Did the Federal Reserve Break the Phillips Curve? 
Theory & Evidence of Anchoring Inflation Expectations
Technical Appendix∗

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A Derivation & Calibration of Theoretical Model

This section provides further details on the derivation and calibration of our theoretical model in Section 2.2 of the main text. Our model combines features from the previous works of Ireland (2007) and Leduc and Liu (2016). The key agents in our model are a representative household, a retail goods sector which produces differentiated products subject to nominal rigidities, an aggregation sector which aggregates the differentiated products into the final output, intermediate goods producers which hire labor in a frictional labor market, and a government which sets the short-term nominal interest rate and sets lump-sum taxes to finance unemployment benefits.

A.1 Households

The model features a representative household populated by a continuum of worker members which maximize utility from consumption and leisure:

$$\max E_t \sum_{s=0}^{\infty} a_{t+s} \beta^s \left\{ \log (C_{t+s}) - \chi N_{t+s} \right\}$$

where $C_t$ denotes consumption, $N_t$ is the fraction of employed household members, $\chi$ denotes the disutility from working, $\beta$ is the household’s discount factor, and $a_t$ is an exogenous preference shock which triggers unexpected fluctuations in household demand. The representative household chooses its consumption and bond holdings to maximize its utility subject to its budget constraint each period:

$$C_t + \frac{B_t}{P_t R_t} = \frac{B_{t-1}}{P_t} + W_t N_t + \phi_u (1 - N_t) + D_t - T_t, \quad \forall t \geq 0,$$

where $P_t$ denotes the aggregate price level, $B_t$ denotes holdings of a nominal risk-free bond, $R_t$ denotes the nominal interest rate, $W_t$ denotes the real wage rate, $\phi_u$ denotes an unemployment benefit (the replacement ratio), $D_t$ denotes profit income from ownership of intermediate goods producers and of retailers, and $T_t$ denotes a lump-sum tax paid to the government. The household’s optimal choices of consumption and bond holdings satisfy the following first-order conditions:

$$\lambda_t = \frac{a_t}{C_t}, \quad (1)$$

$$1 = E_t \left\{ \left( \beta \frac{\lambda_{t+1}}{\lambda_t} \right) \left( \frac{R_t}{\Pi_{t+1}} \right) \right\}, \quad (2)$$

where $\Pi_t = P_t / P_{t-1}$ denotes the gross rate of inflation and $\lambda_t$ denotes the nonnegative Lagrange multiplier on the household’s budget constraint.
The discount factor of the household $\beta$ is subject to shocks via the stochastic process $a_t$. We interpret these fluctuations as demand shocks since an increase in $a_t$ induces households to consume more today for no technological reason. The stochastic process for these fluctuations is as follows:

$$\log (a_t) = \rho_t \log (a_{t-1}) + \sigma_t \varepsilon_t^a,$$

where $\varepsilon_t^a$ is an independent and standard normal random variable.

### A.2 Aggregation Sector

The aggregation sector uses $Y_t(i)$ units of each retail good produced by the retail goods-producing firm $i \in [0, 1]$ to create the final output $Y_t$ using the following constant returns to scale technology:

$$\left[ \int_0^1 Y_t(i) \frac{i-\eta}{\eta} di \right]^{\frac{\eta}{\eta-1}} \geq Y_t,$$

where $\eta > 1$ is the elasticity of substitution between differentiated products. Each intermediate good $Y_t(i)$ sells at nominal price $P_t(i)$ and each final good sells at nominal price $P_t$. The representative producer in the aggregation sector chooses $Y_t$ and $Y_t(i)$ for all $i \in [0, 1]$ to maximize the following expression of firm profits:

$$P_t Y_t - \int_0^1 P_t(i) Y_t(i) di,$$

subject to the constant returns to scale production function. Optimization results in the following first-order condition:

$$Y_t(i) = \left[ \frac{P_t(i)}{P_t} \right]^{-\eta} Y_t.$$

The market for final output is perfectly competitive, and thus the aggregation earns zero profits in equilibrium. Using the zero-profit condition, the first-order condition for profit maximization, and the objective function, the aggregate price index $P_t$ can be written as follows:

