Pseudo-wealth Fluctuations and Aggregate Demand Effects*

PRELIMINARY AND INCOMPLETE

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Abstract

This paper presents a theory of pseudo-wealth in a model that displays aggregate demand externalities. With heterogeneous beliefs and a market for exploiting those differences in beliefs, pseudo-wealth will be created–i.e. the sum of expected wealth of all the individuals will be larger than what it is feasible for the society. Under some conditions, those perceptions will lead to larger levels of consumption of (tradable and non-tradable) goods, leisure, and borrowing than in a world with common beliefs. If those differences in beliefs disappear, pseudo-wealth will disappear, leading to adjustments in behavior

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that amplify the initial decrease in expected wealth. That is, we provide a simple general equilibrium model in which the destruction of pseudo-wealth amplifies the effects of the initial disturbance, leading to large decreases in economic activity. Importantly, this downturn is not associated with any change in the state variables that describe the economy.

More generally, the paper shows that completing markets (in this case by creating a market for bets) may imply lower output both in the present and in the future, raising unsettling questions on criteria for welfare analysis.

Keywords: Pseudo-wealth, Aggregate Demand Externalities, Complete Markets, Welfare

JEL Classification: D84, D91, E21, E23, E24, E32.

1 Introduction

This paper addresses two central issues in macroeconomics. Firstly, it provides a framework that can account for situations in which there are large changes in the state of the economy with no commensurate changes in the fundamentals, the state variables that describe it. Secondly, it demonstrates that under plausible conditions, completing markets leads to more volatility and lower output *always.*

Recent events in the US and Europe have witnessed the limitations of conventional macroeconomic models to predict and explain large economic recessions and crises, and to provide guidance for policies that attempt to resolve them. Many of these situations did not involve large changes in the physical state variables describing the economy (as the labor force, the stock of capital or land), but the levels of economic activity did change significantly. Those models could not account either for situations of persistent underutilization of the factors of production of the economy, a typical feature of crisis times.

There have been different attempts within the standard literature to reconcile macroeconomic theory with the reality faced during times of recession with deflation. Those models introduce shocks to the future state variables of the economy that act as demand shocks in the present (for example, Lorenzoni (2009), Beaudry and Portier (2004, 2006), and Jaimovich and Rebelo (2008)). In those theories, business cycles are driven by changes in the perception of long-run aggregate productivity that lead to changes in demand in the present. But none of them resolve the puzzles described above. The transition from one equilibrium to another one does not provide an explanation for the persistent underutilization of resources observed in large recessions. Besides, changes in demand in the present still require changes in the expected state variables that describe the economy. It is hard to identify any such shocks which have led to major economic downturns.[1]

An alternative approach to explain transitions across different equilibria either with slight or no changes in the state variables is provided by the literature on multiple equilibria and indeterminacy of beliefs. However, this literature does not offer a satisfactory explanation for the type of fluctuations observed in large recessions or crises. The shift in beliefs that triggers a transition across equilibria is left unexplained. At least in one important

[1]Moreover, because technology shocks are global, differences in the shocks experienced by different countries should relate primarily to the composition of their production.

class of such models, the multiplicity of equilibria is the byproduct of the assumptions of common knowledge and the certainty about the behavior of the others in equilibrium. Adding noise to that game pins down which set of fulfilling beliefs will prevail in equilibrium (Morris and Shin, 2000). But even the theories based on multiplicity of equilibria do not explain the persistence of unemployment.

This paper extends the theory of pseudo-wealth introduced earlier in Stiglitz (2014) and Guzman and Stiglitz (2014). The main difference between our framework and conventional models is the removal of the assumption of a unique representative agent, which is replaced by the assumption of two representative agents that have different distributions of beliefs on the probabilities of occurrence of a "rare event". The differences in priors may be the consequence of distortions in the process of formation of beliefs, or simply the consequence of access to different information that leads to overconfidence in their own priors.

The key premise of the model is that differences in beliefs can be economically exploited. We assume there exists a market for bets that makes it possible to do so. (The betting model can be thought of as a metaphor that depicts a general situation in which trade leads to expected gains from differences in priors.) In equilibrium, agents will engage in betting that leverages the side of the distribution of beliefs that each of them perceives as relatively more likely (with respect to the other agent). Because each agent believes that on average he is going to win, the betting leads to a perception of a higher aggregate wealth; under some conditions, the planned aggregate consumption exceeds that which is feasible for the society. The "excess" wealth is what we have defined as pseudo-wealth. If those differences in beliefs disappear or cannot longer be exploited (say because the betting market is shut down), pseudo-wealth will disappear, leading to adjustments in behavior that amplify the initial decrease in expected wealth, with macroeconomic consequences.

The source of the disparity in beliefs is not important for our analysis. What is important is that we refer to an event that rarely occurs, over which it is not sensible to think that all the individuals share the same beliefs on the likelihood of its occurrence. Reforms that may or may not lead to a structural transformation in the economy are events of this nature.[2] And if market participants do not share the same beliefs, there is room for engaging in transactions that reflect those differences and that increase pseudo-wealth.

Even though the mechanisms we describe are consistent with uncommon events that can actually transform the capacity of production of the economy (like a structural transformation), we model the event of interest as a sunspot. Our goal is to show that it is possible, in equilibrium, to obtain changes in the state of the macro-economy with no commensurate changes in its capacity of production. Our assumption simplifies the analysis: by leaving aside any possible change in the capacity of production of the economy, it is clear that all the changes in the state of the macro-economy are the consequence of changes in possibilities of exploiting differences in priors.

There is a well-established literature that develops the connection between heterogeneous beliefs and asset price fluctuations. Most closely, Geanakoplos

[2]The Great Recession provides an example of a perturbation to the economy associated with marked changes in the magnitude of differences in beliefs: Before the crisis, some believed that there was a housing bubble, some did not. Large bets were made. The crisis put an end to those bets.

(2010 and others) offers an approach for explaining excessive volatility of asset prices based on the interaction between heterogeneous expectations, collateral constraints, and leverage. Bad news in the economic environment can be amplified through the interaction between leverage and collateral constraints, leading to large changes in asset prices. In this approach, bad shocks will hurt the optimists –those who were leveraged, and will benefit some of those who are not too optimistic, who will now be able to buy the assets at lower prices. Other studies (Harrison and Kreps (1978), Scheinkman and Xiong (2003), Hong, Scheinkman and Xiong (2006)) emphasize that the option to resell assets to future optimists can induce bubbles in asset prices. In our framework, the negative effects of a shock can be largely amplified even with no binding collateral constraints.

1.1 A preview of the mechanisms

In Guzman and Stiglitz (2014), we showed how pseudo-wealth implied a non-smooth path of consumption both at the individual and aggregate level. In this paper, we extend the results to a production economy, where the endogeneity of output and the labor supply will amplify the initial effects of the shock.

