive for lower values of X and negative for higher values. Note that investors are willing to pay at most $A/2$. So, such an $\bar{X}$ only exists if $\bar{A} > A/2$. We impose this restriction below.

Let us first consider the simplest case $S' = 0$. The evolution of profit is given by $-\frac{d\tilde{w}}{dX}\tilde{l}$. Because $S' = 0$, $\tilde{l}$ is a constant. We thus only need to study the behavior of $\frac{d\tilde{w}}{dX}$. Its properties can be studied from Equation (14). Differentiating this equation gives

$$\frac{d\tilde{w}}{dX} = -\frac{\partial l^*/\partial X}{\partial l^*/\partial w} = \frac{\tilde{w}(A - \tilde{w})}{AX} \tag{18}$$

We know from Result 3 that l^* increases with X and decreases with w. The sign of this derivative is thus positive. Profit is then a decreasing function of the previous profit. This is only true for $p_{t-1} > 0$. For $p_{t-1} \leq 0$, we have $X = 0$ and thus the demand for labor and the wage are equal to zero. In this region, the profit is constant and equal to $\bar{A}S$. Figure (5) represents p_t as a function of p_{t-1}.

Assuming S' positive, the former reasoning would still hold and would in addition have consequences on production. The second term reappears in Equation (17). First notice that $\tilde{l}'$ is positive. If $\tilde{w} > \bar{A}$ (or $X > \bar{X}$), larger previous gains make current profit even more negative through this second term. The intuition is that the higher demand now not only increases the equilibrium wage but also increases the equilibrium quantity. By contrast, if $\tilde{w} < \bar{A}$ (or $X < \bar{X}$), lower previous gains make current profit less positive because the low wage implies that investors can only attract fewer workers. Finally, now that the equilibrium quantity of workers can vary, the behavior of investors can have real effects on the economy. When investors are optimistic, they hire too many workers and over produce. When they are pessimistic, they hire too few workers and underproduce.

We can now look at how the economy evolves over time. Starting from $X > \bar{X}$, we

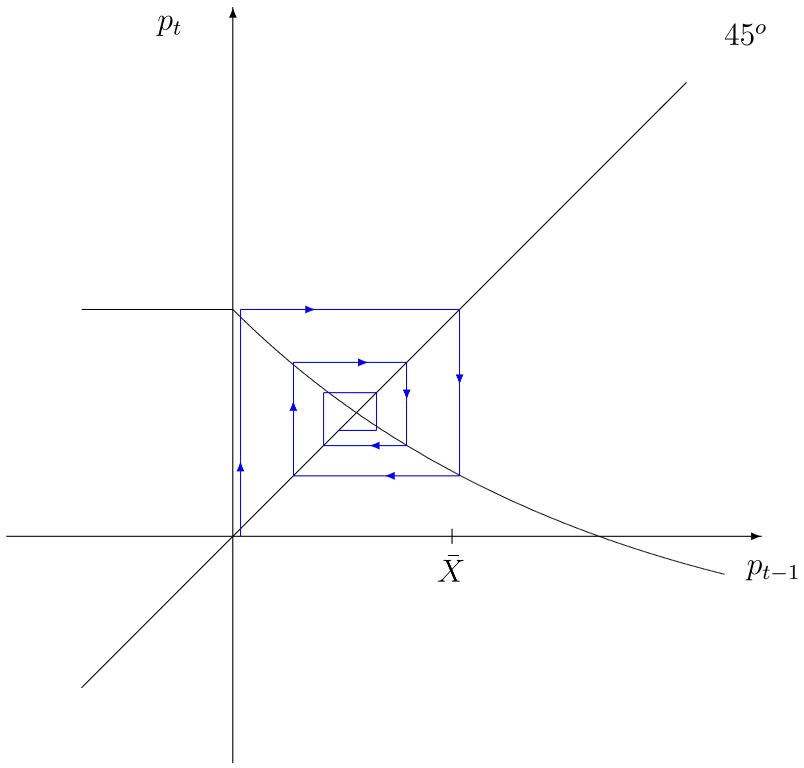

Figure 5: Dynamics

initially have a boom. Investors make negative profits as a result. This implies $X < \bar{X}$ and thus $\tilde{l} < \bar{l}$. Thus:

Result 7 (Boom-bust) *A boom is followed by a bust.*

The fixed point of p_t is given by the intersection of the forty-five degree line and of the profit function. Call it X^*. Given that $X^* < \bar{X}$, if the economy converges to this point, we have a permanent boom. Starting from the neighborhood of X^*, the economy converges to this point if the slope of p_t at this point is greater than -1, as in Figure 5. If this slope is less than -1, the economy features permanent cycles. Profits switch from $p_0 = AS(0)$ to $p(p_0)$. If $p_0 > \bar{X}$, the economy is characterized by permanent boom-bust cycles, as in Figure 6. Otherwise, the economy alternates between small and large busts.

An innovation (higher A) increases the volatility of the fluctuations because it shifts the horizontal part upwards. The decreasing part also shifts upwards at least in $X < \bar{X}$ and becomes steeper. Thus, an increase in A is more likely to bring the kind of dynamics observed in Figure 6, making the economy less stable. In the absence of a lottery ($\pi = 0$), people act rationally and make zero profit. If a new innovation comes with a higher A

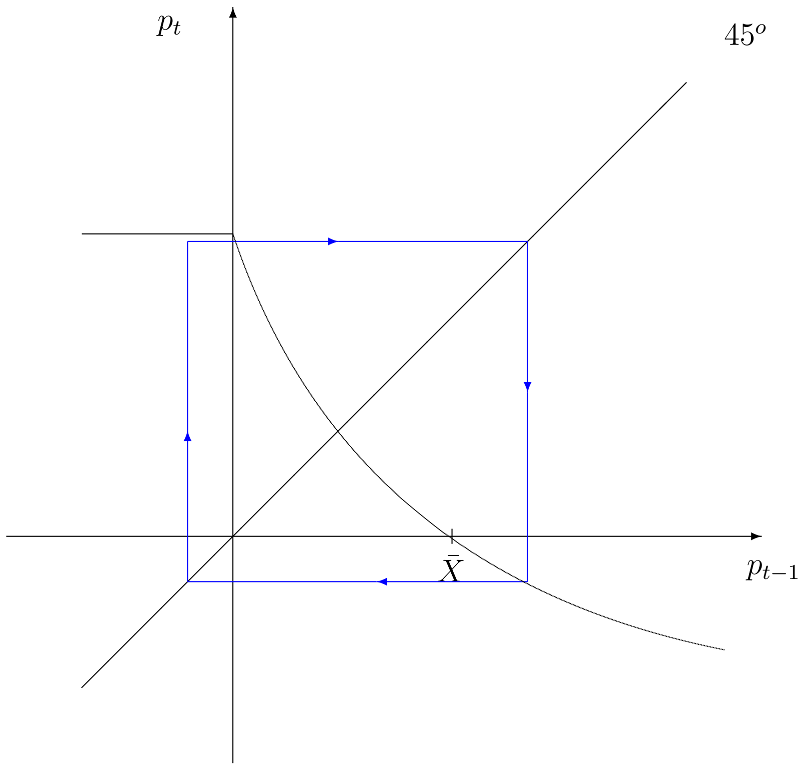

Figure 6: Dynamics (high A)

but with $\pi > 0$, this gives rise to fluctuations as described above where the initial profit is zero.

