On the Propagation of Demand Shocks*

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March 19, 2018

Updated draft, with new model, to be posted soon
See slides: https://economics.mit.edu/files/14903

Abstract

This paper develops a novel theory of how an exogenous drop in consumer spending can trigger a powerful feedback loop between demand and supply, leading to a sizable recession. Unlike the New Keynesian framework, our theory does not hinge on nominal rigidities and on the failure of monetary policy to replicate flexible prices; it also bypasses the empirical failings of old and new Philips curves. Instead, our theory is based on the premise that firms and consumers alike cannot perfectly disentangle idiosyncratic from aggregate shocks and cannot reach common knowledge of the movements in intra- and inter-temporal relative prices. This opens the door to misperceptions of returns to production in the supply side and to misperceptions of income in the demand side. These misperceptions reinforce each other through a general-equilibrium feedback loop that resembles the Keynesian narrative of how demand shocks drive the business cycles.

*An earlier version was entitled “A (Real) Theory of the Keynesian Multiplier.” For helpful comments and suggestions, we thank seminar participants at NYU, MIT, and the 2018 AEA meeting.
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1 Introduction

Can a negative aggregate demand shock, such as a drop in consumer spending triggered by a collapse in housing wealth or by pessimistic beliefs about the future, trigger a recession? A popular narrative suggests yes: the drop in consumer spending is said to cause a fall in aggregate employment and income, which in turn feed back to a further drop in consumer spending, and so on.

This narrative is captured by the Keynesian cross of the old IS-LM framework, but finds no place in the RBC model. This is because the general-equilibrium adjustment in the real interest rate offsets the direct, partial-equilibrium effect of the demand shock. The New Keynesian framework fixes this problem by introducing nominal rigidities, preventing monetary policy from implementing the “natural” rate of interest, and effectively equating a demand-driven recession with a monetary contraction.\footnote{This works, but raises two challenges. One is conceptual: presumably, one would like to make sense of the Great Recession and, more generally, of the idea that shifts in aggregate demand can trigger business cycles even when nominal rigidities are negligible or non-binding. The other is empirical: in the absence of appropriate bells and whistles, the New Keynesian model predicts, counterfactually, that the Great Recession should have been the Great Deflation or, more generally, that inflation should co-move strongly with output and employment. This prediction is embedded in old and new versions of the Philips curve, the evidence for which is quite disconcerting, to say the least.}

This paper attempts to make sense of demand-driven business cycles without nominal rigidity. At the core of our theory is a friction in the agents’ ability to disentangle the forces that drive the variation in the behavior of others (supply and demand) and in their own fortunes (terms of trade and income). This friction allows aggregate demand shocks to trigger realistic business cycles even when prices are flexible and monetary policy is neutral; it bypasses the empirical failings of old and new Philips curves; and it rationalizes sizable fiscal multipliers without commensurate inflationary pressures.

Preview. The backbone of our model is a minimalistic general-equilibrium economy of the kind that is the heart of the neoclassical framework. We simplify the analysis by assuming two periods (“today” and “tomorrow”, or “short run” and “long run”); by abstracting from investment; and by assuming a GHH specification for preferences (which shuts down any wealth effects on labor supply). We let an exogenous shock to the discount factor of the households proxy for shifts aggregate demand. We finally abstract from any kind of nominal rigidity and impose monetary neutrality.

The representative-agent version of this model shares the predictions of the textbook RBC model and provides a stark benchmark for comparison. In this benchmark, the aforementioned shock is predicted to have no effect on employment, output, and consumption. The reason is that, in the absence of investment, the general-equilibrium adjustment in the real interest rate perfectly offsets the direct, or partial-equilibrium, effect of the shock on consumer spending and labor supply.\footnote{Adding investment makes things worse: in general equilibrium, the decrease in consumption is accompanied by an increase in employment, output, and investment.}

We depart from this benchmark by populating the economy with a large number of consumers and producers (“farmers”), who face a variety of idiosyncratic shocks in addition to the aforementioned aggregate shock, and who interact in decentralized markets (“islands”). Each household contains a
single farmer and multiple consumers. The farmer-member of any household is matched to a particular island and produces a single good, whereas the consumer-members are spread across many islands and consume many goods. This is meant to capture the fact that there is far more specialization in production than in consumption. It also lets an island represent a market between a firm and a set of consumers that are neither the owners nor the employees of that firm.

To guarantee monetary neutrality and distinguish our contribution from the older literature on nominal confusion (Lucas, 1972, Barro 1976), we let all prices be denominated in real terms, relative to a composite of the goods produced and consumed in the second period. Furthermore, we allow the firms to condition their prices on the realized local demand. In this sense, prices are flexible and adjust to the point in which supply intersects demand. We nevertheless introduce a friction by requiring that decisions and trades be informationally segmented in the following sense: the firms (respectively, the consumers) have perfect knowledge of the demand (respectively, the prices) in their own islands, but not necessarily of the relevant outcomes in other islands. Because the decisions and the trades that take place in one island depend on beliefs of the outcomes in other islands, the assumed friction amounts to introducing an imperfection in the coordination of economic decisions.

In our baseline model, this imperfection obtains, not only across the different households, but also across the different decisions of the same household. We interpret such within-household friction as a form of bounded rationality and relate it to “metal accounting” in Thaler (1985, 1999) and to “local thinking” in Lian (2018). Although we believe that such bounded rationality is plausible per se, in a variant we dispense with it in order to clarify that our results do not hinge on it.

One way or another, the essential ingredients of our theory are two. First, we open the door to misperceptions of the returns to production in the supply side and to misperceptions of income in the demand side. And second, we let these misperceptions reinforce each other, and propagate from one island to another, through general-equilibrium feedback loops. Whether these misperceptions are rationalized by informational frictions or are the product of bounded rationality is of secondary importance for our purposes.

Consider now an aggregate discount-rate shock which, other things equal, causes the consumers in some of the islands to cut down on their spending. Take any of the affected islands. Holding constant the outcomes in all other islands, the underlying shock triggers a drop in the demand faced by each farmer (or firm) in her own island. Because information is incomplete, some farmers fail to understand that the drop in their demand is due to aggregate rather than idiosyncratic reasons. As a result, these farmers fail to anticipate the adjustments that are likely to take place in other islands, find it optimal to work less, and encourage their consumer-siblings to spend less. But as these consumers spend less, other farmers experience a further drop in their demand. These farmers may now find it optimal to

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3An extension, however, introduces a nominal unit of account in order to offer a more realistic interpretation of our mechanism and to explore some interactions with monetary policy.
work less and to encourage their own siblings to spend less, even if they themselves are fully aware that the initial trigger was an aggregate discount-rate shock and even if that shock had no direct effect on their island. An extra round of reduction in production, employment, and consumption therefore takes place. And so on.

A more realistic version of our theory replaces the farmers with collections of firms and workers (and adds labor markets). In response to the aggregate discount-rate shock, some firms see a decrease in the demand for their products and start hiring less. Some workers see wages go down, or unemployment go up, and start spending less. Additional firms then see their demand go down and respond by contributing to even less hiring. And so on.

Our main analysis abstracts from investment. This sharpens the analysis by guaranteeing that the frictionless level of employment and output are invariant to the shock. In an extension, however, we show that the logic of our results directly extends from the firms’ incentives to hire to the firms’ incentives to invest, so that consumption, employment and investment move in tandem.

Another extension introduces government spending in order to let our theory speak to fiscal policy. By accommodating a mechanism akin to the Keynesian multiplier, our paper allows fiscal stimuli to have large effects. But unlike the New Keynesian model, the fiscal multipliers in our setting does not hinge either on monetary policy or inflationary pressures. Furthermore, our theory favors the front-loading of fiscal stimuli. This is because the effects of fiscal stimuli are maximized when the firms experience the increase in their sales and the consumers experience the increase in their income. This is yet another contrast to the New Keynesian model. The latter favors backloading because that helps pile up inflationary expectations.

Related literature. Our paper is most closely related to Lucas (1972). We borrow from that paper the basic idea that agents may confuse aggregate shocks for idiosyncratic shocks. But whereas Lucas uses such confusion to break monetary neutrality, we use it to modify the GE propagation of non-monetary demand shocks. Furthermore, whereas Lucas allows the confusion to affect only the supply side of the economy, we let it give rise to a Keynesian feedback loop in the demand side.

Our paper shares with Angeletos and Lian (2016a, 2017) the theme that informational frictions can help reduce the gap between PE intuitions and GE predictions. It also shares with Angeletos and La’O (2013), Angeletos et al. (2015), Benhabib et al. (2015), and Huo and Takayama (2015) the theme that frictions in information and coordination can help accommodate the Keynesian view of the business cycle without a reliance on nominal rigidities and without the empirical challenges of old and new Philips curves. However, the context is different and the identified mechanism is novel.4

4In particular, whereas the latter set of papers attribute the business cycle to extrinsic belief shocks akin to animal spirits, our paper allows it to be triggered by intrinsic demand shocks that easier to map to evidence such as that in Mian et al. (2013) and Mian and Sufi (2014). A similar point distinguishes our paper paper from the literature on coordination failures and sunspot fluctuations (Diamond, 1982; Cass and Shell, 1983; Cooper and John, 1988; Benhabib and Farmer, 1999), as well as from that of Ilut and Schneider (2014) on ambiguity aversion and uncertainty shocks.
Closely related, and quite complementary, are the recent papers by Ilut and Saijo (2016) and Chahrour and Gaballo (2017). The first paper shares with ours the strategy of using a belief-centric mechanism to modify the propagation of demand (and other) shocks. But the mechanism in that paper is based on the interaction of learning and ambiguity aversion, whereas ours is based on rational misperceptions of terms of trade and of income. The second paper allows aggregate productivity shocks to be confused with idiosyncratic endowment shocks. It therefore shares with our paper the focus on rational confusion in the demand side, but addresses a different question. It also does not feature the kind of Keynesian feedback loop that is at the core of our paper.