Our model features a stochastic and dynamic small, open economy that produces two goods, with two infinitely lived representative consumers, where the only source of uncertainty is the possibility of a one-time sunspot. Consumers want to maximize the expected discounted value of utility, and firms (that we assume to be foreign) want to maximize profits. Under heterogeneous beliefs on the probability of occurrence of the sunspot, opening a market for bets will generate two effects: it will create pseudo-wealth, and it will increase the variances of incomes. When the wealth effect dominates the precautionary savings effect, it will lead to "high" consumption and "low" labor supply in the present. Consumers will finance the high consumption by borrowing from the rest of the world at a risk-free interest rate, denominated in tradable goods.

Consumers will adjust their behavior over time as a function of the states that are realized. In every period there will be destruction of pseudo-wealth followed by creation of new pseudo-wealth.[3] A perturbation to the economy can interrupt this process of destruction followed by an equivalent creation of pseudo-wealth. In our model, the sunspot constitutes such a perturbation. This event will lead to individual adjustments –adjustments associated with aggregate demand externalities–and consequently to changes in the aggregate state of the economy.

When the sunspot occurs, the loser of the bet will decrease her consumption of tradable and non-tradable goods, and will increase her individual labor supply in order to (partially) make up for the decrease in wealth. The winner of the bet will do the opposite. But as pseudo-wealth disappears, the aggregate demand for tradable and non-tradable goods will decrease, and the aggregate labor supply will increase.

The decrease in the aggregate demand for non-tradable goods will lead to a decrease both in its production and price. Therefore, the labor demand in the non-tradable sector will fall. If there were no diminishing returns to

[3]As there is a winner and a loser in every period, there will be distributional consequences that may affect the equilibrium price and the volume of betting. These effects will not the object of interest of this paper (they are analyzed in Guzman and Stiglitz, 2014).

labor in the tradable sector, the excess labor supply could be fully absorbed by the tradable sector, and the equilibrium in the labor market could be restored with no effects on the equilibrium wage. However, with diminishing returns, real wages fall. In the model explored here, we assume there is a strong complementarity between labor and the other factor of production, land that imposes a strict limit to the amount of labor that can be absorbed. If this limit is binding, the tradable sector will not absorb the excess of labor supply.

The fall in wages creates a macroeconomic externality: The behavioral adjustments of the consumer who loses the bet negatively affect the prospects of the consumer who wins the bet, even though the bet itself can provide insurance against the contingency of the shock occurring. This externality operates as an amplification device. In the second round of adjustments, both the loser and the winner will reduce the consumption of tradable and non-tradable goods and will increase their individual labor supply, triggering further reductions in the prices of non-tradable goods and in wages. This process will continue until a new equilibrium is reached. Thus, fluctuations in pseudo-wealth require large changes in prices to restore equilibrium, even when the economy experienced no modifications in the state variables that describe it.

In the new equilibrium, it is even possible that the winner of the bet is worse-off. This would be the case if the loss associated with the reduction in wages dominates the gain that comes from winning the bet. Therefore, the agent would be worse-off in every possible state,[4] with respect to the

[4]He is worse off ex post. But due to the existence of the market for bets he can even be worse off in terms of ex ante expected utility.

world in which betting is not possible –but not with respect to the world in which betting is possible but she does not bet, as in the later situation she would still suffer from the negative macroeconomic externality (manifested as a decrease in wages) that arises at the time the sunspot occurs.

These results show that there are conditions under which completing markets (such was the implication of the creation of the market for bets) increases the variance of the economy and reduces output in every period. Before the sunspot occurs, output will be lower because consumers will wish to work less as they feel wealthier. After the sunspot occurs, output will also be lower due to the amplification mechanism just described. However, according to standard welfare criteria that respect individual beliefs, markets may still be efficient. This paradoxical result raises unsettling questions in terms of selection of criteria for welfare analysis.

Welfare analysis in a context of heterogeneous beliefs is a non-trivial task. What beliefs should the planner use for assessing welfare? If the planner used what elsewhere has been defined as *reasonable beliefs* (i.e. a convex combination of the different agents' beliefs; see Brunnermeier et al. (2014)), for any set of beliefs utilitarian welfare would be lower in the equilibrium with betting, and there would exist interventions (taxes on betting or its direct prohibition and lump sum payments) such that both groups of consumers would be better-off when their utility is computed using those reasonable beliefs. But if the planner respects the beliefs of each individual, as in Pareto conventional analysis, then there would not be "excessive betting".

For some *reasonable beliefs* (like the ones that would correspond to a utilitarian social welfare function), in Guzman and Stiglitz (2014) there was "excessive betting" due to the perception that betting would lead to higher wealth. In this paper there are additional factors affecting the volume of betting in equilibrium and therefore whether the level of betting is excessive. On the one hand, the non-internalization of the macroeconomic externalities that we have identified makes it more likely that there is excessive betting in equilibrium. On the other hand, under rational expectations consumers know that due to the macro externalities, the value of a dollar is larger in the state in which the sunspot is realized. This second force reduces the appetite for engaging in bets that have a negative payoff at the moment of the sunspot, and vice versa. The equilibrium price of the bet clearly will change, and the effect on the volume of betting is ambiguous.

It has become a policy nostrum in some circles that if only (real) wages were more flexible, the economy would adjust better to adverse shocks. Output would be more quickly restored to the pre-shock level. Skeptics of such policies have emphasized the adverse impact of wage decreases on aggregate demand, suggesting that more flexible wages would actually worsen the downturn. Finally, the paper provides a precise context in which we can evaluate these alternative claims. In our model, one can see the Greenwald-Stiglitz-Fisher effect (Greenwald-Stiglitz, 1993) at work with vengeance, as the decline in real wages increases the burden of the debt, leading to further increases in labor supply. We show, moreover, that there are plausible conditions under which the equilibrium with flexible wages is associated with lower production and aggregate labor income than the equilibrium with (somewhat) rigid wages.

2 A model of pseudo-wealth with aggregate demand effects

The model features an infinitely lived small and open economy with perfect access to international credit markets. Debt is denominated in tradable goods. Finance is provided by foreign risk-neutral investors whose opportunity cost is the risk-free interest rate r.

The environment is composed by two representative consumers and foreign firms that produce tradable and non-tradable goods.

2.1 States

In every period there are two possible states: either a sunspot occurs or it does not. The sunspot is a "rare event". In our setup, it so rare that once it occurs, it cannot occur again. Then, the space of states in one period is $\S_t = \{O, S\}$ before the sunspot occurs, and $\S_t = \{O\}$ $\forall t$ after the sunspot occurs, where S refers to the sunspot state and O refers to the no sunspot state. The set of history of spaces is defined as $S_t = \{\emptyset, O, S, OO, OS, SO, OOO, OSO, SOO, OOO, ...\}$.

