Understanding Post-Covid Inflation Dynamics

Martín Harding (Bank of Canada)
Jesper Lindé (IMF and CEPR)
Mathias Trabandt (Goethe University Frankfurt)

September 29, 2022

Any views in this paper are solely the responsibility of the authors and do not necessarily agree with the Bank of Canada or the IMF, or those of any other person associated with these institutions.
Inflation is increasing rapidly after COVID shock
• Challenge: reconcile the “missing deflation puzzle” of the Great Recession with the recent surge in inflation

• Study recent US inflation and output dynamics using the workhorse SW New Keynesian model
  • Key feature: Kimball (1995) state-dependent demand elasticity
  • State-dependent Phillips curve slope and propagation of shocks
Preview of results

- Our variant of the SW model explains the modest decline in inflation during the Great Recession and its recent post-COVID surge better than the original SW model
  - Nonlinear formulation especially helpful

- Phillips curve steeper during booms, flattened during recessions

- Cost-push shocks amplified in booms, muted in recessions

- Policy tradeoff to stabilize inflation becomes larger as baseline inflation increases
• Nonlinear formulation of Smets–Wouters (2007) model

• Following Dotsey-King (2005), Levin-Lopez-Salido-Yun (2007)

\[
G_Y \left( \frac{Y_t(f)}{Y_t} \right) = \frac{\phi}{1 - \psi} \left[ \left( \frac{\phi - \psi}{\phi} \right) \frac{Y_t(f)}{Y_t} + \frac{\psi}{\phi} \right]^{\frac{1-\psi}{\phi-\psi}} + \left[ 1 - \frac{\phi}{1 - \psi} \right]
\]

• \( \psi > 0 \): Kimball (1995), \( \psi = 0 \): Dixit-Stiglitz case
Intuition: asymmetric price setting with quasi-kinked demand

- Strategic complementarities imply that firms face **quasi-kinked demand**
  - Demand elasticity is an increasing function of price
- Firms increase prices sharply when marginal costs increase but do not cut prices as much when marginal cost falls
Parameterization and Solution

- We follow Harding, Lindé & Trabandt (JME, 2022) to parameterize model
  - Estimate linearized model on pre GFC data
  - Impose tighter prior for steady state markup, Calvo price parameter set in line with micro evidence
  - Estimate price Kimball parameter

- Solution and filtering also follows HLT
  - Solve model with extended path method in Dynare (Fair–Taylor)
  - Stochastic simulation under certainty equivalence teases out difference between linear and nonlinear solutions
Phillips curves in linearized and nonlinear model

Phillips curves with monetary shocks only

- Linearized model
- Nonlinear model
Effect of a cost-push shock on Phillips curves

Phillips curves with monetary shocks only

- Linearized model
- Nonlinear model
- Linearized model + price cost-push shock
- Nonlinear model + price cost-push shock

Output gap

Inflation (APR)
What are the implications for shock propagation?

- Simulate model with shocks evaluated at estimated standard deviations
  - Do this shock by shock, then for all shocks combined

- Feed a $1\sigma_p$ price cost-push shock at each period during the simulations

- Compute the average 1 year effect of the shock across different states
State-dependent effects of cost-push shocks on inflation

- Cost-push shocks amplified when initial inflation is high, irrespective of which shock drives underlying model dynamics
  - Similar results for output gap responses
- Cost-push shocks are main driver of inflation in the model
  - Produce substantial inflation risk

![State-dependent 1-year average response to a price cost-push shock](chart)

**Monetary shocks + price cost-push shock**

- Nonlinear model
- Linearized model
- Steady state inflation rate

![Price cost-push shocks + price cost-push shock](chart)

**Initial inflation level (APR)**

- 0.4
- 0.6
- 0.8
- 1
- 1.2

**Inflation response (APR)**

- 0.4
- 0.5
- 0.6
- 0.7
- 0.8
- 0.9
- 1
- 1.2

**Initial inflation level (APR)**

- 2
- 4
- 6
- 8
- 10
- 12

**Inflation response (APR)**

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3

**More**

**GDP effects**
What explains the increased inflation risk?

- Whether inflation is surging or descending is key
- Inflation risk substantially higher when inflation is surging