Like our paper, Beaudry and Portier (2013) and Bai et al. (2017) also try to make sense of demand-driven fluctuations without nominal rigidities. The first paper focuses on the interaction of incomplete risk sharing with news shocks about the future productivity prospects of the economy. The second allows search frictions in product markets transform preference shocks to endogenous movements in current TFP. Our paper instead allows the demand shocks to be disconnected from either current or future TFP movements, a property that seems empirically desirable.

Last but not least, our focus on the interaction of informational frictions and demand shocks is reminiscent of Lorenzoni (2009). That paper uses informational frictions to develop a theory of demand shocks: it attributes such shocks to noise in consumer expectations of future productivity and future income. However, the propagation of these shocks in that paper is the same as in the standard New Keynesian model: demand shocks generate realistic business cycles only because there is nominal rigidity and monetary policy fails to replicate flexible prices, as in the standard New Keynesian model. By contrast, our paper develops a new theory of the propagation of demand shocks.

**Layout.** Section 2 reviews a simplified version of the RBC model, which serves as a stepping stone for the rest of the analysis. Section 3 introduces our baseline model. Section 4 contains our main results. Section 5 considers a few extensions and discusses the broader insights. Section 6 concludes.

## 2 Preamble: Demand Shocks in the RBC Framework

In this section we study a minimalistic, general-equilibrium economy, featuring competitive markets, a representative consumer and a representative firm. This allows us to review why “demand shocks” cannot generate realistic business cycles in the RBC framework and to highlight how GE effects up-end PE intuitions. Importantly, the economy considered here is also the backbone of the richer, heterogeneous-beliefs economy we study in the rest of the paper: when we shut down the informational friction, the business cycle properties of the two economies coincide.

**Set up.** There are two periods, indexed by \( t \in \{1, 2\} \). In each period, there is a single perishable good that is produced by the representative firm with the use of the household's labor. The firm's
output in period $t$ is given by

$$y_t = \ell_t,$$

(1)

and her profit is given by $\pi_t = y_t - w_t \ell_t$, where $\ell_t$ denotes the labor input and $w_t$ denotes the real wage. The firm’s problem is to maximize her profit subject to (1).

Consider next the representative household. Her preferences are given by

$$U(c_1, \ell_1) + \bar{\beta} U(c_2, \ell_2),$$

(2)

where $c_t$ and $\ell_t$ denote, respectively, consumption and labor supply in period $t$, $U$ is the per-period utility function, and $\bar{\beta}$ is an exogenous preference shock that determines how much the household values the first-period goods relative to the second-period goods. In line with the literature (e.g., Eggertsson and Woodford, 2003; Christiano et al., 2015), we interpret $\bar{\beta}$ as a proxy for credit shocks in the consumer side of the economy, for changes in consumer confidence, and, more broadly, for exogenous shifts in consumer spending; in short, $\bar{\beta}$ defines the “aggregate demand shock.” The household’s problem is to maximize (2) subject to the following intertemporal budget constraint:

$$P_1 c_1 + P_2 c_2 = P_1 (w_1 l_1 + \pi_1) + P_2 (w_2 l_2 + \pi_2)$$

(3)

where $P_t$ is the price of the period-$t$ good denominated in an arbitrary numeraire. We normalize $P_2 = 1$, which makes $P_1$ the price of current goods relative to future goods, a.k.a. the real interest rate. Finally, to simplify the analysis and shut down any wealth effects on labor supply, we let preferences take a GHH form: $U(c, \ell) = u(c - v(\ell))$, where $u$ is strictly increasing and strictly concave, $v$ is strictly increasing and strictly convex, and both are differentiable.

**Equilibrium.** The firm’s optimal behavior imposes

$$w_t = 1 \quad \text{and} \quad \pi_t = 0 \quad \forall t \in \{1, 2\}.$$  

The optimality conditions of the household, on the other hand, are as follows:

$$U_{\ell}(c_t, \ell_t) = w_t U_c(c_t, \ell_t) \quad \forall t \in \{1, 2\}; \quad \text{and} \quad U_c(c_1, \ell_1) = P_1 \bar{\beta} U_c(c_2, \ell_2).$$

(4)

An equilibrium is then a vector $(c_1, \ell_1, y_1, w_1, c_2, \ell_2, y_2, w_2, P_1)$ that satisfies all the aforementioned conditions along with market clearing for the labor markets and the goods markets in both periods.\footnote{Note that market clearing of all the markets together with the zero-profit condition for the representative firm implies that the budget constraint of the representative household is satisfied. This follows from Walras’ Law and explains why we have omitted the budget constraint from set of the equilibrium conditions.} The question of interest is how the equilibrium varies with $\bar{\beta}$, the aggregate demand shock.
Demand and Supply in GE. Clearing the labor markets means \( y_t = \ell_t \). Combining this together with the optimality conditions for labor and the GHH specification of preferences, we get

\[
y_t = \ell_t = \ell^* \quad \forall t \in \{1, 2\} .
\]  

(5)

where \( \ell^* \) solves \( v'(\ell^*) = 1 \). Let us next impose market clearing in the second-period goods market but not in the first-period goods market. This means that we impose \( c_2 = y_2 \) but momentarily allow \( c_1 \neq y_1 \). The Euler condition then reduces to

\[
U_c(c_1, \ell^*) = P_1 \bar{\beta} U_c(\ell^*, \ell^*).
\]

Solving the above for \( c_1 \) as a function of \( P_1 \) gives a negative relation between the demand for current goods and their relative price. This represents downward-sloping aggregate demand (AD) curve. By condition (5), on the other hand, we have that supply is given by \( y_1 = y^* \equiv \ell^* \) regardless of \( P_1 \). This represents a vertical aggregate supply (AS) curve. The equilibrium is completed by imposing market clearing in the first-period goods markets, which corresponds to the intersection of the two curves.

Figure 1: Demand Shocks in General Equilibrium

Demand Shocks in GE. Consider a negative demand shock in the form of an exogenous increase in \( \bar{\beta} \) (an urge to save). This causes the AD curve to shift leftwards, as illustrated in Figure 1. Because the AS curve is vertical, the shock has an effect on the equilibrium price but not the equilibrium quantity. This verifies the claim that a negative demand shock fails to generate a recession. As anticipated in the introduction, the reasons is that the GE adjustment in \( P_1 \) completely offsets the PE effect of the shock on aggregate demand.

The property that the AS curve is vertical hinges on the GHH specification of \( U \). But the lesson that the demand shock has no effect on the equilibrium quantity does not hinge on it. This can be
readily verified by noting (i) that the equilibrium allocation coincides with the Pareto optimum and (ii) that the latter is invariant to $\tilde{\beta}$ simply because there is no capital. Relaxing the second property while maintaining the first makes things worse in the sense that the shock causes a boom in employment and investment at the same time that it causes a drop in consumption. The New-Keynesian framework and the model we develop in this paper relax the first property, albeit in different ways.

**Parenthesis: the New Keynesian framework.** The model considered in this section is deliberately simple: it contains the same elementary ingredients as those that underly demand and supply in microeconomics, and nothing more. It therefore clarifies the subtlety of the Keynesian narrative: although this narrative sounds self-evident in PE, it trembles in GE.

The New Keynesian framework salvages the narrative by dropping the AS curve seen in Figure 1 and by letting monetary policy to control the real interest rate. In effect, the monetary authority is free to pick an arbitrary point along the AD curve, as long as this does not involve a violation of the ZLB constraint.$^6$ It then follows that a negative demand shock can trigger a recession if and only if the monetary policy fails to reduce the real rate as much as implied by “natural rate of interest,” that is, if and only if $P_1$ falls less than $P^*_1 \equiv 1/\beta$.

In this paper, we do not try to argue that this is the “wrong” explanation of why demand shocks matter. We only develop a different formalization, one that does not rest on nominal rigidity, on the removal of the aforementioned AS curve, or on failure or unwillingness of the monetary authority to track the natural rate of interest. This explanation can be seen either as a substitute or as a complement of the New Keynesian formalization.

### 3 The Model

We now introduce our baseline model, which is an extension of the model studied in the previous section. We add monopoly power, so that we can think of the prices as set by the firms rather than a Walrasian auctioneer, but abstract from nominal rigidity and any kind of monetary non-neutrality, so as to distinguish our mechanism from either the one in the New Keynesian model or the one in the earlier literature on nominal confusion (Lucas, 1972, 1973; Barro, 1976, 1978). More crucially, we add a certain friction in information and beliefs. The accommodation of this friction requires a few “auxiliary” assumptions, namely the geographic segmentation of the market interactions and the introduction of a few idiosyncratic shocks that act as sources of noise in the information revealed by prices/trades. We fill in the details below.

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$^6$To illustrate this point within our setting, suppose that nominal prices are rigid at $t = 1$ but flexible at $t = 2$. In the first period, the firms commit to meeting demand at the predetermined prices. This means that the firm’s optimality for labor ceases to apply and, by implication, conditions (5) can be dropped. By controlling the rate of inflation between the two periods and the nominal interest rate in the first period, the monetary authority also controls $P_1$, the real interest rate. It follows that the monetary authority can pick any point it wishes along the AD curve.
**Agents, goods, and geography.** There are again two periods, indexed by $t \in \{1, 2\}$ and interpreted as, respectively, the “present” and the “future.” There is also a continuum of islands, indexed by $i \in [0, 1]$; a double continuum of goods, indexed by $g \in [0, 1] \times [0, 1]$; and a double continuum of households, indexed by $h \in [0, 1] \times [0, 1]$. The islands are interpreted as marketplaces and define the geography of trade and information: in each island, certain trades take place under incomplete information about the trades in other islands. Each household $h$ consists of one farmer, who is located in a particular island and produces a differentiated good on that island, and a continuum of consumers, who are uniformly distributed across all the islands. As a result, each island has a continuum of farmers/sellers, each being a monopolist of a differentiated good, and a double continuum of consumers/buyers, who are price takers. We finally use the following conventions: for goods, $g = (i, j)$ identifies the $j$-th variety produced in island $i$; and for households, $h = (i, j)$ identifies the household whose farmer is located in island $i$ and produces the $j$-th variety in that island.