Figure 1 describes the evolution of possible states.

2.2 Consumers

There are two representative consumers-workers, A and B. They differ in their beliefs on the probability of occurrence the sunspot: $\lambda^A(S) > \lambda^B(S)$, where $\lambda^i(S)$ is the probability of the occurrence of the sunspot as perceived by consumer i. There is a continuum of measure one of each type of consumers. They are identical in all other dimensions.

They receive labor income w_t in period t from each hour they work. They can borrow in the international markets at the risk-free interest rate, as default is ruled out by assumption (see appendix A).

Preferences are defined over the consumption of a tradable and a non-tradable good, and leisure.

$$U_t^i = u(c_{T,t}^i, c_{N,t}^i, h_t^i) \tag{1}$$

where $c_{T,t}^i \geq 0$, $c_{N,t}^i \geq 0$, and $h_t^i \geq 0$ are the consumption of tradable goods and non-tradable goods, and the number of hours agent i works in period t, respectively.

The utility function is increasing and strictly concave in consumption of both goods, and decreasing and strictly concave in the number of hours worked: $u_{T,t} = \frac{\partial u}{\partial c_{T,t}} > 0$, $u_{TT,t} = \frac{\partial^2 u}{\partial c_{T,t}^2} < 0$, $u_{N,t} = \frac{\partial u}{\partial c_{N,t}} > 0$, $u_{NN,t} = \frac{\partial^2 u}{\partial c_{N,t}^2} < 0$, $u_{h,t} = \frac{\partial u}{\partial h_t} < 0$, $u_{hh,t} = \frac{\partial^2 u}{\partial h_t^2} < 0$. We impose additional restrictions on the utility function: We assume it belongs to a class of functions such that the precautionary savings motive is not "too large". The rationale is to represent situations where the positive effect of the creation of pseudo-wealth on demand is larger than the negative effect of precautionary savings on demand.[5]

[5]The quadratic utility function belongs to that class, and it is the function used in Guzman and Stiglitz (2014) to completely isolate from precautionary savings effects. For the CRRA function, the wealth effect dominates if the risk aversion coefficient is less than one.

2.3 Firms

There are foreign firms operating in the domestic economy that produce a tradable and a non-tradable good. We assume that these foreign firms do not spend their profits in the domestic economy. The reason for this assumption is to ensure that demand is not driven by the consumption of entrepreneurs.[6]

Production of the non-tradable good, y_N, requires only labor and exhibits decreasing returns to scale:

$$y_{N,t} = {h_{N,t}}^{\alpha} \tag{2}$$

with $\alpha \in (0, 1)$, and where $h_{N,t}$ is the total number of hours utilized in the production of the non-tradable good in period t.

We introduce a real rigidity in the production function of the tradable good, y_T. Production of y_T requires labor and a fixed factor X (that can be interpreted as land). The production function is Leontieff,

$$y_{T,t} = min\{h_{T,t}, \gamma X_t\} \tag{3}$$

where $h_{T,t}$ is the total number of hours and X_t is the amount of land utilized in the production of the tradable good in period t. Utilization of land is limited by the land endowment constraint:

$$X_t \leq \bar{X} \tag{4}$$

where $\bar{X}$ is the total stock of land in the economy.

[6]Assuming that the marginal propensity to consume is smaller for firms than for workers would suffice. Empirical evidence shows that the marginal propensity to consume is decreasing in the level of income (Mian, Rao, and Sufi, 2013).

The postulated production function for y_T implies that the tradable sector cannot absorb unlimited amounts of labor.[7] The Leontieff assumption is made for simplicity. All we need is an assumption that captures a situation of marked decreasing returns of labor in the tradable sector.

2.4 Bets

There is a market for short-term bets over the realization of the sunspot. One consumer will pay p_t to the other consumer for a bet that returns 1 if $s_t = S$, and zero otherwise. In equilibrium, consumer A (B) will bet in favor of state $s_t = S$ ($s_t = O$). The volume of bets in equilibrium is b_t.

2.5 Decisions

2.5.1 Consumers

Consumers are forward-looking. They decide the consumption of the tradable and the non-tradable goods, the individual labor supply, borrowing, and betting, given all prices, in order to maximize the expected present discounted value of utility,

$$max_{\{c^i_{T,t}, c^i_{N,t}, h^i_t, b^i_t\}} E^i_t \sum_{j=t}^{\infty} \beta^j U^i_j \tag{5}$$

subject to the budget constraints

$$c^A_{T,t} + p_{N,t} c^A_{N,t} + (1+r)(d^A_{t-1} - P^A_{t-1} b^A_{t-1}) + p_t b^A_t = w_t h^A_t + d^A_t \tag{6}$$

[7]This assumption intends to capture situations in which the the tradable sector mostly produces goods that do not absorb large amounts of labor, as it is typical for modern economies whose tradable production is dominated by agriculture.

$$c_{T,t}^{B}+p_{N,t}c_{N,t}^{B}+(1+r)(d_{t-1}^{B}-P_{t-1}^{B}b_{t-1}^{B})-p_{t}b_{t}^{B}=w_{t}h_{t}^{B}+d_{t}^{B} \tag{7}$$

where the price of the tradable good is normalized to one, $p_{N,t}$ is the price of the non-tradable good, and P_t^i are the bet payoffs for agent i, all in period t.

As in equilibrium agent A (B) will bet in favor of the sunspot (no sunspot), bet payments are described as follows:

$$P_t^A = \begin{cases} 1 & \text{if } s_t = S \\ 0 & \text{if } s_t = O \end{cases} \tag{8}$$

and

$$P_t^B = \begin{cases} -1 & \text{if } s_t = S \\ 0 & \text{if } s_t = O \end{cases} \tag{9}$$

Appendix B shows the necessary conditions for solving the utility maximization problem.

2.5.2 Firms

Firms maximize profits. Firms operating in the tradable sector choose how many labor hours to hire and how much land to use, given prices, wages, and the rental cost of land, which is equal to zero as land is not exportable and has no other uses:

$$max_{\{h_{T,t},X_t\}} y_{T,t} - w_t h_{T,t} \tag{10}$$

subject to (4).

Firms operating in the non-tradable sector choose how many labor hours to hire given $p_{N,t}$ and w_t.

$$max_{\{h_{N,t}\}} p_{N,t} y_{N,t} - w_t h_{N,t} \tag{11}$$

Appendix B shows the necessary conditions for profit maximization.

