A (Real) Theory of the Keynesian Multiplier

George-Marios Angeletos  
MIT

Chen Lian  
MIT

Abstract. Can a drop in consumer spending, or “aggregate demand”, trigger a recession? A popular narrative suggests yes: the drop in consumer spending is said to cause a fall in employment and production, which in turn feed back to a further drop in consumer spending, and so on. It is remains unclear, however, under what conditions this narrative, also known as the Keynesian multiplier, makes sense. Indeed, the narrative turns out to be incoherent within the RBC framework, because it abstracts from countervailing general-equilibrium forces; and it finds a place in the New-Keynesian framework only insofar as monetary policy is constrained and nominal rigidity has a significant bite. In this paper, instead, we develop a formalization of this narrative that does not rest on nominal rigidity. At the core of this theory is the idea that markets are decentralized, that firms and consumers have better knowledge of idiosyncratic conditions than of aggregate conditions, and that they cannot reach common knowledge of the latter. The theory can rationalize key co-movement patterns in the data. In terms of policy, the theory can rationalize a sizable fiscal multiplier; in contrast to the New-Keynesian framework, however, the multiplier is predicted to be highest for front-loaded stimuli.
A (Real) Theory of the Aggregate-Demand Channel

George-Marios Angeletos    Chen Lian

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Demand-driven recessions

- Popular view of Great recession / “demand-driven” fluctuations
  - household deleveraging or other shock ⇒
  - consumers demand less ⇒
  - firms produce and hire less ⇒
  - consumers gets lower income ⇒
  - consumers demand less ⇒
  - firms produce and hire less ⇒ ...
  - a recession!
Does this make sense?

- NO in the RBC framework
  - interest rate adjusts to offset the consumer-spending shock

- YES in the NK framework, provided
  - prices are sticky and MP is constrained
  - Philips curves: recession has to disinflationary
Does this make sense?

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- YES in the NK framework, provided
  - prices are sticky and MP is constrained
  - Philips curves: recession has to disinflationary
Constraints on MP not as obvious before the last recession

Weak evidence on Philips curves

The narrative does not invoke these add ons
  - is the missing piece nominal rigidity?
  - or something else?
This Paper

- A novel propagation mechanism
  - similar responses to idiosyncratic and aggregate shocks
  - feedback effects that remind Keynesian multiplier

- A formalization of “aggregate demand channel”
  - does not rest on nominal rigidity
  - but also complements NK mechanism
Parenthesis

- Angeletos, Collard, Dellas (2015)
- Evidence against Philips curves
- Evidence of “demand shocks” unlike those in NK model
Model

- Neoclassical production economy without capital
  - idiosyncratic technology and preference shocks
  - aggregate discount rate shocks (deleverage, consumer spending)

- RBC Benchmark
  - aggregate quantities are constant

- Key modification
  - remove (common) knowledge of aggregate conditions
  - maintain (private) knowledge of local conditions
Motivation for Key Modification

- Strength of the countervailing GE effects in RBC hinge upon:
  - instantaneous adjustment of all real quantities and of all relative prices
  - agent’s perfect knowledge of such adjustment
  - agents’ perfect response to such adjustment

- None of these assumptions are necessarily realistic/useful:
  - frictions in information and coordination
  - rational inattention, behavioral biases
Results

• Realistic business cycles
  ▶ shocks to consumer spending [today]
  ▶ shocks to investment [work in progress]

• A Keynesian multiplier

• Novel policy implications
  ▶ large fiscal multipliers, but
  ▶ disconnect from inflation
  ▶ a rationale for front-loading

• A theory of comovement
Related Literature

- Mechanism broadly related to Lucas (1972)
  - confusion of idiosyncratic and aggregate shocks

- In that vein, also related:
  - Angeletos and La’O, Lorenzoni
  - Benhabib, Wang and Wen
  - Hellwig and Venkateswaran
  - Bergemann, Heumann and Morris
  - ...