**Preferences and demand shocks.** The preferences of household $h$ are represented by

$$U^h = U \left( c_{1,t}^h, \ell_{1,t}^h \right) + \beta^h U \left( c_{2,t}^h, \ell_{2,t}^h \right),$$

where $U$ is the per-period utility function, $\ell_{t}^h$ is the labor supply of the household’s farmer in period $t$, $c_t^h$ is the household’s effective consumption in period $t$ (defined below), and $\beta^h$ is a preference, or discount factor, shock that determines the household’s demand for current goods relative to her demand for future goods.

For the reasons already explained, we assume a GHH specification:

$$U(c, \ell) = \frac{(c - v(\ell))^{1-\gamma}}{1-\gamma} \quad \text{and} \quad v(\ell) = \frac{\ell^{1+\kappa}}{1+\kappa},$$

for some scalars $\gamma, \kappa > 0$. The scalar $\kappa$ is the inverse of the Frisch elasticity of labor supply. The scalar $\gamma$, on the other hand, is negatively related to the elasticity of intertemporal substitution in consumption.

We next let effective consumption be given by a nested CES aggregator of the consumption of the various differentiated goods. Specifically, we let

$$c_{1,t}^h = F \left( \left\{ c_{i,j,t}^h \right\}_{i \in [0,1]} \right) \quad \text{and} \quad c_{i,j,t}^h = \xi_{i,t} H \left( \left\{ c_{i,j,t}^h \right\}_{j \in [0,1]} \right),$$

where $c_{i,j,t}^h$ is household $h$’s consumption of variety $j$ from island $i$, $c_{t}^h$ is a consumption index for all the goods purchased from island $i$, and $\xi_{i,t}$ is preference shock that affects the relative demand goods for the goods of island $i$. The functions $F$ and $H$ are increasing and homogenous of degree one; the former aggregates across islands, the latter aggregates the varieties within given island. We think of the islands as different categories of expenditure (e.g., food vs entertainment) and the different goods within each island as different varieties of the same category. With this interpretation in mind,
we fix the elasticity of substitution across categories to 1, which means that the households spend a fixed share of their income on each category, and let the elasticity across the different varieties of the same category be $\epsilon > 1$.\footnote{That is, we let $F \{(c_{h,t}^i)_{i \in [0,1]}\} = e^{\int w(c_{h,t}^i)di}$ and $H \{(c_{i,j,t}^h)_{j \in [0,1]}\} = \left( \int (c_{i,j,t}^h)^{1-\epsilon} dj \right)^{\frac{1}{1-\epsilon}}$.} As usual, $\epsilon$ controls the elasticity of demand faced by each farmer and the associated monopoly markup.

The discount factor if each household is log-normally distributed and has both an idiosyncratic and an aggregate component. In particular, for every household $h = (i, j)$, we let

$$\log \beta^h = \log \beta^i = \log \bar{\beta} + \log \delta^i,$$

where $\log \bar{\beta} \sim N \left( 0, \sigma_\beta^2 \right)$, $\log \delta^i \sim N \left( 0, \sigma_\delta^2 \right)$, and $\log \delta^i$ is i.i.d. across $i$. The idiosyncratic component, $\delta^i$, guarantees that each household’s private knowledge of her own discount factor does not imply common knowledge of the aggregate component, $\bar{\beta}$. The latter, in turn, plays the same role as in the model of Section 2: it defines the aggregate demand shock. Finally, the island-specific demand shock, $\xi_{i,t}$, is i.i.d. across islands and periods, independent of any other shock, and log-normally distributed, with $\log \xi_{i,t} \sim N \left( 0, \sigma_\xi^2 \right)$. As it will become clear, the sole modeling role of this shock is to limit the information that the farmers can extract about $\bar{\beta}$ and the aggregate economic conditions from the observation of the local demand in any given island.

**Technology and supply shocks.** Consider the farmer of household $h = (i, j)$, namely the one located in island $i$ and producing variety $j$ from that island. Her output in period $t$ is given by

$$y_{i,j,t} = a_{i,t} l_{i,t}^h,$$

where $l_{i,t}^h$ is the farmer’s labor and $a_{i,t}$ is an exogenous island-specific productivity shock. The latter is i.i.d. across islands and periods, independent of any other shock, and log-normally distributed, with $\log a_{i,t} \sim N \left( 0, \sigma_a^2 \right)$. As it will become clear, the modeling role of this shock is to limit the information that the consumers can extract about $\bar{\beta}$ and the aggregate economic conditions from the observation of the local prices in any given island.

**Trading and IOUs.** As already noted, a single segmented market operates in every island during the first period. In this market, the local consumers purchase the local good from the local farmer in an exchange of a local IOU denominated in terms of a second-period good, which also serves as the numeraire. This IOU represents both the medium of exchange and a store of value. We let the numeraire be the period-2 CES composite defined in (8). Let $P_t$ denote the ideal price index in period $t$.\footnote{Namely, $P_t = \lim_{n \to -1} \left( \int \xi_{i,t} (p_{i,t})^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}$ with $p_{i,t} = \left( \int (p_{i,j,t})^{1-\epsilon} dj \right)^{\frac{1}{1-\epsilon}}$.} As in the previous section, we normalize $P_2 = 1$ and focus on the determination of $P_1$, the price of the current goods relative to the future goods (or the real interest rate).
In an extension studied in Section 5, we replace the aforementioned IOU with fiat money, whose supply is determined by the monetary authority. Although this extension is presumably more realistic, it raises the question of whether money is neutral. Here, we use the aforementioned IOU precisely to bypass this question and to isolate our mechanism from one that gives rise to monetary non-neutrality in Lucas (1972, 1973) and Barro (1976, 1978).

**Budget constraints.** Consider household \( h = (i, j) \). Given the trading structure described above, we can write her first-period budget as

\[
\int \int p_{i', j'} c_{i', j', 1}^h d{\ell'}_i d{\ell'}_j = p_{i, j, 1} y_{i, j, 1} + b_h,
\]

and her second-period budget as

\[
\int \int p_{i', j'} c_{i', j', 2}^h d{\ell'}_i d{\ell'}_j + b_h = p_{i, j, 2} y_{i, j, 2},
\]

where \( b_h \) is the net amount of IOUs issued in period 1 and paid in period 2.

**The question of interest.** The economy features a single aggregate shock, the demand shock captured by \( \bar{\beta} \). Its key macroeconomic outcomes are the aggregate levels of employment and output, which we measure by, respectively,

\[
L_t \equiv \int_0^1 \ell^h_t dj \quad \text{and} \quad Y_t \equiv F(\{y_{i, t} \}_{i \in [0, 1]}),
\]

with \( y_{i, t} \equiv H(\{y_{i, j, t} \}_{j \in [0, 1]}) \). The question of interest is how the period-1 macroeconomic outcomes vary with the aggregate demand shock.

To address this question, we must specify the beliefs that the agents in each island/marketplace form about the current outcomes in other islands, as well as about the future outcomes. Throughout, we assume that these beliefs are consistent with actual behavior, that is, we impose Rational Expectations. This assumption alone, however, is not sufficiently strong to pin down the answer to the question of interest. Instead, it has been augmented with assumptions about how much the agents know or do not know about the state of Nature.

Let \( s \) denote the state of Nature; this contains the aggregate shock \( \bar{\beta} \) and the entire profile of the idiosyncratic shocks. If we let that \( s \) becomes common knowledge in period 1, then the aggregate outcomes of our model coincide with those of the model studied in the previous section, and the \( \bar{\beta} \) shock has no effect on aggregate employment and output.\(^{10}\) This defines our “frictionless benchmark”

\(^9\)Given the presence of island-specific preference shocks, another plausible measure of aggregate output is \( Y'_t \equiv F(\{y'_{i, t} \}_{i \in [0, 1]}), \) where \( y'_{i, t} \equiv \xi_{i, t} H(\{y_{i, j, t} \}_{j \in [0, 1]}). \) Adopting this alternative measure makes no difference for our purposes, because, in the equilibria we study, the following restriction holds: \( \log Y'_t = \log Y_t + \text{const}, \) where \( \text{const} \) is invariant across periods and realizations of uncertainty.

\(^{10}\)This claim is verified in Section 4 by letting \( s \) become exogenously common knowledge. But the same is true if we allow
and explains why this benchmark is essentially the same as the familiar RBC framework. We next describe the departure we take from this benchmark.

**Introducing Informational/Belief Frictions.** We maintain Rational Expectations but introduce an informational friction. For our purposes, it is essential that this friction is present in period 1 (the “short run”) but it is fine if it disappears in period 2 (the “long run”). To simplify the analysis, we therefore assume that the exogenous state of Nature, which contains the aggregate shock $\bar{\beta}$ and the entire cross-sectional profile of the idiosyncratic shocks $(a_{i,t}, \beta^j, \xi_{i,t})$, and all the period-1 outcomes become common knowledge in period 2.

The first-period information is incomplete, but it is also endogenous, because the agents in each marketplace can extract information from the local trades/prices. This is akin to noisy rational-expectations models such as Lucas (1972) and Grossman and Stiglitz (1980), except for the fact that the supply side of each marketplace (the farmers) are price setters rather than price takers. We tackle the combination of monopolistic price-setting behavior with the endogeneity of information in a similar fashion as in Kyle (1989): we let the farmers post supply schedules, which allow the realized price to vary with the demanded quantity.

This guarantees that our framework features neither sticky prices nor sticky quantities: it is as if each farmer observes the demand curve for her product and picks her optimal point along it.11 This differentiates our work from the New Keynesian literature and works such as Woodford (2003a), Mackowiak and Wiederholt (2009) and Lorenzoni (2009), in which prices cannot adjust to realized demand but quantities can, as well as from works such as Angeletos and La’O (2010) and Benhabib et al. (2015), in which the opposite scenario (flexible prices but sticky quantities) is considered.