2.6 Equilibrium

Definition 1 *An equilibrium is a vector of quantities* $\{c^i_{T,t}, c^i_{N,t}, h^i_t, d^i_t\}_{i=A,B}$, $\{h_{j,t}, y_{j,t}\}_{g=T,N}$, *and prices* $\{p_{N,t}, p_t, w_t; r\}$ *such that consumers maximize utility given prices, firms maximize profits given prices, and all markets clear in every state:*

$$c^A_{T,t} + c^B_{T,t} = y_{T,t} + d^A_t + d^B_t - (1+r)(d^A_{t-1} + d^B_{t-1}) \tag{12}$$

$$c^A_{N,t}(\cdot) + c^B_{N,t}(\cdot) = y_{N,t}(\cdot) \tag{13}$$

$$h_{T,t}(\cdot) + h_{N,t}(\cdot) = h^A_t + h^B_t \tag{14}$$

$$b^A_t(p_t) = b^B_t(p_t) = b_t(p_t) \tag{15}$$

Equation (12) describes the equilibrium condition in the market for tradable goods. Equation (13) describes the equilibrium condition in the market for non-tradable goods. Equation (14) describes the equilibrium condition in the labor market. Equation (15) describes the equilibrium condition in the market for bets. We refer to the set of variables that determine the demands and supplies as $(\cdot)$. Appendix A provides a full characterization of the demands and supplies.

2.7 Shocks and adjustments

2.7.1 Pre-sunspot dynamics

In every period before the sunspot occurs, agent A will lose the bet and agent B will win it. Therefore, the path of consumption of c_T and c_N of agent A (B) will be decreasing (increasing) over time (see propositions 1 and 2 in Guzman and Stiglitz, 2014).

Additionally, as agent A (B) is less wealthy (wealthier) in every period in which the sunspot does not occur, she will increase (decrease) her labor supply. These changes are of small magnitude, and if there are price changes that lead to wealth effects, they will be minor. We center our attention in the case in which the sunspot occurs, a moment when there are significant wealth effects associated with aggregate demand externalities.

2.7.2 Adjustments when the sunspot occurs

When $s_t = S$, agent A wins the bet and agent B loses. But both agents see that betting opportunities vanish, what implies the disappearance of pseudo-wealth for everyone. The society as a whole feels less wealthy. The economy will transit to a new equilibrium. The following timeline describes the dynamics of adjustment following the occurrence of the sunspot:

- If agent A feels wealthier, she will adjust her behavior by increasing c_T, increasing c_N, and reducing her labor supply h^A.[8]

[8] As we describe below, it is possible that even the winner of the bet perceives that is less

- Agent B will feel less wealthy, hence she will adjust her behavior by reducing c_T, reducing c_N, and increasing her labor supply h^B.

- • But there is destruction of pseudo-wealth after the sunspot that will not be compensated by the creation of an equivalent amount of new pseudo-wealth. Then, aggregate expected wealth will be lower than before the sunspot. The decrease in demand for goods and the increase in the labor supply of the bet loser will not be compensated by equivalent changes in the opposite direction in the demands and supplies of the bet winner. As a result, the aggregate demand for the tradable and the non-tradable good will fall, and the aggregate labor supply will increase.

- The decrease in the demand for non-tradable goods leads to a fall of demand for labor in the non-tradable sector and a decrease in the price of the non-tradable good.

- Further adjustments depend on the capacity of the tradable sector to absorb the excess of labor supply.

  - If there is a sufficiently large excess of capacity of land in the tradable sector, it will absorb the excess of labor supply. Wages would not fall. The adjustment process would end with a larger number of hours worked in equilibrium, a larger total labor income, and an improvement in the trade balance and in the current account.

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wealthy, due to the fall in wages implied by the adjustments triggered by the destruction of aggregate pseudo-wealth.

- If instead the land constraint is binding, there will be a lower aggregate labor demand and a decrease in wages. This is the case we continue analyzing.

- Note that there is a macroeconomic externality. Consumers of type A did not push the labor supply upwards, but they also receive a lower wage. The decrease in wages increases the value of real debt.

- As wages fall, there is a new round of new adjustments: now all agents want to reduce their demand for (tradable and non-tradable) goods, and to work more hours.

- The new adjustments lead to a further decrease in wages. The new equilibrium will feature a lower wage, lower labor income, a more depreciated real exchange rate (defined as the ratio between the price of the non-tradable good over the price of the tradable good), and an improvement in the trade balance and the current account.

In the new equilibrium, it is possible that even the winner of the bet is worse-off. This will be the case when the loss for consumer A associated with the decrease in wages outweighs the gain from the bet. If this situation arises,this consumer will be worse-off *always* –i.e., both when she loses and when she wins the bet. However, given that the others bet, she will still find optimal to bet –the macroeconomic externality will operate independently of her behavior.

2.7.3 Post-sunspot dynamics

After the sunspot, there is no more uncertainty. Therefore, consumption of the tradable and the no-tradable good will be smooth over time for all consumers, and will satisfy the marginal rates of substitution and the Euler equations that characterize the optimal solution (see Appendix).

2.7.4 The analytics of the adjustment

At the time the sunspot occurs, bets disappear, and pseudo-wealth disappears. The following propositions hold (see proofs in Appendix):

Proposition 1 *If* $s_t = S$, $c^B_{f,t+1} < c^B_{f,t}$, $f = T, N$.

Proposition 2 *If* $s_t = S$, $c_{f,t+1} < c_{f,t}$, $f = T, N$.

Proposition 1 establishes that the bet loser will decrease her consumption of both the tradable and the non-tradable good. The initial decrease in wealth for this consumer is amplified by the fall in wages.

Under "normal" circumstances, consumption of worker A (both of the tradable and the non-tradable good) would increase (although as explained below, the fall in wages that follows the sunspot could make even the winner of the bet worse-off, leading also to decrease in her demand for goods). Nevertheless, aggregate consumption of both goods will fall. This is the result established in proposition 2. From this last proposition, we obtain the following corollaries.

From proposition 2, we obtain the following corollaries:

Corollary 1 *If* $s_t = S$, $y_{T,t+1} - c_{T,t+1} > y_{T,t} - c_{T,t}$

Corollary 2 *If* $s_t = S$, $y_{N,t+1} < y_{N,t}$

Trade balance will improve, as domestic consumption falls but production does not fall (it will eventually remain the same if there was full utilization of land in the tradable sector before the sunspot). Instead, production of non-tradable goods falls.

Labor supplies will also respond to the occurrence of the sunspot:

Proposition 3 *If* $s_t = S$, $h^B_{t+1}(w_t) > h^B_t(w_t)$

Proposition 4 *If* $s_t = S$, $h_{t+1}(w_t) > h_t(w_t)$

where w_t is the equilibrium wage that prevails before the sunspot occurs.