$$P_t = \left[ \int_0^1 P_t(i)^{1-\eta} di \right]^{\frac{1}{1-\eta}}.$$

### A.3 Retail Goods-Producing Firms

There exists a continuum of retail goods-producing firms, each producing a differentiated product using a homogeneous intermediate good as input. The production function of a retail good of type $i \in [0, 1]$ is given by

$$Y_t(j) = X_t(i),$$

subject to the constant returns to scale production function.
where $X_t(i)$ is the input of intermediate goods used by retailer $j$ and $Y_t(i)$ is the output. The retail goods producers are price takers in the input market and monopolistic competitors in the product markets, where they set prices for their products, taking as given the demand schedule in Equation (4) and the price index in Equation (5).

Firm $i$ faces a quadratic cost to adjusting its nominal price $P_t(i)$:

$$\frac{\phi_P}{2} \left[ \frac{P_t(i)}{\Pi_{t}^{LT} P_{t-1}(i)} - 1 \right]^2 Y_t$$

where $\phi_P$ governs the magnitude of the adjustment costs. $\Pi_{t}^{LT} = \exp(\pi_{t}^{LT})$ is the gross rate of long-term inflation expectations which are determined by the following equation:

$$\pi_{t}^{LT} = \pi_{t-1}^{LT} + \delta^\pi \left( \pi_t - \pi_{t-1}^{LT} \right), \quad (7)$$

where $\pi_t = \log(\Pi_t)$. The coefficient $\delta^\pi$ determines the degree to which long-term inflation expectations are anchored. In the extreme case, if $\delta^\pi = 0$, then long-term inflation expectations are fully anchored in the sense that they are invariant to realized inflation. On the other extreme, if $\delta^\pi > 0$, then inflation expectations are unanchored and drift with realized inflation.

Each retail firm producing good $i$ chooses $P_t(i)$ to maximize its discounted present-value of profits:

$$\mathbb{E}_t \sum_{s=0}^{\infty} \left( \frac{\beta^s}{\lambda_t} \right) \left[ \frac{P_{t+s}(j)}{P_{t+s}} - q_{t+s} \right] Y_{t+i} - \frac{\phi_P}{2} \left( \frac{P_{t+s}(i)}{\Pi_{t+s}^{LT} P_{t+s-1}(i)} - 1 \right)^2 Y_{t+s}, \quad (8)$$

where $q_t$ denotes the relative price of the intermediate good. In a symmetric equilibrium with $P_t(i) = P_t$ for all $i$, the optimal price-setting decision implies:

$$q_t = \frac{\eta - 1}{\eta} + \frac{\phi_P}{\eta} \left\{ \left( \frac{\Pi_t}{\Pi_{t+1}^{LT}} \right) \left( \frac{\Pi_t}{\Pi_{t}^{LT}} - 1 \right) - \mathbb{E}_t \left[ \left( \frac{\beta^s \lambda_{t+1}}{\lambda_t} \right) \left( \frac{\Pi_{t+1}}{\Pi_{t+1}^{LT}} \right) \left( \frac{\Pi_{t+1}^{LT}}{\Pi_{t+1}^{LT}} - 1 \right) \left( \frac{Y_{t+1}}{Y_t} \right) \right] \right\}. \quad (9)$$

A.4 The Labor Market

Our formulation of the labor market in our model closely follows Leduc and Liu (2016). At the beginning of each period, there exist $N_{t-1}$ employed workers, $u_t$ unemployed workers searching for jobs, and $v_t$ vacancies posted by firms. Matches between unemployed workers and vacancies are created using a Cobb-Douglas matching function:

$$m_t = \mu u_t^\alpha v_t^{1-\alpha},$$

(10)
where \( m_t \) is the number of successful matches, the parameter \( \alpha \in (0, 1) \) denotes the elasticity of job matches with respect to the number of searching workers, and the parameter \( \mu \) scales the matching efficiency. We define the job filling rate, the probability that an open vacancy is matched with a searching worker, as follows:

\[
q_u^t = \frac{m_t}{v_t}.
\]

We define the job finding rate, the probability that an unemployed and searching worker is matched with an open vacancy, as follows:

\[
q_v^t = \frac{m_t}{u_t}.
\]