- But:
  - different context, different kinds of shocks, different implications
  - no nominal confusion
  - lack of CK vs lack of knowledge;
  - feedback effects/Keynesian multiplier
Baseline Model

- Two periods, $t \in \{1, 2\}$
- A continuum of islands, $i \in [0, 1]$
- A continuum of families, $i \in [0, 1]$, each with
  - one farmer (or firm), working in island $i$
  - a continuum of consumers, one in each island
- Decentralized markets and dispersed information
Preferences

- **Family i’s utility:**
  \[ u_i = \beta_i U(c_i^1, l_i^1) + U(c_i^2, l_i^2) \]
  - \( \beta_i \): family-specific discount-rate shock
  - proxy for deleveraging or consumer-spending shocks

- **Dixit-Stiglitz:**
  \[ c_i^t = \left\{ \int_0^1 (\xi_j c_{i,j}^t)^{\frac{\varepsilon-1}{\varepsilon}} dj \right\}^{\frac{\varepsilon}{\varepsilon-1}} \]
  - \( \xi_j \): good-specific preference shock
  - proxy for firm-specific demand shocks

- **GHH (for this talk):**
  \[ U(c, l) = u(c - v(l)) \]
  \[ u(x) = \frac{x^{1-\gamma}}{1-\gamma} \quad v(l) = \frac{l^{1+\kappa}}{1+\kappa} \]
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Farmer’s production in period $t$:

$$y_i^t = a_i I_i^t$$

- $a_i$: family-specific productivity shock
- proxy for firm- and good-specific supply shocks

Family budget

$$\int p_j^1 c_{i,j}^1 dj + \int p_j^2 c_{i,j}^2 dj = p_i^1 y_i^1 + p_i^2 y_i^2$$

Remark: $a_i$ and $\xi_i$ act also as idiosyncratic income shocks
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$$y_i^t = a_i l_i^t$$

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Shocks

- $\beta_i$ has an aggregate component:

$$\int \log \beta_i di = \log \bar{\beta} \neq 0$$

- All other shocks are purely idiosyncratic
Information

- $t = 2$ ("long run"): everything is common knowledge
- $t = 1$ ("short run"): information is local / disaggregated

Farmer on island $j$:
- knows $a_j$ (own productivity/cost)
- observes local demand curve
- does not observe either $\xi_j$, or $\bar{\beta}$, or prices and quantities in other islands

Consumer from family $i$ on island $j$:
- knows $\xi_j$ and $\beta_i$ (own preference shifters)
- observes $p^1_j$ (price of good he buys)
- receives message about $p^1_i y^1_i$ (family income)
- does not observe either $a_j$, or $\bar{\beta}$, or prices and quantities in other islands
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Consumer from family \( i \) on island \( j \):
- knows \( \xi_j \) and \( \beta_i \) (own preference shifters)
- observes \( p_j^1 \) (price of good he buys)
- receives message about \( p_i^1 y_i^1 \) (family income)
- does not observe either \( a_j \), or \( \bar{\beta} \), or prices and quantities in other islands
Key Assumption

- Decisions based mostly on “local” information
  - “local” may mean geographic/idiosyncratic
  - but can also mean choice- or domain-specific

- Complementary alternatives:
  - rational inattention (a la Sims, Gabaix, etc)
  - behavioral (heuristics, salience)
Remarks on IO Aspects of the Model

- Are firms quantity or price setters?
- They are both!
- Firms observe their demand curve
- Choose optimal pair \((p_i, y_i)\)
Remarks on IO Aspects of the Model

- Allow monopolistic power
- But assume away informational power a la Kyle
  - firms do not manipulate price to change consumer beliefs
- Justified by a variant model
  - a continuum of farmers competitively producing on each island
Numeraire and Transactions