3 Destabilizing adjustments

The presumption in conventional economic theory is that there exists a *stable* equilibrium in which resources are fully utilized. Adjustments in wages and prices play a key role to ensure the stability of the equilibrium. Only rigidities for wage and price adjustments would impede a quick transition to the new equilibrium.

In the model presented, the adjustments are indeed conducive to a new equilibrium. After the shock, there is full employment with lower wages –and "full employment" means that consumers voluntarily want to work less hours at the new wages, even though as a response to the shock they intended to work more hours (at the former wages). It is a full employment equilibrium, but one in which utility levels are significantly lower than prior to the shock

–and as we will demonstrate, possibly lower than if there were impediments to rapid changes in wages.

There is an alternative theory that suggests that the forces responding to the disequilibrum initially generated by a shock may actually be destabilizing. These theories, originating in Fisher (1933)'s theory of debt deflation, and revived in the 1980's and 1990's by Greenwald and Stiglitz, among others, argue that the problem is excessive price flexibility –the fall in prices or wages, in the presence of unindexed debt and other contracts, would increase leverage. This work calls attention to a different "market failure" than price rigidities: the incompleteness of markets and contracts. As in the general theory of the second best, correcting one market failure, i.e. making wages and prices more flexible, can exacerbate the consequences of other market failures.

These destabilizing adjustments can play an important role in our theory of pseudo-wealth induced fluctuations. The previous section explained how changes in the possibilities of exploiting different priors may lead to a large decrease in aggregate pseudo-wealth, and as a consequence also in aggregate consumption and labor demand. The restoration of full employment needs to offset the wealth effects, requiring large adjustments in wages and relative prices, especially if substitution effects are relatively weak compared to wealth effects. The "natural" adjustments lead to further reductions in expected wealth and lower aggregate demand, worsening the macroeconomic state.

Our model shows that it is plausible that the equilibrium with flexible wages is associated with lower production and aggregate labor income than the equilibrium with (somewhat) rigid wages. Suppose that there is a limit to the speed at which wages can change from one period to another, represented by the parameter θ that puts a lower bound to the value of wages in period t with respect to the value in period $t-1$:

$$w_t \geq \theta w_{t-1} \tag{16}$$

where $\theta \in [0,1]$. The condition $\theta = 1$ corresponds to the case of total downward wage rigidity, while the condition $\theta = 0$ would assure maximum wage flexibility.

Let w_t^* be the equilibrium wage when the sunspot occurs, and let $\bar{w}_t$ be the wage of the "constrained solution", i.e. the wage that would prevail when the constraint (16) is binding. When the wage rigidity constraint binds, there will be excess labor supply, and the level of employment will be $h_{T,t}(\bar{w}_t)+h_{N,t}(\bar{w}_t)$.

If $\bar{w}_t \leq 1$, then there will be full utilization of land in the tradable sector, and the demand for labor in that sector will be

$$h_{T,t} = \gamma \bar{X}$$

In the appendix, we show that the equilibrium with wage rigidity may be associated with larger total labor income than the solution with wage flexibility. This would be the case if

$$w_t^*[h_{T,t}(w_t^*) + h_{N,t}(w_t^*)] < \bar{w}_t[h_{T,t}(\bar{w}_t) + h_{N,t}(\bar{w}_t)] \tag{17}$$

In the appendix, we show that the above inequality will hold if (see appendix)

$$(p_{N,t}\alpha)^{\frac{1}{1-\alpha}} w_t^{*\frac{\alpha}{\alpha-1}} - (p_{N,t}\alpha)^{\frac{1}{1-\alpha}} \bar{w}_t^{\frac{\alpha}{\alpha-1}} < (\bar{w}_t - w_t^*)\gamma\bar{X} \tag{18}$$

The above inequality is more likely to hold when (i) the size of the tradable sector is larger; (ii) the elasticity of labor demand to wages in the non-tradable sector is not too large. When that is the case, the restoration of full employment requires a large fall in wages. The optimal policy in this context (assuming the profits of foreign firms receive no weight in the welfare function) would be to set the wage $\bar{w}_t = 1$, a solution that would maximize labor income and would reduce the profits in the tradable sector to zero.

We have shown that with a market failure different than wage rigidities, it is then plausible that a slower pace of decline in wages leads to an increase in total labor income, as the new rigidity would impose a redistribution of wealth from foreign firms to consumers.[9]

The intuition is the following, and is seen most easily in the case where the land constraint is binding. Lower wages increase the profits of the foreign owners of firms. But since they buy none of the non-tradable good, as income is transferred to them, the demand for non-tradable goods goes down. Workers are thus doubly hurt by the wage reduction, both as a result of the transfer of income and as a result of a decrease in aggregate demand for the non-tradable good, which cannot be compensated for by an increase in the demand for the tradable good. With rigid wages, workers work less than they would have liked, but the demand for the non-tradable good is higher,

[9] The "paradox of wage flexibility" has also recently been pointed out by Eggertsson and Krugman (2012).

and labor income is doubly higher.[10]

This redistribution of profits has positive amplification effects on the economy through demand effects. The larger labor income leads to a higher demand for both the tradable and the non-tradable good. While the higher demand for the tradable good does not alter its level of production (but decreases the trade balance), the higher demand for the non-tradable good leads to an increase in their price and production, and an associated increase in the demand for labor in the non-tradable sector. These adjustments lead to further increases in aggregate demand, until a new equilibrium (where the wage constraint may be binding or not) is reached. If these demand effects are strong, the new equilibrium could even feature a larger level of production of non-tradable goods and employment than in the equilibrium with flexible wages. Generally, this will be the case when the demand effect is more important than the substitution effect.

4 Notes on Welfare

Is the betting equilibrium socially desirable? Should betting be banned? Answering these questions requires a criterion for dealing with heterogeneous beliefs.

[10] It is understandable, in this context, why the owners of the foreign firms and those representing their interests would argue for the virtue of wage flexibility.

4.1 Respecting individual beliefs

There are deep philosophical questions regarding what beliefs should be used for determining policy interventions.

The standard argument is that we should respect individual's own beliefs and preferences. Normally, that would imply that betting should be allowed, since individuals' ex ante expected utility is increased. There is nothing more than an economist can say (according to this view).

But in the case of our model, that perspective is not persuasive. On the one hand, there are general equilibrium consequences, and it is only under very special conditions that market equilibrium is Pareto efficient. On the other hand, even if the betting equilibrium is Pareto efficient, it will lead to lower levels of output *in every period*. If we followed the Pareto efficiency criterion respecting individual beliefs, we would conclude that it would be optimal to create a market that leads to lower production in the economy *always*. This possibility raises unsettling questions in terms of welfare analysis.