Let us fill in the details. Consider the farmer from household $h = (i, j)$ working on island $i$. Her exogenous information is given by $x_{i,1} = \{a_{i,1}, \beta^j\}$, that is, by her own productivity and her family’s discount factor (which are also the productivity and discount factors of all the other farmers in the island). Given this information, the farmer chooses a pricing schedule, namely a function that maps her exogenous information and the realized quantity to the realized price. Denote this mapping by $p_{i,j,1}(\cdot)$, with the understanding that $p_{i,j,1}(y_{i,j,1}; x_{i,1})$ gives the price when the demanded quantity is $y_{i,j,1}$ and the farmer’s signal is $x_{i,1}$.

Consider, next, the consumer from household from household $h = (i', j')$ that is located in island $i$, for any $i \neq i'$. This consumer knows her family’s productivity, $a_{i',t}$, her family’s discount factor, $\beta^{i'}$, and the taste shock $\xi_{i}$, which affects the demand for the local good. In addition, the consumer learns the endogenous information of her sibling farmer: she can condition her demand on $(p_{i',j',1}, y_{i',j',1})$, the realized price and quantity pair. This allows us to capture the feedback from income to consumer...
spending. Finally, the consumer observes the local prices but not the prices in other islands: her demand can be conditioned on \((p_{i,j,1})_{j \in [0,1]}\), but not on \((p_{k,j,1})_{j \in [0,1]}\) for \(k \neq i\).

Because of the CES structure, it is sufficient for the consumer to condition the demand for good \(j\) on \(p_{i,j,1}\) and \(p_{i,1} \equiv \left(\int (p_{i,j,1})^{1-\epsilon} dj \right)^{\frac{1}{1-\epsilon}}\), the good’s own price and the local price index, rather than the entire profile of the local prices. With this in mind, we henceforth express the demand schedule of household \(h\) for good \(j\) in island \(i\) as a function \(c^h_{ij,1}(\cdot)\) such that \(c^h_{ij,1}(p_{i,j,1}, p_{i,1}; z^h_{i,1})\) gives the quantity purchased and consumed when the good’s own price is \(p_{i,j,1}\), the local price index is \(p_{i,1}\), and the rest of the consumer’s information is \(z^h_{i,1}\), where \(z^h_{i,1} \equiv \xi_{i,1,1}, x, \alpha_{i,1,1}, \beta_{i,1,1}, \gamma_{i,1,1}, y\).

The assumptions made above embed an informational friction: the supply and demand in each island cannot depend on the prices in other islands. As already mentioned, this friction vanishes in the second period: the demand and supply schedules may now depend on the entire state of Nature. This, however, does not mean that the second-period outcomes are the same as in the frictionless benchmark: to the extent that the friction affects the first-period trades, it can also affect the net worth that a household enters the second period with, namely her net position in terms of IOUs. Accordingly, for any household \(h = (i', j')\), the second-period supply and demand schedules \(p_{i',j',2}(\cdot)\) and \(c^h_{i,j,2}(\cdot)\) are allowed to depend, not only on the exogenous state of Nature, but also on \(b^h\), the net worth implied by the households’ first-period trades. With these points in mind, and to ease the notation, we let, for any \(h = (i, j)\) and any \(i', x_{i,2} = z^h_{i,2} = \{s, b^h\}\), where \(s\) is the exogenous state of Nature (the collections of aggregate and idiosyncratic shocks in the entire economy).

**Equilibrium Definition.** In the tradition of Kyle (1989) and Vives (2005), an equilibrium can be defined as a fixed point between the demand and the supply schedules of all the agents. For convenience, we augment this definition with the realized quantities and the realized prices. We thus define an equilibrium as a combination of demand and supply schedules, along with the realizations of quantities and prices, such as the following properties hold.

1. For every \(h = (i, j)\), the farmer’s pricing schedule \(p_{i,j,t}(\cdot; x_{i,1})\) and the consumer’s demand schedules \(c^h_{i,j,t}(\cdot; z^h_{i,1})\), for all \((i', j')\), jointly maximize the family’s expected utility, taking as given the pricing and demand schedules of all other families in the economy.

2. For each period \(t\), each realization of uncertainty, and each island \(i\), the realized price-and-quantity pair \((p_{i,j,t}, y_{i,j,t})\) is such that

\[
p_{i,j,t} = p_{i,j,t}(y_{i,j,t}; x_{i,1}) \quad \text{and} \quad y_{i,j,t} = \int c^h_{i,j,t}(p_{i,j,t}, p_{i,1}; z^h_{i,1}) \, dh.
\]

Furthermore, for each family \(h\), the realized labor supply \(\ell_t^h\) is given by (9); the realized consumption levels are given by \(c_{i,j,t}^h = c_{i,j,t}^h(p_{i,j,t}, p_{i,1}; z^h_{i,1})\), with \(p_{i,1} = \left(\int (p_{i,j,t})^{1-\epsilon} dj \right)^{\frac{1}{1-\epsilon}}\); and the realized IOU position, \(b^h\), clears the family’s budget constraint.
Property 1 allows us to understand the equilibrium in effect as the Perfect Bayesian Equilibrium of a game among the families, with the strategy of each family being the combination of her pricing and demand schedules. Property 2 identifies the realized quantities and prices, along with the realized IOU positions (which, as already noted, are relevant because they affect second-period decisions).

Throughout, we restrict attention to equilibria in which the choices of a single consumer or farmer cannot affect the information of the entire marketplace she belongs to. This restriction seems natural given the each island/marketplace contains a continuum of agents on both the demand and the supply side. Unless otherwise stated, we keep the analysis tractable by working with the log-linearization of the equilibrium around a steady state in which all the shocks take their unconditional mean values. We also focus on the limit as $\sigma_a^2 \to +\infty$, that is, with large idiosyncratic supply shocks. This is not strictly needed for our results, but simplifies the exposition by letting consumers’ average belief about the aggregate shock $\beta$ of the to coincide with that of the farmers.\(^\text{12}\)

## 4 Equilibrium

We characterize the equilibrium in a few steps. First, we derive the relevant optimality conditions. Next, we derive the relevant AS and AD curves and compare them to their frictionless counterparts. Finally, we characterize the response of the economy to the $\bar{\beta}$ shock.

### 4.1 Optimality and preliminary points

To understand the optimal behavior of each agent, we first momentarily discard from log-linearization and characterize the optimal consumption and production decisions under incomplete information.

Pick an arbitrary household $h = (i, j)$. Her IOUs are cleared and the two per-period budgets are satisfied if and only if the following intertemporal budget constraint is also satisfied:

$$
\int \int p_{i', j', 1} c_{i', j', 1} d i' + \int \int p_{i', j', 2} c_{i', j', 2} d i' = p_{i, 1} y_{i, 1} + p_{i, 2} y_{i, 2}.
$$

This is akin to allowing the household to participate in complete Arrow-Debreu markets, except for one key difference: insofar as the informational friction of interest is present, the trades made in one marketplace cannot be conditioned on the trades made in other marketplaces.\(^\text{13}\) Notwithstanding

\(^{12}\)This limit guarantees that the consumers do not extract information about $\bar{\beta}$ from the observation of local prices, and members of a household share the same information about the aggregate shock $\beta$. However, it does not shut down endogenous learning: because the farmers know the local productivity shock, they can extract information from the local demand and convey that information to their consumer siblings.

\(^{13}\)It is therefore as if the household consists of multiple selves, with each self making a different decision in a particular marketplace under incomplete information of the conditions faced by other selves in other marketplaces. This can be interpreted as of form of “local thinking” along the line of Lian (2018), as a form of “mental accounting” along the lines of (Thaler, 1985, 1999), or an example of the generalized forms of rational inattention studied in Angeletos and Sastry (2018).
this point, the household chooses its supply and demand schedules so as to maximize the rational expectation of its lifetime utility, taking into account the monopoly power of its farmer-member.

The household’s problem is akin to a “team problem” in the sense Marschak and Radner (1972): each member of the team (the family) chooses her action so as to maximize the team’s objective. Alternatively, one can think of each household run by a family planner, who dictates to the family members what strategies to follow (that is, what choices to make on the basis of their information, whatever the latter may happen to be).

The optimality conditions in the second period, when everything has become common knowledge, are quite standard. The following result focuses on the optimality conditions in the first period, which are less familiar due to the informational friction. For convenience, these conditions are expressed in terms of the optimal demand and supply schedules in each island.

**Proposition 1** Consider the consumer from household $h$ that is located island $i$. Her optimal demand schedule for variety $j$ is given by

$$c_{i,j,1}^h \left( p_{i,j,1}, p_{i,1}; z_{i,1}^h \right) = \xi_{i,1} \left( \frac{p_{i,j,1}}{p_{i,1}} \right)^{-\epsilon} \left( p_{i,1} \right)^{-1} \left( \frac{E_i^h \left[ \lambda^h \right]}{E_i^h \left[ \left( c_{i,1}^h \right)^{1-\epsilon} u_c (c_{i,1}^h, p_{i,1}) \right]} \right)^{-\epsilon}, \quad (11)$$

where $\lambda^h$ denotes the household’s marginal value of wealth (the Lagrange multiplier associated with the intertemporal budget constraint) and $E_i^h[\cdot]$ denotes the rational expectation conditional on both the consumer’s signal $z_{i,1}^h$ and the realized local prices and.