4.4 Integrating Losses

We now consider the case $X = p < 0$. The salience functions become:

$$\sigma_h = \begin{cases} 1 & \text{if } -(A-w)l < X \leq 0, \\ \frac{(A-w)l}{-(A-w)l-2X} & \text{if } X \leq -(A-w)l, \end{cases} \tag{19}$$

$$\sigma_l = \frac{wl}{wl-2X}. \tag{20}$$

As before, analyzing the function $\sigma_h - \sigma_l$ is key to understand the salient expectation operator given by Equation (8). We show a first result:

Result 8 *If $X < 0$, there exists a threshold l^* above (below) which the high state becomes more (less) salient than the low state. At $l = 0$ and $l = l^*$, both states are equally salient.*

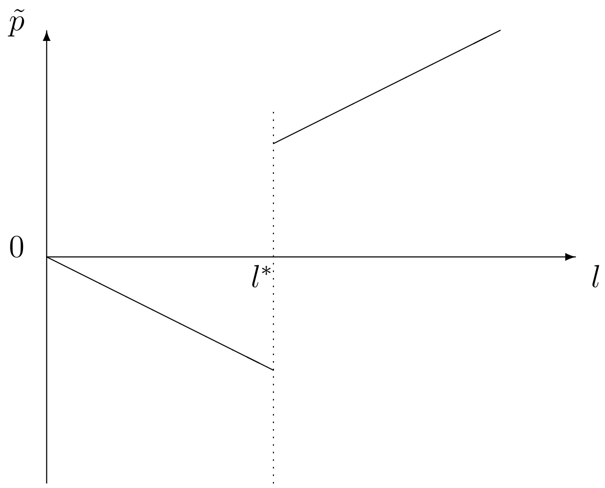

Figure 7: Profits and labor (case $X < 0$)

From Equations (10) and (11), $l = 0$ and

$$l^* = X\left(\frac{1}{w} - \frac{1}{A-w}\right). \tag{21}$$

are solutions to $\sigma_l = \sigma_h$ in the case $X < -(A-w)l$. For $l < l^*$, the prospect of making a negative profit is salient. However, for $l > l^*$, the prospect of the large gain becomes more salient. It is easy to show that the case $-wl + X \leq 0$ does not affect the result. This is thus the opposite of Result 2. This is in line with the break-even effect described in Thaler and Johnson (1990). Following losses, investors are willing to take more risk if they can break-even. In this setting, investors can only break-even if they hire a large enough number of workers.

We now turn to the maximization programme of the investor. As before, for each l, the investor computes the salience of the two states and chooses the level of l that maximizes the resulting salient expected profit function, which we call $\tilde{p}$.

The function $\tilde{p}$ is represented in Figure 7. The investor chooses the level of l that maximizes $\tilde{p}$. The solution is given in the following result.

Result 9 *The minimum demand for labor* $\tilde{l}^d$ *is given by* $\tilde{l}^d = \max(0, l^*)$.

For $l < l^*$, the downside of the lottery is more salient and in this region investors want to hire as few workers as possible. For $l > l^*$, the upside is more salient and investors

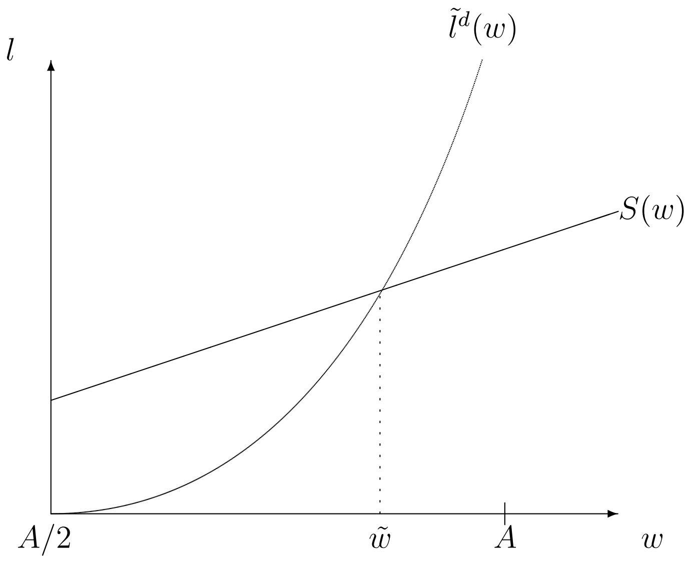

Figure 8: The equilibrium on the labor market with salient expectations (case $X < 0$)

want to hire as many workers as possible. Overall, investors thus want to hire an infinity of workers. However, they would as well be willing to hire fewer workers as long as this gives them a positive profit. The minimum they are willing to hire is l^*.