There exist \( N_{t-1} \) workers in the beginning of period \( t \). Each period, a fraction \( \rho \) of these workers lose their jobs. Thus, the number of workers who survive the job separation is \((1-\rho)N_{t-1}\). At the same time, \( m_t \) new matches are formed. Following the timing assumption in Blanchard and Galí (2010), we assume that new hires start working in the period they are hired. Thus, aggregate employment in period \( t \) evolves according to

\[
N_t = (1-\rho)N_{t-1} + m_t.
\]

With a fraction \( \rho \) of employed workers separated from their jobs, the number of unemployed workers searching for jobs in period \( t \) is given by

\[
u_t = 1 - (1-\rho)N_{t-1}.
\]

We assume full participation and define the unemployment rate as the fraction of the population who are left without a job after hiring takes place. Thus, we can write the unemployment rate as follows:

\[
U_t = u_t - m_t = 1 - N_t.
\]

### A.5 Intermediate Goods Producers

Each intermediate goods firm produces a homogenous intermediate good and hires at most one worker subject to search and matching frictions in the labor market. Since our model abstracts from changes in productivity, each firm employs a single worker produces one unit of the intermediate good each period. If a firm finds a match, the firm obtains a flow profit in the current period after paying the worker. In the next period, the match may survive with probability probability \( 1-\rho \) or dissolve with probability \( \rho \). If the match dissolves, the
firm posts a new job vacancy at a fixed cost $\kappa$ units of the final good with the value $V_{t+1}$. Thus, the following Bellman equation captures the value of the firm:

$$J^F_t = q_t - W_t + \mathbb{E}_t \left\{ \left( \frac{\beta_{t+1}}{\lambda_t} \right) \left( (1 - \rho)J^F_{t+1} + \rho V_{t+1} \right) \right\}.$$  \hfill (16)

where $q_t$ denotes the relative price of the intermediate good, $W_t$ denotes the real wage, and $\lambda_t$ is the representative household’s marginal utility from consumption. $\kappa$ denotes the cost of posting a new vacancy in terms of final goods. The vacancy is filled with probability $q^v_t$, in which case the firm obtains the value of the match. Otherwise, the vacancy remains unfilled and the firm goes into the next period with the value $V_{t+1}$. Thus, the value of an open vacancy is given by

$$V_t = -\kappa + q^v_t J^F_t + \mathbb{E}_t \left\{ \frac{\beta_{t+1}}{\lambda_t} (1 - \rho) V_{t+1} \right\}. \hfill (17)$$

Free entry implies that $V_t = 0$ which implies:

$$\frac{\kappa}{q^v_t} = J^F_t,$$ \hfill (18)

which describes the optimal job creation decisions. The benefit of creating a new job is the match value $J^F_t$ while the expected cost of creating a new job is the flow cost of posting a vacancy $\kappa$ multiplied by the expected duration of an unfilled vacancy $1/q^v_t$.

If a worker is employed, he obtains wage income but pays a utility cost of working. In period $t+1$, the match is separated with probability $\rho$ and the separated worker can find a new match with probability $q^u_{t+1}$. Thus, a separated worker failed to find a new job in period $t+1$ and enters the unemployment pool with probability $\rho(1-q^u_{t+1})$. Otherwise, the worker continues to be employed. The marginal value of an employed worker (denoted by $J^W_t$) therefore satisfies the Bellman equation

$$J^W_t = W_t - \frac{\chi}{\lambda_t} + \mathbb{E}_t \left\{ \frac{\beta_{t+1}}{\lambda_t} \left[ (1 - \rho(1-q^u_{t+1})) J^W_{t+1} + \rho(1-q^u_{t+1}) J^u_{t+1} \right] \right\}, \hfill (19)$$

where $J^u_t$ denotes the value of an unemployed worker. An unemployed worker obtains the flow unemployment benefit $\phi_u$ and can find a new job in period $t+1$ with probability $q^u_{t+1}$.