Consider next the farmer producing variety $j$ in island $i$. Her optimal pricing schedule is given by

$$p_{i,j,1} \left( y_{i,j,1}; x_{i,1} \right) = (1 + \vartheta) \frac{E_{i,j}^f \left[ u_t \left( c_{i,1}^{h'}, y_{i,j,1}; a_{i,1} \right) \right]}{E_{i,j}^f \left[ \lambda^{h'} a_i^{1} \right]}, \quad (12)$$

where $\vartheta \equiv \frac{1}{\epsilon - 1} > 0$ is the monopoly markup and $E_{i,j}^f[\cdot]$ denotes the rational expectation conditional on both on the farmer’s signal $x_{i,1}$ and the demanded quantity $y_{i,j,1}$, and where $h' = (i, j)$.

The pricing schedule in condition (12) means that, regardless of the realized quantity, the local price is equated to the expected marginal cost, which is given by the fraction in the RHS of the condition, plus the monopoly markup. In this condition, the quantity $y_{i,j,1}$ plays a dual role: it influences both the farmer’s marginal cost and the beliefs she holds regarding the rest of the economy and the conditions faced by her consumer-siblings in other islands. The first effect is captured by the fact the disutility of labor, $u_t \left( c_{i,1}^{h'}, y_{i,j,1}; a_{i,1} \right)$, increases with $y_{i,j,1}$. The second effect enters through the dependence of the expectation operator, $E_{i,j}^f[\cdot]$, on the information that realized quantity contains about of the aggregate demand shock $\bar{\beta}$ and the local demand shock $\xi_{i,1}$. 

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Similar points apply to the demand curve in condition (11), except that a learning channel is muted in the limit as $\sigma_a \to \infty$. Away from that limit, prices influence demand, not only by determining the cost of purchasing the goods, but also by acting as a joint signal of the aggregate demand shock $\bar{\beta}$ and the local supply shock $a_{i,1}$. But as $\sigma_a \to \infty$, the signal about $\bar{\beta}$ becomes arbitrarily imprecise. This is not strictly needed for our results, but simplifies the analysis by guaranteeing that the only endogenous information that a household has about $\bar{\beta}$ is the one that the farmer-member extracts from the local demand in her own island and shares with her consumer-siblings.

More important for our purposes is how demand depends on perceived income. This effect relates to the Keynesian multiplier and is captured in condition (11) via the Lagrange multiplier. Its central role in our analysis will become evident in the sequel.

To complete the equilibrium characterization, we combine the optimality conditions described above with those pertaining to the second period and impose market clearing in all the markets. Because the second-period optimality conditions are taken under complete information, they are familiar and are therefore omitted from the main text. Regarding market clearing, we follow a similar strategy as in the frictionless benchmark: we first combine the optimality conditions with clearing in all the markets except the first-period goods markets so as to obtain a modified version of the AS and AD curves; we then reduce the entire equilibrium to the intersection of the two curves.

For the remainder of the analysis, we log-linearize the equilibrium conditions and, with abuse of notation, re-interpret all the variables as log-deviations from the steady state. It is straightforward to check that the equilibrium features $Y_2 = C_2 = 0$ regardless of $\bar{\beta}$, that is, the second-period aggregate outcomes are invariant to the realization of $\bar{\beta}$. We can thus focus on the determination of the equilibrium outcomes in period 1. Finally, for $X = \bar{\beta}$, $X = P_1$, and any other aggregate outcome that is a function of $\bar{\beta}$, we henceforth let $\bar{E} [X]$ denote the average belief in the population.\footnote{Note that, because the members of a household share the same information about the aggregate shock $\bar{\beta}$, the average belief of all the farmers coincides with that of all the consumers: $\int \int \bar{E}^{h_i} [X] \, dh' \, di = \int \int \bar{E}^{f_{i,j}} [X] \, dj \, di$. We thus let $\bar{E} [X]$ denote either average belief of farmers or the average of consumers.}

### 4.2 Aggregate supply

We start by characterizing aggregate supply. Consider the farmer from family $h = (i, j)$. After some manipulations that we delegate to the Appendix, condition (12) reduces the following:

$$p_{i,j,i} = p_{i,1} (y_{i,j,1}; x_{i,1}) = \kappa y_{i,j,1} - (\kappa + 1) a_{i,1} + E_{i,j}^f [P_1]. \tag{13}$$

To interpret this condition, note that the LHS gives the price of the good $j$ in island $i$ (relative to the price of second-period goods) and the RHS gives the expected marginal cost (also relative to the second-period goods). This condition can thus be read as the log-linearized version of “price equals
marginal cost plus markup," with the understanding that the markup is always equal to its steady-state (and ideal) value and hence the markup in terms of log-deviations is identically zero.

Aggregating the above condition, we arrive at the following result.

**Proposition 2** Aggregate supply is given by

$$P_1 = \bar{E}[P_1] + \kappa Y_1,$$

(14)

This condition represents the AS curve of our model. Conditional on \(\bar{E}[P_1]\), it gives a positive relation between \(P_1\) and \(Y_1\). It thus resembles an expectation-augmented Philips curve, like those found in Friedman (1968) and Lucas (1972, 1973), but differs from them in that it relates aggregate quantity of goods with the mean forecast error of a real price, namely the real interest rate, rather than then mean forecast error of the nominal price level.

Also note that \(P_1\) is the average of the prices set by the farmers, rather than a single price set by a Walrasian auctioneer. The AS curve obtained above is thus best understood as the equilibrium outcome of a game among the farmers. In this game, the farmers choose their supply, or pricing, schedules taking as given the demand schedules of the consumers. The aggregate outcome of this game is summarized in the AS curve seen above.

When the farmers share the same information with one another, they reach common knowledge of \(P_1\) along any rational-expectations equilibrium, implying that \(\bar{E}[P_1]\) and \(P_1\) coincide in all states of nature. The aforementioned condition then reduces to \(Y_1 = 0\), which means that the aggregate supply curve is vertical, like in Section 3. When, instead, the farmers have differential information, they face uncertainty about one another's beliefs and choices and, as a result, they may fail to reach common knowledge of \(P_1\) in equilibrium. It follows that, in general, \(\bar{E}[P_1]\) differs from, and is only imperfectly correlated with, \(P_1\). This property is the hallmark of higher-order uncertainty and it is also the reason why aggregate supply ends up being positively sloped in our setting.

Let us emphasize that the key friction is whether the farmers can coordinate their behavior, not per se how much they know about \(\bar{\beta}\). This differentiates our supply side from that of Lucas (1972). In that paper, the marginal cost of a firm was determined by the monetary shock itself, implying that higher-order uncertainty was irrelevant.\(^{15}\) In our context, instead, the marginal cost of a farmer depends on the price choices of other farmers, implying that higher-order uncertainty plays a crucial role and can indeed alone justify an upward sloping AS curve.\(^{16}\)

In this respect, the supply side of our model resembles those of Angeletos and La’O (2013) and Woodford (2003a): both of these models emphasize the role of higher-order uncertainty in firm behavior. There are, however, a few notable differences. Angeletos and La’O (2013) study a model in

\(^{15}\)For a detailed exposition of this points, see Section 8.4 in Angeletos and Lian (2016b).

\(^{16}\)Keep in mind that another crucial difference between Lucas (1972) and our paper is that the AS curve in that paper was in terms of inflation, whereas in our paper it in terms of the real interest rate.
which the firms set their quantities prior to observing demand and then prices adjust so as to equate demand and supply. Conversely, Woodford (2003a) studies a model in which the firms set their prices prior to observing demand and then quantities adjust. Unlike either of these papers, our paper allows the firms to pick their optimal quantity-price pair conditional on the realized demand. Furthermore, whereas the prices in Woodford (2003a) are set in nominal terms, in our model they are set in real terms, insulating our supply-side mechanism from monetary non-neutrality. Last but not least, neither of the aforementioned papers features the demand-side mechanism we describe next.

4.3 Aggregate demand

We now turn attention to aggregate demand. Using (11) together with the budget constraint (10), it is possible to show that local demand on island \( i \) satisfies the following restriction:

\[
\int \int c_{ij}^h(\cdot)dh'dj = \xi_i - \psi(1-m) \left( \bar{\beta} + \int E_i^h[P_1]dh' \right) - \left( p_{i,1} - \int E_i^h[P_1]dh' \right) + \varphi L_1 + \Omega_i, \quad (15)
\]

where \( \psi > 0 \) is a scalar that measures the elasticity of intertemporal substitution, \( \varphi > 0 \) is a scalar that measures the labor-consumption complementarity embedded in GHH preferences, and \( m \in (0, 1) \) is a scalar that measures the marginal propensity to consume.\(^{17}\)

Let us interpret this condition. The first term captures the effect of \( \xi_i \), the island-specific demand shock. The second term represents the combination of two inter-temporal substitution effects: the one corresponding to the aggregate demand shock \( \bar{\beta} \), and the consumers’ response to the perceived \( P_1 \). The third term represents an intra-temporal substitution effect, resulting from the consumers’ response to the perceived price of the local goods relative to the prices of other goods.

The fourth term captures the complementarity between consumption and labor implied by the GHH specification. This effect is not central to our results and is abstracted from in the subsequent discussion in order to simplify the exposition. That is, without serious loss of generality, we momentarily set \( \varphi = 0. \)\(^{18}\)

The last term, which is the most interesting to us, captures a perceived income effect. We next elaborate on its precise meaning and on its significance for our purpose. This term is defined as

\[
\Omega_i \equiv m \int E_i^{h'}[\omega^{h'}]dh',
\]

\(^{17}\)In particular, \( \psi \equiv \frac{1}{\gamma(\mu+1)} > 0 \) and \( \varphi \equiv (1-m) \frac{\mu(\kappa+1)}{\mu+1} \), where \( \mu \) is the steady-state value of the ratio \( v(\ell) / [c - v(\ell)] \), and \( m \) is given by the steady-state share of the first-period income to lifetime income. Because we have assumed that there are only two periods and that income is, on average, the same in the two periods, we have imposed \( m = 1/2 \). However, the more realistic case in which \( m < 1/2 \) can be readily accommodated by introducing more periods or rescaling the second-period income. On the other hand, allowing the idiosyncratic shocks to be persistent over time is akin to raising \( m \), because the misperceptions of current income now come together with misperceptions of future income.