- Let period-2 composite be the numeraire and normalize $P^2 = 1$
- Consumers pay farmers IOUs denoted in the numeraire
- Later on: monetary variant
- Here: isolate “real” mechanism
Rational-Expectations Equilibrium

- Optimal consumption/production strategies such that
  - The strategies of all farmers and consumers are optimal
    - conditional on both exogenous and endogenous information
  - Market clearing on every island $j$ in every period $t$

$$y_j^t = \int c_{i,j}^t \, di$$
Optimal Decisions

- Second period: complete information ⇒ boring
- First period: incomplete information ⇒ interesting
- A “Team Problem”:

\[
\begin{align*}
\max & \quad E \left[ \beta_i U(c_i^1, l_i^1) + U(c_i^2, l_i^2) \right] \\
\text{s.t} & \quad \int p_j^1 c_{i,j}^1 dj + \int p_j^2 c_{i,j}^2 dj = p_i^1 y_i^1 + p_i^2 y_i^2 \quad \text{for all states}
\end{align*}
\]

where different members’ choices contingent on different information

- Let \( \beta_i \lambda_i \) be the Lagrange multiplier
Optimal Decisions

- Focus at $t = 1$ and drop superscript 1 for first-period variables

- Optimal pair $(p_i, y_i)$ satisfies
  
  $$
  p_i = \mu \frac{-E^f_i \left[ U_n(c_i, l_i) \right]}{E^f_i \left[ \lambda_i \right] a_i}
  $$

  (i.e., price = MC + markup)

- Optimal $c_{ij}$ satisfies

  $$
  \xi_j^{\frac{\varepsilon-1}{\varepsilon}} E_{ij} \left[ \left( \frac{c_{ij}}{c_i} \right)^{-\frac{1}{\varepsilon}} U_c (c_i, l_i) \right] = E_{ij} \left[ \lambda_i \right] p_j^1
  $$

- Familiar conditions (but novel predictions shortly)
Shocks

- From now on: all variables in log deviations from SS
- Discount rates: $\beta_i = \bar{\beta} + \delta_i$, $\delta_i \sim N(0, \sigma_\delta^2)$
- Aggregate demand shock: $\bar{\beta} \sim N\left(0, \sigma_{\bar{\beta}}^2\right)$
- Idiosyncratic/local demand shock: $\xi_i \sim N\left(0, \sigma_{\xi_i}^2\right)$
- Idiosyncratic/local supply shock: $a_i \sim N\left(0, \sigma_a^2\right)$
RBC Benchmark: Complete Information

Theorem

Under complete information, output $Y$ is invariant to AD shock $\bar{\beta}$

- Optimal consumption implies
  \[ C = \bar{\beta} - \psi P \]

- “AD” increases with the shock and decreases with the real interest rate
- “AS” is vertical (because no capital and fixed technology)
  \[ Y = 0 \]

- In equilibrium, $P$ moves to perfectly offset the AD shock
- No room for “Mian-Sufi shocks”
Incomplete Information

- Incomplete information:
  - cannot tell apart aggregate from local shocks (at least not fully)
  - cannot reach common knowledge of all shocks

- Special case:
  - limit as $\sigma_\beta \to 0$ (relative to idiosyncratic)
    $\Rightarrow$ trivialize signal-extraction problem
    $\Rightarrow$ agents behave as if no aggregate shock
  - GHH $\Rightarrow$ no wealth effects on labor supply
Aggregate Supply

- If information had been perfect, firms would set
  \[ y_j = \Phi \begin{bmatrix} a_j \\ \xi_j \end{bmatrix} \quad p_j = \Psi \begin{bmatrix} a_j \\ \xi_j/\beta \end{bmatrix} \]
  for some constants (vectors) \( \Phi, \Psi \). That is, AD shock absorbed solely in real interest rate

- With incomplete information, firms set
  \[ y_j = \Phi \begin{bmatrix} a_j \\ E^f_j \xi_j \end{bmatrix} \quad p_j = \Psi \begin{bmatrix} a_j \\ E^f_j \xi_j/\beta \end{bmatrix} \]