Thus, the value of an unemployed worker satisfies the Bellman equation

$$J^U_t = \phi_u + \mathbb{E}_t \left\{ \frac{\beta_{t+1}}{\lambda_t} \left[ q^u_{t+1} J^W_{t+1} + (1 - q^u_{t+1}) J^U_{t+1} \right] \right\}. \hfill (20)$$
Firms and workers bargain over wages. Leduc and Liu (2016) derive the following expression for the Nash bargaining wage.

\[ W^N_t = (1 - b) \left[ \frac{\chi}{\lambda_t} + \phi_u \right] + b \left\{ q_t Z_t + \beta (1 - \rho) \mathbb{E}_t \left[ \frac{\beta \lambda_{t+1} \kappa v_{t+1}}{u_{t+1}} \right] \right\} . \] (21)

The Nash bargaining wage is a weighted average of the worker’s reservation value and the firm’s productive value of a job match. By forming a match, the worker incurs a utility cost of working and forgoes unemployment benefits. By employing a worker, the firm receives the marginal product from labor in the current period and saves the vacancy cost from the next period.

Following Hall (2005) and Blanchard and Galí (2010), we assume actual wages adjust slowly to changing economic conditions:

\[ W_t = W^N_{t-1} \left( W^N_t \right)^{1-\gamma} \] (22)

where \( W^N_t \) is the wage under Nash bargaining and \( \gamma \in (0, 1) \) represents the degree of real wage rigidity.

**A.5.1 Monetary Policy**

The central bank in the model sets its short-term nominal policy rate \( R_t \) to minimize fluctuations in inflation in deviation from its long-term expectations and output growth, smoothing changes in interest rates over time:

\[ \log \left( R_t \right) = \log \left( R_{t-1} \right) + \phi_\pi \log \left( \Pi_t / \Pi_t^{LT} \right) + \phi_y \log \left( Y_t / Y_{t-1} \right) , \] (23)

where \( \phi_\pi \) and \( \phi_y \) denote the central bank’s response to inflation deviations and changes in output growth.

**A.6 Government Policy**

The government finances transfer payments for unemployment benefits through lump-sum taxes. We assume that the government balances the budget in each period so that

\[ \phi_u (1 - N_t) = T_t. \] (24)
A.7 Equilibrium

In equilibrium, the markets for final consumption goods, intermediate goods, and the zero net-supply bonds \((B_t = 0)\) all clear. Therefore, we can write the aggregate resource constraint:

\[
C_t + \kappa V_t + \frac{\phi_P}{2} \left( \frac{\Pi_t}{\Pi_{t+1}} - 1 \right)^2 Y_t = Y_t. \tag{25}
\]

A.8 Complete Model

We can write down the complete model as follows:

\[
\lambda_t = \frac{\alpha_t}{C_t}, \tag{26}
\]

\[
1 = E_t \left\{ \left( \beta \frac{\lambda_{t+1}}{\lambda_t} \right) \left( \frac{R_t}{\Pi_{t+1}} \right) \right\}, \tag{27}
\]

\[
q_t = \frac{\eta - 1}{\eta} + \frac{\phi_P}{\eta} \left\{ \left( \frac{\Pi_{t+1}}{\Pi_{t}^{LT}} \right) \left( \frac{\Pi_t}{\Pi_{t}^{LT}} - 1 \right) - E_t \left[ \left( \beta \frac{\lambda_{t+1}}{\lambda_t} \right) \left( \frac{\Pi_{t+1}}{\Pi_{t}^{LT}} \right) \left( \frac{\Pi_{t+1}}{\Pi_{t+1}^{LT}} - 1 \right) \left( \frac{Y_{t+1}}{Y_t} \right) \right] \right\}, \tag{28}
\]

\[
m_t = \mu u^\alpha_t v_t^{1-\alpha}, \tag{29}
\]

\[
a_t^u = \frac{m_t}{v_t}, \tag{30}
\]

\[
a_t^v = \frac{m_t}{u_t}, \tag{31}
\]

\[
N_t = (1 - \rho)N_{t-1} + m_t, \tag{32}
\]

\[
u_t = 1 - (1 - \rho)N_{t-1}, \tag{33}
\]

\[
U_t = 1 - N_t, \tag{34}
\]

\[
Y_t = N_t, \tag{35}
\]