Betting creates variance of output and consumption in an economy that would otherwise be stable. As each individual is atomistic, each of them correctly perceives that her individual behavior will have no effect on variances.

There are different scenarios in terms of the optimality of the decentralized solution. In one scenario, everyone will feel better off *given her individual beliefs* when betting is possible. This will be the case when the increase in expected wealth as a consequence of betting more than compensates for the costs of the increase in the variance of consumption –an increase that should be larger for type B consumers, who will have a negative payoff on the bet precisely at the time they receive less income, i.e., when wages fall. In this case and under this criterion, the betting equilibrium is Pareto efficient.

In another scenario, everyone could feel worse-off when betting is possible, *given her individual beliefs.* This case would arise when the fall in wages after the sunspot occurs is so large that the net effect on the market for bets on expected utility is negative for everyone. The betting equilibrium would then be inefficient, and prohibiting the bet could increase everyone's welfare (at least within this economy).[11]

While this analysis says that betting has made both parties better off relative to the no betting equilibrium it does not say that there aren't some interventions which could make both groups better off. Indeed, the previous section showed that there were–reducing wage flexibility. We have not examined other interventions, such as a tax on betting.

4.2 Taking a stance on beliefs

A criterion that requires respecting individual beliefs may be overly constraining. For instance, if we were trying to decide social policy behind a veil of ignorance, where individuals knew that there were differences in beliefs, but they didn't know whether they would be born optimists or pessimists, then there is a long tradition arguing for evaluating policy using a utilitarian criterion, where we maximize the sum of utilities. Since betting increases variances–and by lowering wages, redistributes money to foreign capitalists–there is some presumption that betting should be banned.

A criterion that requires respecting individual beliefs would significantly

[11]Remember, we are not including the welfare of the foreign owned companies.

constrain the scope of action of the planner, and could effectively undermine the planner's mandate. An alternative criterion for welfare analysis gives the planner the freedom to take a stance on the set of beliefs she considers reasonable, and to act accordingly.

Brunnermeier, Simsek, and Xiong (2014) propose a criterion that follows the latter approach. They propose that the planner uses *reasonable beliefs*, defined as any convex combination of individual beliefs, $\lambda^R = \sum_{i=A,B} a_i \lambda^i$, with $\sum_{i=A,B} a_i = 1$. We can establish that for any λ^R, and for a utilitarian welfare function, welfare is lower when the market for bets exists than when it is prohibited. Then, there would exist a set of taxes and lump sum payments such that consumers of both types are better off if *we compute their welfare using the planner's reasonable beliefs*.

The intuition is the following. Under reasonable beliefs, there cannot be creation and destruction of pseudo-wealth. Then, the decreases in production that would otherwise occur cannot occur either. The planner may believe that the belief of one type of consumer is more correct than the one of the other type of consumer. If this were the case, the planner would still find optimal to prohibit the bet, and to redistribute resources from the consumer that is "relatively wrong" to the consumer that is "relatively right". From the planner's beliefs viewpoint, everyone would be better off with this solution, as the expected value of wealth (from the planner's perspective) would be larger, and consumption would be stable over time. Of course, the consumer whose beliefs the planner considers to be wrong will not feel better off ex-ante (from the viewpoint of her own beliefs).

5 Conclusions

Much of well-established macro-economic theory relies on the assumption of common beliefs. It should be clear that such an assumption is not consistent with much observed economic behavior (besides, the literature on global games has shown how fragile equilibrium analysis can be to the assumption of common knowledge). The key question is whether it is only a convenient simplifying assumption with no major consequences for explaining important macroeconomic issues, or it misses issues that are especially significant in times of macroeconomic instability.

This paper has suggested that differences in beliefs can play an important role in explaining macro-economic fluctuations. Our analysis focused on the concept of pseudo-wealth, and the associated notion that there can be large changes in perceptions of aggregate expected wealth even when there are no changes in the real factors of production of the economy. We have shown that the sum of the present discounted value of individuals' "planned" consumptions may (because of differences in beliefs that can be exploited through betting and other markets) exceed the feasibility set during times, only to fall short of the feasibility set later on. These fluctuations have repercussions on the aggregate economy: We have shown how fluctuations in the possibility of exploiting differences in beliefs give rise to large fluctuations in pseudo-wealth, and thereby, into aggregate demand and economic activity.

Contrary to the standard wisdom, we have also seen that in the presence of non-contingent debt contracts and macroeconomic externalities, the natural adjustments may exacerbate the economic downturn, moving the economy to an equilibrium with lower aggregate labor income than would be obtained under non-fully flexible wages. Then, an optimal policy might be directed towards *reducing* rather than increasing wage flexibility.[12]

Finally, the paper has shown that there are plausible circumstances under which completing markets leads to lower production in the economy in every period. Even if by respecting individual beliefs everyone feels better-off with the creation of the market for bets, everyone would also know that the economy would produce less. Still, under the standard welfare criterion, creating this market would be optimal –a result that raises unsettling questions in terms of welfare analysis. Instead, if the planner takes a stance on a particular set of beliefs, there would be interventions that entail the prohibition of the betting markets that would result in increases in social welfare.

[12]It is perhaps worth noting that President Roosevelt's response to the Great Depression was predicated on such a belief.

A Consumers

A.1 No default condition

Default is ruled out by assumption. Then, debt can never exceed the present discounted value of incomes associated with the worst-case scenario for each agent.

The worst-case scenario for agent B is the realization of the sunspot. After the sunspot occurs, there is no more uncertainty. Denoting the equilibrium values after the sunspot with the subscript **, agent B will face the following constraint:

$$d_t^B \leq \sum_{j=t}^{\infty} \frac{w_j^{**} h_j^{B**}}{(1+r)^j} - (1+r) d_{t-1}^B \tag{19}$$

The worst-case scenario for agent A will "normally" B to lose the bet in every period. But it is also possible that she is worse-off when she wins the bet, due to the negative macroeconomic externality that arises in that period due to the destruction of pseudo-wealth that may have large negative effects on the equilibrium wage. In the last case, the expression for her debt limit would be equivalent as the one for agent B:

$$d_t^A \leq \sum_{j=t}^{\infty} \frac{w_j^{**} h_j^{A**}}{(1+r)^j} - (1+r) d_{t-1}^A \tag{20}$$

In the "normal" case, denoting the equilibrium values when the sunspot does not occur with the subscript *, she will face the following constraint:

$$d_t^A \leq \sum_{j=t}^{\infty} \frac{w_j^{*} h_j^{A*}}{(1+r)^j} - (1+r) d_{t-1}^A \tag{21}$$

A.2 Consumers-Workers' problem

Let H_t be the set of possible histories of states in period t. [13] Let $\eta_{t,k} \in H_t$ be a particular history of states at time t, with $k \in [1, t]$.