- Aggregating gives
  \[ Y = \Phi \begin{bmatrix} 0 \\ E^f_j \xi_j \end{bmatrix} \quad P = \Psi \begin{bmatrix} 0 \\ E^f_j \xi_j/\beta \end{bmatrix} \]
Aggregate Supply

- Since there is only one aggregate shock, $\bar{E}^f \xi_i$ and $\bar{E}^f \beta_i$ are just functions of $\bar{\beta}$. It follows that

\[ \text{Theorem} \]

There exists a $\phi > 0$ such that the aggregate behavior of the firms imposes

\[ Y = \phi P \]

In the limit, $\sigma_\beta \to 0$, $\phi = \frac{1}{k}$.

- An upward sloping AS curve (or a Philips curve)
- But, on real variables: output and relative prices
- Mechanism:
  - Firms do not differentiate between local and aggregate demand
  - When they see more customers coming into their stores, they raise both prices and quantities
  - When this happens to be due to an aggregate shock, $Y$ and $P$ commove
Demand

- Demand on island $j$:

$$
\int c_{ij} \, di = (\xi_j + \beta) - \varepsilon \left( p_j - \int E_{ij} P \, di \right) - \psi \int E_{ij} P \, di + \int E_{ij} z_i \, di + \Delta_j
$$

  - first term = shocks
  - second term = perceived relative price
  - third term = perceived real interest rate
  - fourth term = perceived permanent income

- $z_i$ annuity value of income stream

- last term = disappears in the limit

- Interpretation of forth term: firms see higher demand $\Rightarrow$ hire more workers and boost wages $\Rightarrow$ consumers feel richer
Aggregate Demand

- Aggregate demand
  \[ C = \bar{\beta} - \varepsilon P - (\psi - \varepsilon) \bar{E} P + \bar{E} z_i + \bar{\Delta} \]
- \( \bar{E} P, \bar{E} z_i, \) and \( \bar{\Delta} \) are functions of \( \bar{\beta} \), and thus collinear with \( P \)
- In the limit, \( \bar{\Delta} = 0, \int_i E_{ij} P di = 0, \) and \( \bar{E} z_i = \frac{\kappa + 1}{\kappa} P \)

Theorem

There exist \( \psi^* \) such that the aggregate behavior of consumers imposes

\[ C = \bar{\beta} - \psi^* P \]

In the limit, \( \sigma_\beta \rightarrow 0, \)

\[ \psi^* = \varepsilon - 1 - \frac{1}{\kappa} \neq \psi \]
Aggregate Demand

- An AD curve that can be either negatively or positively sloped
- In the limit:
  - positive comes from perceived income effect
  - negative from perceived substitution across goods
- Away from the limit:
  - additional negative from intertemporal substitution
- Either way, a feedback effect akin to Keynesian multiplier
AD-AS: Complete Information

Figure: Perfect Information
Figure: Incomplete Information, Limit
Keynesian Multiplier

- When a positive AD shock hits
  - Firms see their demand curves move up★
    - raise prices and produce more
  - The increase in local prices partially offsets the AD shock
  - But the increase in perceived income tends to amplify it

- There is a sort of Keynesian multiplier
Strategic Complementarity and Common Knowledge

- Thought experiment:
  - let one family be perfectly informed
  - while other families stay under incomplete information
  - informed farmer still produces more in response to a $\bar{\beta}$ shock
  - informed consumer still consumes more in response to a $\bar{\beta}$ shock

- To obtain the RBC benchmark, one must assume
  - not only knowledge, but also common knowledge
  - plus strong solution concept
Fiscal Policy