\[
\log \left( R_t \right) = \log \left( R_{t-1} \right) + \phi_\pi \log \left( \Pi_t/\Pi_{t}^{LT} \right) + \phi_y \log \left( Y_t/Y_{t-1} \right), \tag{36}
\]
\[ C_t + \kappa V_t + \frac{\phi_P}{2} \left( \frac{\Pi_t}{\Pi_{LT}^t} - 1 \right)^2 Y_t = Y_t, \]  
\[ J_t^F = q_t - W_t + \mathbb{E}_t \left\{ \left( \frac{\beta \lambda_{t+1}}{\lambda_t} \right) \left( 1 - \rho \right) J_{t+1}^F + \rho V_{t+1} \right\}, \]  
\[ \frac{\kappa}{q_t} = J_t^F, \]  
\[ W_t^N = (1 - b) \left[ \frac{\chi}{\lambda_t} + \phi_u \right] + b \left\{ q_t Z_t + \beta (1 - \rho) \mathbb{E}_t \left[ \frac{\beta \lambda_{t+1} \kappa v_{t+1}}{\lambda_t u_{t+1}} \right] \right\}, \]  
\[ W_t = W_{t-1}^\gamma (W_t^N)^{1-\gamma}, \]  
\[ \log (a_t) = \rho_a \log (a_{t-1}) + \sigma_a^\alpha \epsilon_t^a, \]  
\[ \log \left( \Pi_t^{LT} \right) = \log \left( \Pi_{t-1}^{LT} \right) + \delta \pi \left( \log \left( \Pi_t \right) - \log \left( \Pi_{t-1}^{LT} \right) \right). \]  

To keep track of the model’s predictions for inflation and the nominal interest rate, we also include the growth rates of inflation and the nominal interest rate as equations in our model:

\[ g_t^\pi = \Pi_t / \Pi_{t-1}, \]  
\[ g_t^r = R_t / R_{t-1}. \]  

### A.9 Stationary Model

Due to our random-walk specification for long-term inflation expectations, the nominal variables in our model feature a unit root. To write our model in stationary form, we define the following variables: \( \pi_t = \Pi_t / \Pi_t^{LT} \), \( \tilde{\pi}_t^{LT} = \Pi_t^{LT} / \Pi_{t-1}^{LT} \), and \( \tilde{r}_t = R_t / \Pi_t^{LT} \). Then, we can re-write our model in terms of these stationary variables as follows:

\[ \lambda_t = \frac{a_t}{C_t}, \]  
\[ 1 = \mathbb{E}_t \left\{ \left( \frac{\beta \lambda_{t+1}}{\lambda_t} \right) \left( \frac{\tilde{r}_t}{\pi_{t+1}^{LT}} \right) \left( \frac{1}{\pi_{t+1}^{LT}} \right) \right\}. \]
\[ q_t = \frac{\eta - 1}{\eta} + \frac{\phi_P}{\eta} \left\{ \left( \tilde{\eta}_t \right) \left( \tilde{\eta}_t - 1 \right) - \mathbb{E}_t \left[ \left( \frac{\beta \lambda_{t+1}}{\lambda_t} \right) \left( \tilde{\eta}_{t+1} \right) \left( \tilde{\eta}_{t+1} - 1 \right) \left( \frac{Y_{t+1}}{Y_t} \right) \right] \right\}, \]  

\[ m_t = \mu \alpha_t v_t^{1-\alpha}, \]  

\[ q_t^u = \frac{m_t}{\alpha_t}, \]  

\[ q_t^v = \frac{m_t}{\alpha_t}, \]  

\[ N_t = (1 - \rho)N_{t-1} + m_t, \]  

\[ u_t = 1 - (1 - \rho)N_{t-1}, \]  

\[ U_t = 1 - N_t, \]  

\[ Y_t = N_t, \]  

\[ \log \left( \tilde{r}_t \right) = \log \left( \tilde{r}_{t-1} \right) + \phi_x \log \left( \tilde{\eta}_t \right) + \phi_y \log \left( Y_t / Y_{t-1} \right) - \log \left( \tilde{\eta}_t^{LT} \right), \]  

\[ C_t + \kappa V_t + \frac{\phi_P}{2} \left( \frac{\tilde{\eta}_t}{\alpha} - 1 \right)^2 Y_t = Y_t, \]  