The Lagrangian of consumers A and B for the optimization problem are described by

$$\mathcal{L}_t^A = E_t^A \sum_{j=t}^{\infty} \beta^j U_j^A + \sum_{j=t}^{\infty} \sum_{\eta_{j,k} \in H_j; k \leq j} \mu^A_{j,\eta_{j,k}} [w_{j,\eta_{j,k}} h^A_{j,\eta_{j,k}} + d^A_{j,\eta_{j,k}} - c^A_{T,j,\eta_{j,k}} - p_{N,j,\eta_{j,k}} c^A_{N,j,\eta_{j,k}} - (1+r)(d^A_{j-1,\eta_{j-1,k}} - P^A_{j-1} b^A_{j-1,\eta_{j-1,k}}) - p_{j,\eta_{j,k}} b^A_{j,\eta_{j,k}}] \tag{22}$$

$$\mathcal{L}_t^B = E_t^B \sum_{j=t}^{\infty} \beta^j U_j^B + \sum_{j=t}^{\infty} \sum_{\eta_{j,k} \in H_j; k \leq j} \mu^B_{j,\eta_{j,k}} [w_{j,\eta_{j,k}} h^B_{j,\eta_{j,k}} + d^B_{j,\eta_{j,k}} - c^B_{T,j,\eta_{j,k}} - p_{N,j,\eta_{j,k}} c^B_{N,j,\eta_{j,k}} - (1+r)(d^B_{j-1,\eta_{j-1,k}} - P^B_{j-1,\eta_{j-1,k}} b^B_{j-1}) + p_{j,\eta_{j,k}} b^B_{j,\eta_{j,k}}] \tag{23}$$

where $\mu^i_{j,\eta_{j,k}}$ is the Lagrange multiplier of agent i's problem associated with the budget constraint that prevails in period j if the history of states is η_{jk}.

The necessary conditions for the consumers' utility maximization problem (assuming interior solutions) are given by the following expressions:

$$c^i_{T,t}: \ \beta^t u_{T,t} - \mu^i_t = 0^{14} \tag{24}$$

$$c^i_{T,t+1,\eta_{t+1,k}}: \ \beta^{t+1} u_{T,t+1,\eta_{t+1,k}} - \mu^i_{t+1,\eta_{t+1,k}} = 0 \tag{25}$$

$$\beta^{t+1} E_t u_{T,t+1} = \sum_{\eta_{t+1,k} \in H_{t+1}} \mu^i_{t+1,\eta_{t+1,k}} \tag{26}$$

[13] Note that by assumption there are t possible particular histories of states in period t. For example, for $t = 4$, the set of possible histories is $H_4 = \{OOO, OSO, SOO, OOO\}$.

[14] Note that if t is the period, then $H_t = \{\emptyset\}$, and then $\mu^i_{t,\eta t,k} = \mu^i_t$. In general, past history is irrelevant, and we count the set of possible histories since the current period.

$$c^i_{N,t}: \ \beta^t u_{N,t} - p_{N,t}\mu^i_t = 0 \tag{27}$$

$$h^i_t: \ \beta^t u_{h,t} - w_t \mu^i_t = 0 \tag{28}$$

$$h^i_{t+1}: \ \beta^{t+1} u_{h,t+1} - \mu^i_{t+1,\eta_{t+1,k}} w_{t+1,\eta_{t+1,k}} = 0 \tag{29}$$

$$\beta^{t+1} E_t u_{h,t+1} = \sum_{\eta_{t+1,k} \in H_{t+1}} \mu^i_{t+1,\eta_{t+1,k}} w_{t+1,\eta_{t+1,k}} \tag{30}$$

$$d^i_t: \ \mu_t - (1+r) \sum_{\eta_{t+1,k} \in H_{t+1}} \mu^i_{t+1,\eta_{t+1,k}} = 0 \tag{31}$$

$$b^A_t: \ -p_t \mu^A_t + \mu^A_{t+1,\eta_{t+1}=S} = 0 \tag{32}$$

$$b^B_t: \ p_t \mu^B_t - \mu^B_{t+1,\eta_{t+1}=S} = 0 \tag{33}$$

Conditions (32) and (33) only hold before the sunspot, as betting is no longer possible once the sunspot occurs.

Then, in equilibrium the following marginal rates of substitution (MRS) must be satisfied:

$$MRS_{c_{N,t},c_{T,t}} = \frac{u_{T,t}}{u_{N,t}} = \frac{1}{p_{N,t}} \tag{34}$$

$$MRS_{h_t,c_{T,t}} = \frac{u_{T,t}}{u_{h,t}} = -\frac{1}{w_t} \tag{35}$$

$$MRS_{h_t,c_{N,t}} = \frac{u_{N,t}}{u_{h,t}} = -\frac{p_{N,t}}{w_t} \tag{36}$$

The optimal intertemporal path of consumption of tradable goods must satisfy the following Euler equation:

$$u^i_{T,t} = (1+r)\beta E_t u^i_{T,t+1} \tag{37}$$

The optimal intertemporal path of employment must satisfy the following

Euler equation:

$$(1+r)\beta E_t u^i_{h,t+1} = u^i_{h,t} \frac{\sum_{\eta_{t+1,k} \in H_{t+1}} \mu^i_{t+1,\eta_{t+1,k}} w_{t+1,\eta_{t+1,k}}}{w_t \sum_{\eta_{t+1,k} \in H_{t+1}} \mu^i_{t+1,\eta_{t+1,k}}} \tag{38}$$

A.3 Pseudo-wealth

Before the sunspot occurs, pseudo-wealth will be created. Aggregate pseudo-wealth will be increasing in the discrepancy of beliefs, $\lambda^A - \lambda^B$. Individual pseudo-wealth will be increasing in the difference between λ^i and the equilibrium betting price p.

In equilibrium, one-period pseudo-wealth of consumers A and B is given by

$$PW^A_t = (\lambda^A - p_t) b_t \tag{39}$$

$$PW^B_t = (p_t - \lambda^B) b_t \tag{40}$$

We denote the expected present discounted value of pseudo-wealth of consumer i as $E_t PW^i$.

Consumers' demands for goods and labor supplies are given by

$$c^i_{T,t} = c^i_T(p_{N,t}, w_t, E_t PW^i, d^i_{t-1} - P^i_{t-1}; \beta, r) \tag{41}$$

$$c^i_{N,t} = c^i_N(p_{N,t}, w_t, E_t PW^i, d^i_{t-1} - P^i_{t-1}; \beta, r) \tag{42}$$

$$h^i_t = h^i(p_{N,t}, w_t, E_t PW^i, d^i_{t-1} - P^i_{t-1}; \beta, r) \tag{43}$$

where $c^i_{T,t}$ and $c^i_{N,t}$ are increasing in $E_t PW^i$ and decreasing in $d^i_{t-1} - P^i_{t-1}$ (as realization of states act as permanent wealth shocks; see Guzman and

Stiglitz; 2014), and h_t^i is decreasing in $E_t PW^i$ and increasing in $d_{t-1}^i - P_{t-1}^i$.