- Shut down aggregate discount rate shock $\bar{\beta}$
- Add aggregate government spending shock, $G^t$, with

\[
G^t = \left\{ \int_0^1 \left( \xi_j g^t_j \right)^{\frac{\varepsilon-1}{\varepsilon}} dj \right\}^{\frac{\varepsilon}{\varepsilon-1}}
\]

- Officials buy differentiated goods to achieve aggregate spending goals
  - Paying farmers IOUs
  - Lump sum tax in second period
  - After log-linearization and rescaling of $\xi$:
    - $g^t_j = \xi_j + G^t - \varepsilon \left( p^t_j - P^t \right)$
- Study the limit case $\sigma_G^2 \to 0$ (relative to idiosyncratic shocks)
Fiscal Multiplier

- With complete info, GHH ⇒ multiplier is zero.
- With incomplete info, instead,

**Theorem**

*The fiscal multiplier is given by*

\[
\Gamma \equiv \frac{dY^1}{dG^1} = \frac{1}{\kappa \lambda \left( (1 - \lambda) \varepsilon - 1 \right)}
\]

*where* \( \lambda = \frac{G^*}{Y^*} \)

- Same mechanism as before:
  - when a positive \( G^1 \) shock hits
  - firms see that their demand curves move up and produce more
  - consumers, seeing higher income, demand more

- Multiplier increases with flatter supply curves (lower \( \kappa \))
Front or Back Loading?

- Like NK, our model can rationalize large fiscal multipliers
- Unlike NK, higher multiplier when the stimulus is front loaded
- In NK, it’s all about promising inflation in the future
- Here, it is all about acting now!
Relevance

- Strictly speaking, our model rationalizes large multipliers only if the $G$ shock is unknown.
- Is our mechanism irrelevant if fiscal stimuli widely debated in the news?
- Not necessarily.
- Suppose people live most of the time in a world where $G$ shocks are either unobserved or observed with delay.
- In that world, our mechanism applies.
- If one runs a regression on data from that world, one will find $G$ shocks to have real effects.
- Now suppose that an unusual event occurs and the government announces a fiscal stimulus.
  - agents look in the past (run regressions) to form beliefs about how $G$ matters
  - then again $Y$ goes up.
Nominal Variant

- **Numeraire = dollars**
  - \( \tilde{p}_i^t \): dollar price of good \( i \) in period \( t \)
  - \( \tilde{P}_t \): dollar price of composite in period \( t \)
  - \( i \): nominal interest rate

- IOUs = bank balance movements

- Agents observe dollar prices and interest rate \( i \)

- Consider MP that \( \tilde{P}_2 = 0 \) but differ in terms of interest rate \( i \)
Two Neutrality Results

- Suppose $i = \text{constant}$.

- Then, $Y$ is the same as in the benchmark.

- Suppose $i = m$

  where $m$ is a commonly-known monetary shock (a random variable that is independent of $\bar{\beta}$).

- Then, $Y$ is the same as in the benchmark and are independent of $m$.

- But inflation moves one-to-one with $m \Rightarrow$ reconcile earlier evidence
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A Non-Neutrality Result

Suppose

\[ i = \phi \hat{Y} + m, \]

where \( \hat{Y} \) is the MP’s signal of output and \( m \) is a monetary shock.

Then, the response of \( Y \) to \( \beta \) is dampened.

But now \( Y \) also moves with \( m \).

- monetary non-neutrality due to rational confusion.
Conclusion

- A theory of “demand-driven fluctuations” that
  - does not require nominal rigidity
  - can bypass empirical failures of Philips curves
  - but also complements NK mechanism

- Distinct Policy Implications
Philosophical Afterthoughts

- What is this paper about?
  - informational frictions?
  - behavioral frictions?
  - solution concepts?

- From a theoretical perspective, it’s about *all* the above.

- From an applied side, it’s about
  - accommodating a plausible mechanism
  - disentangling AD from MP
Work In Progress

- Multi-period version
- Testable implications
- Relationship with Phillips Curves
- Interactions with nominal rigidity