\(^{18}\)See the Assumption 1 for how the analysis extends to \( \varphi > 0. \)
where
\[
\omega_{h}^{\prime} \equiv p_{i^\prime,j^\prime,1} + y_{i^\prime,j^\prime,1} - P_{1} + p_{i^\prime,j^\prime,2} + y_{i^\prime,j^\prime,2}
\]
captures the present value of income for household \(h^\prime = (i^\prime,j^\prime)\). Because our assumptions guarantee that future income is unpredictable, we have that, for each household \(h^\prime\),
\[
E_{h^\prime}^{h'}[\omega_{h}^{\prime}] = E_{h^\prime}^{h'}[p_{i^\prime,j^\prime,1} + y_{i^\prime,j^\prime,1} - P_{1}].
\]
And because each household knows its own labor supply and the price of the good it produces,
\[
E_{h^\prime}^{h'}[\omega_{h}^{\prime}] = p_{i^\prime,j^\prime,1} + y_{i^\prime,j^\prime,1} - E_{h^\prime}^{h'}[P_{1}].
\]
It follows that the
\[
\int E_{h^\prime}^{h'}[\omega_{h}^{\prime}] dh^\prime = Y_{1} + (P_{1} - \bar{E}[P_{1}]).
\]
Perceived income is therefore given by the sum of actual income, \(Y_{1}\), and a term that captures the average misperception of real wages: whenever \(P_{1} > \bar{E}[P_{1}]\), the typical consumer believes, rationally but incorrectly, that her farmer-sibling is facing improved terms of trade and is making more income, which in turn justifies more spending.

This kind of misperception is reminiscent of that operating in Lucas (1972): as long as some farmers do not know \(P_{1}\) perfectly, they may rationally mistake the movements in \(P_{1}\) as the movements in the relative price of their product and, in this sense, as movements in their real wage. There are, however, two notable differences. First, as already noted, \(P_{1}\) represented the nominal price level in Lucas (1972), whereas here it represents a real price. Second, in that paper the misperception of real wages was driving supply but not demand. This was because the demand side of the model was fixed by the exogenous supply of money. Here, instead, the misperception of real wages is allowed to feed to aggregate demand, opening the door to a Keynesian feedback loop: as some consumers misperceive their income and spend more, the raise the demand for the farmers of other families, which in turn feeds to more spending by other consumers (including any who don’t themselves suffer from any misperception), and so on.

Let us proceed with the characterization of aggregate demand. Aggregating condition (15) across islands, and using the simplification \(\varphi = 0\), gives
\[
C_{1} = -\psi (1 - m) \left( \bar{\beta} + \bar{E}[P_{1}] \right) - (P_{1} - \bar{E}[P_{1}]) + m \cdot \{P_{1} - \bar{E}[P_{1}] + Y_{1}\}.
\]
To interpret this condition, consider momentarily the case in which the informational friction is shut down. In this case, \(\bar{E}[P_{1}] = P_{1}\) and the above reduces to
\[
C_{1} = -\psi (1 - m) \left( \bar{\beta} + P_{1} \right) + m \cdot Y_{1}.
\]
This is effectively the aggregate consumption function under complete information. The first term captures the relevant two intertemporal substitution effects, namely those associated with the discount-rate
shock and the real interest rate. The second term captures the consumption-labor complementarity, which can be assumed away without serious loss of generality. And the third term captures the effect of income, which \( m \) measuring the marginal propensity to consumer. Using the fact that income equals spending \( (Y_1 = C_1) \), and solving the above for \( C_1 \), gives

\[
C_1 = -\psi (\bar{\beta} + P_1),
\]

which is the log-linearized Euler condition of the representative agent. Clearly, this is the same AD curve as the one in Section 2.

What happens away from that benchmark? The aggregate consumption function is now given by (16). Comparing the latter to (17), we see three differences. First, the term corresponding to the two intertemporal substitution effects is modified from \( \bar{\beta} + P_1 \) to \( \bar{\beta} + \bar{E}[P_1] \). This reflects the uncertainty that consumers face about the real interest rate. Second, the new term \( P_1 - \bar{E}[P_1] \) shows up. This reflects the rational confusion of intra- and inter-temporal terms of trade. Finally, the income effect is modified from \( m \cdot Y_1 \) to \( m \cdot \{ P_1 - \bar{E}[P_1] + Y_1 \} \). This reflects the aforementioned feedback from the misperceptions of income to consumer spending.

Consider how the informational friction matters through the first two terms. The friction means that \( \bar{E}[P_1] \) moves less than one to one with \( P_1 \). This has opposing effects via the first two terms. On the one hand, it weakens the intertemporal-substitution effect, contributing to a smaller covariation between \( C_1 \) and \( P_1 \). On the other hand, it lets inter-temporal price movements to be confused for intra-temporal price movements, contributing to the opposite direction. To simplify the exposition, we henceforth assume that these effects cancel out. More precisely, we impose the following assumption, which re-accommodates \( \varphi > 0 \).

**Assumption 1** \( \psi(1 - m) = 1 - \frac{\varphi}{\kappa}. \)

This assumption guarantees that the aforementioned two effects along with that of the consumption-labor complementarity sum up to zero, so that the informational friction enter aggregate demand only through the last term in condition (16). That is, this assumption isolates the role played by the misperceptions of income, which is the mechanism of interest to us.

Using condition (16) along with Assumption 1 and the fact that aggregate income equals aggregate consumption, and solving for \( C_1 \), we reach the following result.

**Proposition 3** Aggregate demand is given by

\[
C_1 = -\psi (\bar{\beta} + P_1) + \frac{m}{1 - m} (P_1 - \bar{E}[P_1]),
\]

(18)
This is the same AD curve as that in the frictionless benchmark, except for the last term. This term is given by the product of two components, $m \left(P_1 - \bar{E}[P_1]\right)$ with $1/(1-m)$. The first component captures the direct or PE effect of the aforementioned misperceptions of income: when a consumer misperceives her current income to be 1 unit of goods higher, she spends $m$ units more. The second component, namely $1/(1-m)$, is a GE multiplier, known as the Keynesian multiplier: when the aforementioned consumer spends more, others consumers experience an increase in their actual income, which in turn raises their own consumption and feeds into the income and consumption of others.

Holding $\bar{\beta}$ and $\bar{E}[P_1]$ constant, a one-unit change in $P_1$ causes $C_1$ to change by $d$ units, where $d \equiv \frac{m}{1-m} - \psi$. By Assumption 1, $d$ reduces to $d = -1 + \frac{\varphi}{\kappa(1-m)}$. In principle, $d$ can be positive, meaning the demand can be upward sloping. To avoid this paradoxical possibility, we henceforth impose the following restriction.

**Assumption 2** $\frac{\varphi}{\kappa(1-m)} < 1$.

### 4.4 Equilibrium response to demand shock

Similarly to the frictionless benchmark studied in Section 2, the equilibrium is given by the intersection of the AD and the AS curve. Furthermore, by Propositions 2 and 3, the only difference as we move away from the frictionless benchmark is the emergence of the misperceptions of the farmers’ terms of trade and, relatedly, of the consumers’ income. Understanding the overall equilibrium is therefore equivalent to understanding the determination of these misperceptions.

Because of the Gaussian specification of the information structure, and because $\bar{\beta}$ is the only aggregate shock, the following is trivially true.

**Lemma 1** There exists a $\lambda \in (0, 1)$ such that

$$\bar{E}[\bar{\beta}] = \lambda \bar{\beta} \quad \text{and} \quad \bar{E}[P_1] = \lambda P_1$$

The first property is obtained by taking the projection of $\bar{E}[\bar{\beta}]$ on $\bar{\beta}$, letting $\lambda$ denote the projection coefficient, noting that there cannot be a residual because that would have been an additional aggregate shock (which, by assumption, cannot exist), and using the fact that the forecast of a variable are less volatile than the variable itself to establish that $\lambda \in (0, 1)$. The second property follows from the first along with the fact that, in any (log-linearized) equilibrium, $P_1$ is a multiple of $\bar{\beta}$.

The scalar $\lambda$ measures the informational friction: it is inversely related to the precision of posterior of the typical agent about $\bar{\beta}$. Because the agents extract information from the realized local outcomes, the value of $\lambda$ is endogenous to the equilibrium, as in other models with rational signal-extraction. The endogeneity of $\lambda$, however, is not important for our purposes. Rather, the essence is the following.
When $\beta$ is common knowledge, $E[\beta] = \beta$ and similarly $E[P_1] = P_1$, which means that there cannot be income misperceptions. When, instead, information is incomplete, $\lambda < 1$ and

$$P_1 - E[P_1] = (1 - \lambda)P_1,$$

which proves that the misperceptions of income are non-zero and co-move with $P_1$. Using this property together with the AD and AS curves, we reach the following result.

**Proposition 4** The equilibrium satisfies

$$Y_1 = -\left\{ \frac{1}{K \psi + (1 - \lambda) \left( \frac{1}{K m} - \frac{m}{1-m} \right)} \right\} \beta \quad \text{and} \quad P_1 = -\left\{ \frac{\psi}{\psi + (1 - \lambda) \left( \frac{1}{K m} - \frac{m}{1-m} \right)} \right\} \beta.$$

A negative demand shock (higher $\beta$) therefore causes a joint decrease in output and the real interest rate.

Similarly to the frictionless benchmark, a negative demand shock (higher $\beta$) triggers an increase in the equilibrium interest rate. But whereas in that benchmark the demand shock had no effect on employment and output, now it triggers a recession. This is because the shock causes the farmers to perceive a decrease in their terms of trade and the consumers to perceive a decrease in their income, and the one kind of misperception feeds the other. This feedback is evident in the first of following comparative statics.