Understanding Inflation Risk:
Pass-through of Cost-Push Shocks in Inflation Surge and Descend Episodes
Monetary policy trade-offs during the post-Covid period

- What is the policy trade-off at the current juncture?
- Compute IRFs to cost-push and monetary shocks in nonlinear and linearized model conditional on 2021Q4 filtered state
- Compute the cost of full inflation stabilization in response to a cost-push shock for different levels of initial inflation
IRFs to a $1 \sigma_p$ price cost-push shock in 2021Q4

Inflation

Policy rate

GDP growth

GDP gap

Nonlinear model
Linearized model
IRFs to a $1 \sigma_r$ monetary shock in 2021Q4

- **Inflation**
- **Policy rate**
- **GDP growth**
- **GDP gap**

Nonlinear model
Linearized model
Inflation stabilization cost in response to a \( 1 \sigma_p \) cost-push shock

- Compute the policy contraction that would be necessary to undo the effects of a cost-push shock over 1 year
  - Monetary policy trade-off increasingly larger as inflation increases

![Graph showing tightening and output cost to provide full inflation stabilization](chart.png)
Conditional forecast distributions during the post-Covid period

Inflation
- Forecast conditional on 2022Q1
- Forecast conditional on 2020Q4

Policy rate
- Forecast conditional on 2022Q1
- Forecast conditional on 2020Q4

GDP growth
- Forecast conditional on 2022Q1
- Forecast conditional on 2020Q4

Data
- Linearized model
- Nonlinear model

Forecast conditional on 2022Q1
Forecast conditional on 2021Q4
Forecast conditional on 2021Q2
Forecast conditional on 2020Q4
Key takeaways

- Our model explains the modest decline in inflation during the Great Recession and its recent post-COVID surge better than the standard workhorse macro model.

- Nonlinear Phillips curve and state-dependent propagation of cost-push shocks key to understand post-Covid inflation dynamics.

- Inflation risk is much higher when inflation is already elevated, implying large policy tradeoffs if cost-push shocks truly exogenous.
APPENDIX
Kimball aggregator

- Competitive firms aggregate intermediate goods $Y_t(f)$ into final goods $Y_t$ using technology $\int_0^1 G(Y_t(f)/Y_t)df = 1$
- Kimball aggregator:

$$\frac{G_Y \left( \frac{Y_t(f)}{Y_t} \right)}{1 - \psi} = \frac{\phi}{1 - \psi} \left[ \left( \frac{\phi - \psi}{\phi} \right) \frac{Y_t(f)}{Y_t} + \frac{\psi}{\phi} \right]^{\frac{1 - \psi}{\phi - \psi}} + \left[ 1 - \frac{\phi}{1 - \psi} \right]$$

with $\psi = (\phi - 1)\varepsilon$
- $\varepsilon > 0$ governs demand curvature; $\varepsilon = 0$ is Dixit-Stiglitz case
State-dependent effects of cost-push shocks on inflation

TFP shocks + price cost-push shock
\[ \frac{dy}{dx} = 0.26 \]

Risk premium shocks + price cost-push shock
\[ \frac{dy}{dx} = 0.24 \]

Fiscal shocks + price cost-push shock
\[ \frac{dy}{dx} = 0.25 \]

Investment shocks + price cost-push shock
\[ \frac{dy}{dx} = 0.24 \]

Monetary shocks + price cost-push shock
\[ \frac{dy}{dx} = 0.24 \]

Price cost-push shocks + price cost-push shock
\[ \frac{dy}{dx} = 0.22 \]

Wage cost-push shocks + price cost-push shock
\[ \frac{dy}{dx} = 0.26 \]

All shocks + price cost-push shock
\[ \frac{dy}{dx} = 0.21 \]
State-dependent effects of cost-push shocks on GDP gap

TFP shocks + price cost-push shock

dy/dx = -0.38

Risk premium shocks + price cost-push shock

dy/dx = -0.34

Fiscal shocks + price cost-push shock

dy/dx = -0.33

Investment shocks + price cost-push shock

dy/dx = -0.34

Monetary shocks + price cost-push shock

dy/dx = -0.35

Price cost-push shocks + price cost-push shock

dy/dx = -0.32

Wage cost-push shocks + price cost-push shock

dy/dx = -0.38

All shocks + price cost-push shock

dy/dx = -0.3