B Firms

B.1 Non-tradable sector

Employment in the non-tradable sector is given by

$$h_{N,t} = \left(\frac{\alpha p_{N,t}}{w_t}\right)^{\frac{1}{1-\alpha}} \tag{44}$$

B.2 Tradable sector

Optimality requires

$$h_{T,t} = \gamma X_t \tag{45}$$

If

$$w_t \leq 1 \tag{46}$$

there will be full utilization of land in the tradable sector.

C Adjustments after the sunspot

When the sunspot occurs, betting is no longer possible, and pseudo-wealth vanishes. The realization of the sunspot removes the uncertainty on the budget constraints.

C.1 Initial effects

Note that in the period the sunspot occurs, *ceteris paribus* $\mu^A_{t+1\eta_{t+1,S}} > \mu_t > \mu^A_{t+1,\eta_{t+1,O}}$ and $\mu^B_{t+1,\eta_{t+1,S}} < \mu_t < \mu^B_{t+1,\eta_{t+1,O}}$, as agent A wins the bet when the sunspot occurs (and the gain from the bet cannot be smaller than expected pseudo-wealth). Therefore, if the sunspot occurs in period t and if w_t and $p_{N,t}$ did not change after the realization of the sunspot, we would observe $c^A_{g,t+1} > c^A_{g,t}$, $c^B_{g,t+1} < c^B_{g,t}$, $g = T, N$; and $h^A_{t+1} < h^A_t$, $h^B_{t+1} > h^B_t$.

The *initial* total change in consumption of the tradable and non-tradable good and in labor supply are described by

$$dc^I_{T,t} = \sum_{i=A,B} \frac{\partial c^i_{T,t}}{\partial E_t PW^i} dE_t PW^i + \sum_{i=A,B} \frac{\partial c^i_{T,t}}{\partial (d^i_{t-1} - P^i_{t-1})} d(d^i_{t-1} - P^i_{t-1}) \quad (47)$$

$$dc^I_{N,t} = \sum_{i=A,B} \frac{\partial c^i_{N,t}}{\partial E_t PW^i} dE_t PW^i + \sum_{i=A,B} \frac{\partial c^i_{N,t}}{\partial (d^i_{t-1} - P^i_{t-1})} d(d^i_{t-1} - P^i_{t-1}) \quad (48)$$

$$dh^{ls^I}_t = \sum_{i=A,B} \frac{\partial h^i_t}{\partial E_t PW^i} dE_t PW^i + \sum_{i=A,B} \frac{\partial h^i_t}{\partial (d^i_{t-1} - P^i_{t-1})} d(d^i_{t-1} - P^i_{t-1}) \quad (49)$$

where the subscripts I and ls refer to "initial effects" and "labor supply" (as different of labor in equilibrium), respectively.

There are conditions under which $\sum_{i=A,B} \frac{\partial c^i_{T,t}}{\partial (d^i_{t-1} - P^i_{t-1})} d(d^i_{t-1} - P^i_{t-1}) \approx 0$ (this is the case in Guzman and Stiglitz (2014) under a quadratic utility function), $\sum_{i=A,B} \frac{\partial c^i_{N,t}}{\partial (d^i_{t-1} - P^i_{t-1})} d(d^i_{t-1} - P^i_{t-1}) \approx 0$, and $\sum_{i=A,B} \frac{\partial h^i_t}{\partial (d^i_{t-1} - P^i_{t-1})} d(d^i_{t-1} - P^i_{t-1})$.

Therefore, as $E_t PW^i$ vanishes $\forall i$ when the sunspot occurs, we obtain $dc_{T,t} < 0$, $dc_{N,t}$, and dh^{ls}_t as the initial effects of the shock.

C.2 Amplification effects

At the former equilibrium wage w_t^*, there is excess of labor supply. Assuming full utilization of land, the new equilibrium w_t^{**} must satisfy the equilibrium condition (14) –rewritten below:

$$\gamma\bar{X}+\left(\frac{\alpha p_{N,t}}{w_t^{**}}\right)^{\frac{1}{1-\alpha}} = h^A(p_{N,t}, w_t, E_tPW^i, d_{t-1}^i - P_{t-1}^i; \beta, r) + h^B(p_{N,t}, w_t^{**}, E_tPW^i, d_{t-1}^i - P_{t-1}^i; \beta, r) \tag{50}$$

The fall in wages is amplified by the adjustments to the shock: the fall in demand for non-tradable goods decreases the equilibrium value of $p_{N,t}$ and $h_{N,t}$, what leads to a decrease in w_t, which further depresses demand both for tradable and non-tradable goods.

The new equilibrium wage is lower: $w_t^{**} < w_t^*$. The fall in wages will amplify the fall in consumption (it reinforces the fall in consumption for agent B, and counterbalances (and might even reverse) the increase in consumption for agent A). The *final* total change in consumption of the tradable and non-tradable good and in labor supply are described by

$$dc_{T,t}^F = \sum_{i=A,B} \frac{\partial c_{T,t}^i}{\partial w_t} dw_t + \sum_{i=A,B} \frac{\partial c_{T,t}^i}{\partial E_tPW^i} dE_tPW^i + \sum_{i=A,B} \frac{\partial c_{T,t}^i}{\partial (d_{t-1}^i - P_{t-1}^i)} d(d_{t-1}^i - P_{t-1}^i) < dc_{T,t}^I \tag{51}$$

$$dc_{N,t}^F = \sum_{i=A,B} \frac{\partial c_{N,t}^i}{\partial w_t} dw_t + \sum_{i=A,B} \frac{\partial c_{N,t}^i}{\partial E_tPW^i} dE_tPW^i + \sum_{i=A,B} \frac{\partial c_{N,t}^i}{\partial (d_{t-1}^i - P_{t-1}^i)} d(d_{t-1}^i - P_{t-1}^i) < dc_{N,t}^I \tag{52}$$

$$dh_t^{ls^F} = \sum_{i=A,B} \frac{\partial h_t^i}{\partial w_t} dw_t + \sum_{i=A,B} \frac{\partial h_t^i}{\partial E_tPW^i} dE_tPW^i + \sum_{i=A,B} \frac{\partial h_t^i}{\partial (d_{t-1}^i - P_{t-1}^i)} d(d_{t-1}^i - P_{t-1}^i) < dh_t^{ls^I} \tag{53}$$

where the subscript F refers to "final effects".

D TO BE COMPLETED

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