Surprisingly, this minimum demand for workers is now an increasing function of the wage. It is represented in Figure 8.

We saw above that for $X = 0$, investors are not willing to hire unless the wage is equal to 0. This section shows, however, that when X turns negative investors are again willing to hire.

The dynamics are a bit more complicated than above. The dynamic equation that describes the evolution of profit is represented in Figure 9 in the case $\bar{A} < A/2$ (consistent with above). If there is an initial boom ($X > \bar{X}$), profits turn negative and remain so forever. Depending on the slope of the profit function in the region $X < 0$, we can have permanent cycles or converge towards a steady state of overinvestment and negative profits. This, however, cannot last forever, as at some point the wealth of investors will evaporate and they will not be able to invest anymore.

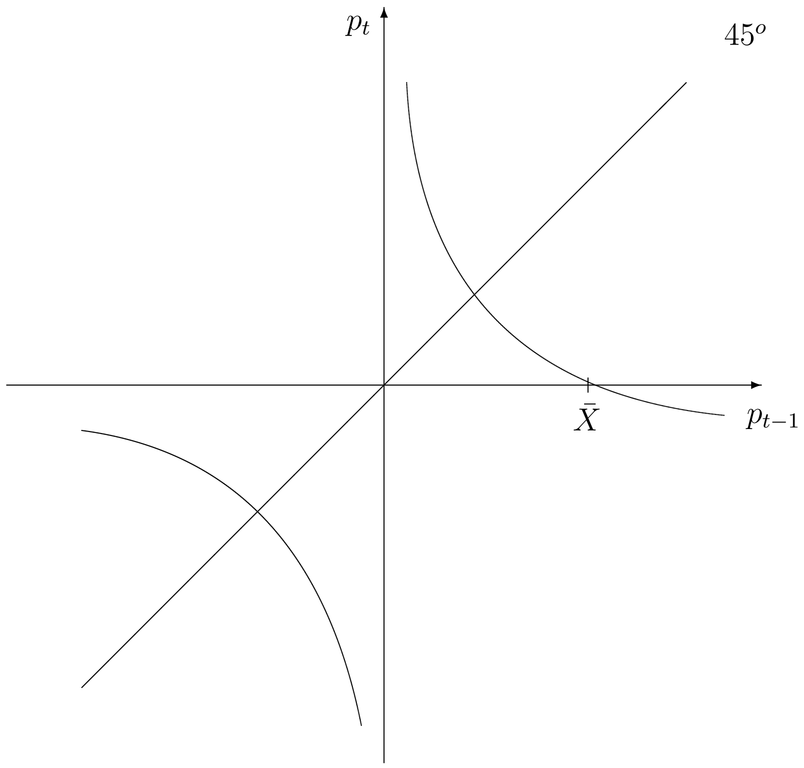

Figure 9: Dynamics (case $X < 0$)

If $\bar{A} > A/2$ (not represented), $\bar{X}$ is negative. We can now have a boom following large losses. If this happens, X turns positive and remain so. Then, the analysis above applies.

5 Discussion

In this paper, we assume that investors bias their expectations towards the more salient states of nature. We find that this can generate endogenous cycles of investment. In particular, this allows us to derive predictions on the likelihood of future recessions.

This brings a natural question: How to prevent the next economic crises? A government could tax investors to bring them to reason. The welfare criterion and the policy tools remain to be determined. The tools could be a tax or a subsidy that would affect previous gains or losses or the cost of hiring workers. If the objective is to reduce volatility, the steady-state could be achieved by a one time policy that would bring the economy to the desired level of previous gains or to the desired cost of workers. This may not be optimal for other reasons, for example, because investors would systematically underinvest, which could have adverse consequences on employment and prices in a richer model. Another welfare criterion could be to bring the economy to a competitive state as in the rational case. This would necessitate a more proactive policy because the economy would be at an unstable point. Finally, the issue of how these policies are financed is an important one and is left for future research.

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