The determination of the equilibrium is illustrated in Figure 2. Relative to the frictionless benchmark, we see two key differences. First, the AS curve is now positively sloped rather than vertical; this reflects the Lucas-like misperceptions operating in the supply side. And second, the AD curve is steeper than in the frictionless benchmark; this reflects the Keynesian feedback loop between the misperceptions of income and aggregate spending operating in the demand side. A negative demand shock of a given size causes the AD curve to shift leftwards by the exact same amount as in the frictionless benchmark. By itself, the fact that the AS curve is positively sloped allows the shock to have a contractionary effect on employment and output. The Keynesian feedback loop then amplifies the misperceptions and reinforces the contractionary effect on employment and output.

**Corollary 1** The contractionary effect of a negative demand shock increases with all of the following: the Keynesian multiplier, the elasticity of labor supply, the elasticity of intertemporal substitution, and the level of friction (as measured by $1 - \lambda$).

Turning to the real interest rate, we have the following comparative statics.
Corollary 2 The response of the real interest rate increases with the Keynesian multiplier and the elasticity of labor supply, decreases with the elasticity of intertemporal substitution, and can either increase or decrease with the level of friction.

The last property seems particularly interesting because it means that the friction can dampen the equilibrium variation in the real interest rate at the same time that it opens the door to demand-driven business cycles. This property is reminiscent of the New Keynesian framework, in which demand shocks are expansionary if and only if the real interest rate moves less than its flexible-price counterpart (the “natural rate”). But whereas in that model the relative stability of the real interest rate is the product of nominal rigidity and of a monetary policy that fails to replicate flexible prices, here it is a property for the flexible-price allocations themselves: the natural rate itself has become more stable at the same time that the natural level of output responds to demand shocks.

We conclude this section by noting that our result regarding the contractionary effect of a negative demand shock does not hinge on either of the following two assumptions: the limit with large idiosyncratic supply shocks \((\sigma_a \to \infty)\); and Assumption 1. These assumptions only simplified the exposition. Finally, relaxing the GHH specification allows the misperceptions of income to feed into the supply side through the wealth effect of labor supply. This mitigates the effects we have documented here but does not upset them as long as the wealth effect on labor supply is not too strong.

5 Discussion and Extensions

In this section we discuss our results and offer a few extensions. In Subsection 5.1, we comment on the value of theories, such as ours, that account for the apparent disconnect between the business
cycle and either productivity or inflation. In Subsection 5.2, we explore the implications of our theory for the effects of fiscal stimuli. In Subsections 5.3 and 5.4, we discuss how our results extend in two variants, one that add investment and another that adds a monetary system. In Subsection 5.5, we comment on the role played by higher-order beliefs. And in Subsection 5.6, we elaborate on the kind of bounded rationality that is embedded in our baseline model and discuss how our results extend to a variant that abstracts from it.

5.1 Non-Inflationary Demand-Driven Fluctuations

Our theory offers a simple account of two salient features of the data. First, the business-cycle variation in output and employment is disconnected from the variation in utilization-adjusted TFP and labor productivity. Second, the business-cycle variation in output and employment is also disconnected from inflation.

These facts are illustrated Figure 1, which reports the scatterplots of the business-cycle component of output (on the horizontal axis) against the business-cycle components of hours worked, investment, consumption, TFP, labor productivity, and inflation (on the vertical axis). The top three panels reveal the strong co-movement of the real quantities; the bottom three panels reveal the absence of commensurate co-movement with either TFP and labor productivity, or inflation.

The disconnect from TFP and labor productivity represents a challenge, not only to the baseline RBC model, but also to a large class of models in which a variety of mechanisms generate realistic business cycles only by generating endogenous pro-cyclical movements in aggregate TFP and labor productivity. Example include the models of Bloom et al. (2012) and Bai et al. (2017), where such movements are caused by, respectively, uncertainty shocks and preference shocks. The second fact represents a challenge for the New Keynesian framework and, more generally, for models in which demand shocks operate through a Philipsian curve.

While it is possible to accommodate these patterns in DSGE models featuring a multitude of structural shocks coupled with appropriate bells and whistles, in our eyes these patterns indicate the value of parsimonious theories that let the business cycle be disconnected from both productivity and inflation. Our paper is an example of such a theory.²⁰

²⁰The data are in quarterly frequency and cover the 1960-2015 period. Output is measured by GDP; hours worked by the hours of all persons in the non-farm business sector; consumption by the sum of personal consumption expenditures in nondurables goods and services; investment by the sum of personal consumption expenditures on durables goods, fixed private investment and changes in inventories; TFP by the utilization-adjustment measure provided in Fernald (2014); labor productivity by the ratio of GDP to total hours; and inflation by the change in the CPI index. The business-cycle components are obtained by applying the Band-Pass filter and isolating the frequencies corresponding to 6-32 quarters, as in Stock and Watson (1999). The results are nearly identical if the HP filter is applied instead.

²²Angeletos et al. (2017) provide further evidence in support of such theories by using a SVAR on the key macroeconomic times series to document the existence of a structural shock that can account for nearly 2/3 of the variation in employment, output, and investment at the business cycle frequencies while also being essentially orthogonal to TFP and inflation at any frequency. such a propagation mechanism. Also, as noted in the Introduction, Angeletos and La’O (2013), Benhabib et al.
5.2 Adding Government Spending

We now explore the implications of our analysis for the macroeconomic effects of government spending. In the New Keynesian model, fiscal stimuli are most effective when they boost inflation expectations, a property that tends to favor their back-loading. In our context, instead, large fiscal multipliers do not require inflationary pressures and are highest when they are front-loaded.

**Set up.** The model is the same, except that we shut down the shocks to the households’ discount factor and introduce shocks to government spending. In each period, the government chooses its purchases of the various goods in the economy so as to minimize the cost, \( \int_i \int_j p_{i,j,t} g_{i,j,t} d j d i \), to meet an exogenous spending target, \( G_t \), where

\[
G_t = F \left( \{ g_{i,t} \}_{i \in [0,1]} \right), \quad g_{i,t} = \xi_{i,t} H \left( \{ g_{i,j,t} \}_{j \in [0,1]} \right),
\]

(19)

\( g_{i,j,t} \) is the government’s purchase of variety \( j \) from island \( i \) and \( g_{i,t} \) is a government spending index for all the goods purchased from island \( i \). This means that the government uses the CES aggregator as that of the households and, for simplicity, is subject to the same island-specific taste shocks. Government-,

(2015), Huo and Takayama (2015), and Ilut and Schneider (2014) are other examples of such theories. The mechanisms at work are different, as these papers focus on extrinsic belief shocks rather than intrinsic demand shocks, but the contributions are complementary.
spending shocks are introduced by letting $G_t$ be random. Because we wish to concentrate on shocks to first-period spending, we fix $G_2 = 0$ and let $G_1 / Y^* \sim N (0, \sigma_{G1}^2)$, where $Y^*$ is the level of output in a steady state in which government spending is zero.

To sharpen the analysis and make sure that our results are not driven by a violation of Ricardian equivalence, we next impose budget balance in each period, let government spending be financed by lump-sum taxation, and let each household be fully aware of its own tax burden. At the same time, we prevent the observation of one’s own tax burden revealing the aggregate level of government spending by introducing idiosyncratic shocks to the former. Specifically, for every household $h = (i, j)$, we let her lump-sum tax in period 1 be $T^h_1 = T_1 + \Delta^i_1$, where $T_1$ is the average tax and $\Delta^i_1 \sim N (0, \sigma_{\Delta}^2)$ is i.i.d. across $i$ and $t$, and independent from other variables in the economy. The aggregate tax, $T_1$, is determined so that the government maintains budget balances:

$$\int T^h_1 dh = \int \int p_{i,j,1} g_{i,j,1} di dj.$$  \hspace{1cm} (20)

Finally, the second-period taxes are identically zero, like the second-period government spending.

We next specify the information structure in a similar manner as in our baseline model: we let each household know $T^h_1$, but prevent it from knowing $G_1$. In particular, the information with which the typical farmer enters the market in island $i$ is given $x_{i,1} = \{ a_{i,1}, T^i_1 \}$; and that of the typical consumer on island $i$ is given by $z^h_{i,1} = \{ \xi_{i,1}, a_{i',1}, T^i_1, p_{i',j',1}, y_{i',j',1} \}$, where $h = (i', j')$ is her family. As before, the equilibrium is defined in terms of contingent supply and demand schedules, which means that both the farmers and the consumers are allowed to extract additional information from the realized market outcomes.

As in Section 4, we log-linearize the equilibrium conditions and re-interpret all the variables as log-deviations from their steady-state counterparts. Finally, we once again consider the limit with large idiosyncratic supply shocks ($\sigma_a \to +\infty$). Like before, this is not strictly needed but simplifies the exposition by letting us use the same average expectation operator for the farmers and the consumers about aggregate shocks and outcomes.

**Equilibrium characterization.** Let us momentarily abstract from the informational friction. In this case, an increase in government spending can influence the equilibrium levels of employment and output only via its negative wealth effect of labor supply. But since the GHH specification shuts down the wealth effect on labor supply, government spending has no effect on the equilibrium levels of employment and output in our frictionless benchmark, offering a sharp benchmark for comparison.

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21Similar to the case of discount rate in Section 3, this means that households that produce in the same island $i$ share the same tax.

22The following exception applies: $G_1$ and $T$ henceforth represent as $G_1 / Y^*$ and $T / Y^*$. This is as standard trick in the literature on fiscal multipliers (e.g., Woodford, 2011). It simply takes care of the issue that the log-deviation of the government spending is not well defined when its steady-state value is 0.
Consider now the case of interest. Because the farmers can no more tell apart aggregate shocks to government spending from shocks to relative tastes, they rationally misperceive any increase in local demand as an improvement in their terms of trade and respond by working harder. By the same token, their consumer-siblings perceive an increase in their income and respond by spending more. In short, the same mechanism as the one described before is at work, except that now the trigger is a shock to government spending rather than a shock to private spending. Following similar steps as in Section 4, we indeed reach the following result.

**Proposition 5** Aggregate supply and aggregate demand are given by, respectively,

\[
P_1 = \bar{E}[P_1] + \kappa Y_1 \quad \text{and} \quad C_1 + G_1 = -\psi P_1 + \frac{m}{1 - m} (P_1 - \bar{E}[P_1]) + G_1.
\]  

(21)

The AS curve is therefore exactly same as in our baseline model: each farmer sets her price as perceived marginal cost plus markup. The AD curve is also the same, except that the government-spending shock has taken the place of the discount-factor shock. Like before, the term \(\frac{m}{1 - m} (P_1 - \bar{E}[P_1])\) captures the misperceptions of income. The only twist is that these misperceptions are now triggered by variation in government spending.

The equilibrium characterization is completed by noting that, thanks to the Gaussian specification, there once again exists a scalar \(\lambda \in (0, 1)\) such that the equilibrium beliefs satisfy \(\bar{E}[G_1] = \lambda G_1\) and \(\bar{E}[P_1] = \lambda P_1\). It follows that the equilibrium levels of aggregate output and of the real interest rate are given by Proposition 4, replacing \(\beta\) with the negative of \(G_1\). This proves that an increase in government spending triggers a boom and gives the following formula for the fiscal multiplier in our model:

\[
\frac{\partial Y_1}{\partial G_1} = \frac{1}{\kappa \psi} \frac{(1 - \lambda)}{(1 - \lambda) \left(\frac{1}{\kappa} - \frac{m}{1 - m}\right)}.
\]

The above is necessarily positive, contrasting the zero effect obtained in the frictionless benchmark. What is more, a large enough friction (\(\lambda\) low enough) and a strong enough Keynesian feedback (large \(\frac{m}{1 - m}\)) can make the fiscal multiplier exceed one, which means that \(C_1\) moves in the same direction as \(G_1\).

**Corollary 3** The fiscal multiplier can exceed one, meaning that government spending crowds in private spending.

**Front-loading vs backloading.** So far we have concentrated on the effects of a front-loaded fiscal stimulus, namely a policy that varies \(G_1\) while holding \(G_2\) fixed at zero. Let us now consider a back-loaded fiscal stimulus, namely a policy that fixes \(G_1\) at zero and varies \(G_2\) by a comparable amount as before. In this case, we have to modify Proposition 5 by fixing \(G_1\) at zero. Yet, the equilibrium outcome
can still deviate from its frictionless counterpart, provided that the anticipation of the future fiscal policy movement in $P_1$ and triggers misperceptions of income in the present period. However, even if these misperceptions were of the same sign and size as in the case studied above, the equilibrium effect would be smaller because, unlike $G_1$, $G_2$ has no direct effect on the first-period aggregate demand. This suggests that the overall effect on current output and employment is attenuated.

What is more, to the extent that the households receive the bad news about their future taxes, the equilibrium output can actually move in the opposite direction: a back-loaded fiscal stimulus can cause the agents to feel poorer and to spend less.

For both these reasons, we conclude that our analysis favors the front-loading of fiscal stimuli. This contrasts the New Keynesian framework, in which the backloading helps raise the fiscal multiplier by allowing for more rounds of the positive feedback between inflation and aggregate demand.

5.3 Adding Investment

[To Be Completed]

5.4 Adding a Monetary System

In the preceding analysis, we let the numeraire be the second-period composite good. This permitted us to bypass the role of monetary policy and to distinguish our contribution from the literature on “nominal confusion” (Lucas, 1972, 1973; Barro, 1976, 1978). In this section, we discuss how our results extend to a variant where all prices are denominated in “dollars,” namely, an arbitrary unit of account that happens to be under the control of a monetary authority.

Specifically, we now let $p^t_{i,j}$ denote the dollar price of good $j$ in island $i$ and period $t$. Similarly, we let $P_t$ denote the dollar price of the composite in period $t$. Compared to Section 3, consumers see dollar prices and the farmer see demand curves in terms of dollars. Furthermore, the IOUs introduced in Section 3 can be thought of as dollar-denominated balances kept in the central bank; and transactions through IOUs represent transfers of such balances between buyers and sellers. Finally, we let the central bank pay a nominal interest rate equal to $i$, financed with lump-sum taxes. The real interest rate, $r$, can then be defined by the equation $1 + r = \frac{P_t(1+i)}{P_{t+1}}$. \(^{23}\)

We preclude the agents from observing the nominal prices on other islands so as to preserve the confusion over relative prices and the mechanism described before. Nevertheless, we can preserve monetary neutrality by allowing the agents to observe the nominal interest rate $i$ and the long-run price-level target of the central bank.

\(^{23}\)This specification of the monetary system follows closely Woodford (2003b) and Lorenzoni (2009).
Proposition 6 Suppose that monetary policy maintains long-run price stability, \( P_2 = \bar{P} \), and lets the nominal interest rate be \( i = m \), where \( \bar{P} \) is a constant and \( m \) is a random variable that is common knowledge to the agents and orthogonal to \( \bar{\beta} \). Then:

(i) Monetary policy is neutral, in the sense that the equilibrium allocations are invariant to the realization of \( m \).

(ii) The equilibrium allocations are the same as in our baseline analysis.

Clearly, this scenario is not meant to be realistic. It only helps recast our results in terms of a monetary economy while preserving the orthogonality between our mechanism and any other mechanism that breaks the non-neutrality of monetary policy. The more realistic scenario in which the two kinds of mechanisms interact is outside the scope of this paper.

5.5 On Lack of Common Knowledge

To deepen our understanding of how the equilibrium works, it is useful to recast the equilibrium value of \( P_1 \) as the solution to an incomplete-information game. This helps reveal how, for arbitrary information structures, the equilibrium outcomes depend on the entire hierarchy of beliefs about the underlying shock.

Imposing \( Y_1 = C_1 \), substituting the AD curve from (18) into the AS curve from (2), and solving for \( P_1 \) as a function of \( \bar{\beta} \) and \( \bar{E}[P_1] \), we obtain the following result.

Proposition 7 The equilibrium value of \( P_1 \) satisfies the following restriction

\[
P_1 = -\pi_\beta \bar{\beta} + \pi_{EP} \bar{E}[P_1]
\]

where \( \pi_\beta \equiv \frac{\psi}{\psi + \frac{1}{\kappa} - \frac{m}{1-m}} \) and \( \pi_{EP} \equiv \frac{1 - \frac{m}{1-m}}{\psi + \frac{1}{\kappa} - \frac{m}{1-m}} \).

By Assumption 1, \( \psi + \frac{1}{\kappa} - \frac{m}{1-m} = 1 - \frac{\varphi}{\kappa(1-m)} + \frac{1}{\kappa} = d + \frac{1}{\kappa} \). By Assumption 2, this term is positive, which means that \( \pi_\beta \) is also positive. On the other hand, \( \pi_{EP} \) is necessarily less than 1, but can be either positive or negative, depending on whether \( \kappa \) is low or high relative to \( m/(1-m) \). When \( \pi_{EP} > 0 \), the above can be understood as a game of strategic complementarity; and when \( \pi_{EP} < 0 \), it is a game of strategic substitutability.

Suppose the first scenario applies, which is the case when \( \kappa \) is low enough relative to \( (1-m) \), meaning that the AS curve is sufficiently flat and/or the Keynesian multiplier is sufficiently large. In this case, the informational friction implies that \( P_1 \) moves more than \( \bar{E}[P_1] \) but less than its complete-information counterpart. To see this, iterate the above condition to obtain \( P_1 \) as a linear combination
of the hierarchy of beliefs about the underlying aggregate shock:

\[ P_1 = -\pi_\beta \sum_{k=0}^{\infty} (\pi_{EP})^k \bar{E}^k[\bar{\beta}], \]

where \( \bar{E}^0[\bar{\beta}] \equiv \bar{\beta} \) and \( \bar{E}^k[\bar{\beta}] \equiv \bar{E}[\bar{E}^{k-1}[\bar{\beta}]] \) for all \( k \geq 1 \). When \( \bar{\beta} \) is common knowledge, \( \bar{E}^k[\bar{\beta}] = \bar{\beta} \) for all \( k \). When instead information is incomplete, the average forecast of any order varies less than \( \bar{\beta} \), and the less so the higher the belief order. It follows that \( P_1 \) moves less than its frictionless counterpart, and especially so when \( \pi_{EP} \) is large. For instance, letting \( \psi \) is close to zero, \( \pi_{EP} \) is close to 1, which means that \( P_1 \) is driven almost exclusively by beliefs of extremely higher order. And because such beliefs move arbitrarily little relative to \( \bar{\beta} \), the equilibrium value of \( P_1 \) can move arbitrarily little relative to its frictionless benchmark.

This illustrates how our results depend, not merely on first-order uncertainty, but also, and indeed quite crucially, on higher-order uncertainty. Indeed, even if every agent knew what \( \bar{\beta} \) is, to the extent that this fact is not itself common knowledge, the equilibrium average expectation of \( P_1 \) would move less than the actual value of \( P_1 \), opening the door to a negative perceived income effect in response to an increase in \( \bar{\beta} \) and hence also to a recession in employment and output.

Relatedly, the following is true.

**Proposition 8** Allow a zero-mass random sample of the households in the economy to have perfect information and consider their equilibrium behavior. In response to a negative demand shock (higher \( \bar{\beta} \)), these households produce less and consume less.

The logic is simple. Because these households have zero mass, they do not affect aggregate outcomes. But as long as the rest of the households work and consume less, these households, too, wish to work and consume less. This is due to a strategic complementarity that runs across the households as well as across the islands: the spending of one agent is the income of another. This complementarity has a Keynesian flavor, but can operate in neoclassical economies too. It also helps further distinguish our results from those of Lucas (1972): in that paper, such a complementarity is effectively shut down by the assumption that there is no trade across the islands.

5.6 On Bounded Rationality and Local Thinking

[To Be Completed]

6 Conclusion

[To Be Completed]
References


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