\[ J_t^F = q_t - W_t + \mathbb{E}_t \left\{ \left( \frac{\beta \lambda_{t+1}}{\lambda_t} \right) \left( (1 - \rho)J^F_{t+1} + \rho V_{t+1} \right) \right\}, \]  

\[ \frac{\kappa}{q_t^v} = J_t^F, \]  

\[ W_t^N = (1 - b) \left[ \frac{\alpha}{\lambda_t} + \phi \right] + b \left\{ q_t Z_t + \beta (1 - \rho) \mathbb{E}_t \left[ \frac{\beta \lambda_{t+1} \kappa v_{t+1}}{\lambda_t u_{t+1}} \right] \right\}, \]  

\[ W_t = W_{t-1}^{\gamma} \left( W_t^N \right)^{1-\gamma}, \]  

\[ \log \left( a_t \right) = \rho a \log \left( a_{t-1} \right) + \sigma^a \varepsilon_t^a, \]
\[
\log(\tilde{\pi}_t^{LT}) = \delta \left( \log(\tilde{\pi}_t) - \log(\tilde{\pi}_t^{LT}) \right), \tag{63}
\]

\[
g_t^\pi = (\tilde{\pi}_t / \tilde{\pi}_{t-1}) \tilde{\pi}_t^{LT}, \tag{64}
\]

\[
g_t^r = (\tilde{\pi}_t / \tilde{\pi}_{t-1}) \tilde{\pi}_t^{LT}. \tag{65}
\]

### A.10 Calibration and Solution Method

After writing the model in stationary form, we calibrate the parameters of the model and solve the model using a first-order approximation around the deterministic steady state. Table A.1 contains the calibrated parameters of our model. Since our model combines the frictional market specification of Leduc and Liu (2016) with the estimated macroeconomic model of Ireland (2007), we almost exclusively use the parameters from those papers in calibrating our model. Following Blanchard and Galí (2010), we set the matching elasticity parameter \(\alpha\) and the wage bargaining parameter \(b\) equal to 0.5. Our calibration of job separations \(\rho = 0.1\) implies a monthly job separation rate of roughly 3.5%. Consistent with calibration of Hall and Milgrom (2008), the replacement ratio of unemployment is set such that \(\phi = 0.25\). The remaining labor market parameters are calibrated using the strategy in Section 4.1 of Leduc and Liu (2016) which implies a steady-state unemployment rate of \(U = 0.064\) and a total cost of posting vacancies at roughly 2 percent of gross output. The real wage rigidity parameter \(\gamma = 0.8\), which is in line with Gertler and Trigari (2009).

With a couple of exceptions, the remaining parameters are calibrated match the calibrated or estimated values in Ireland (2007). We set the household discount factor \(\beta = 0.9995\) and the elasticity of substitution across intermediate goods \(\eta\) equal to 6. For the persistence of the preference shock process, we calibrate \(\rho_a = 0.9097\) to the estimated value of Ireland (2007). We set the volatility of the preference shock process \(\sigma_a = 0.01\) such that a one standard deviation shock moves the demand shock process by one percent. For the monetary policy rule, Ireland’s assumption of full interest rate smoothing (a coefficient of one on lagged interest rates in the policy rule), allows us to write the policy rule in a stationary form. We calibrate the policy response of inflation deviations \(\phi_\pi = 0.8594\), the estimated value of Ireland (2007). With respect to the policy response to changes in the real economy, Ireland (2007) includes a nontrivial response of policymakers to changes in output growth. However, we find that including a response to output growth generates much larger (and
likely counterfactual) fluctuations in inflation when we incorporate frictions in the labor market, so we set \( \phi_y \) equal to zero to generate more sensible inflation dynamics.

For the remaining parameters of the model (\( \delta^\pi \) and \( \phi_P \)), we calibrate them based on our empirical evidence in Tables 1 and 5 of the main text which we discuss in Section 3.2.1.

B Additional Empirical Exercises

B.1 Break in \( \delta^\pi \), Not Change in Nature of CPI Surprises

Related to the discussion in footnote 5 of Section 3.1 in the main text, we now show that the break in the estimate of \( \delta^\pi \) we document appears to reflect a change in the reaction of inflation expectations to CPI surprises rather than a change in the nature of CPI surprises. Table B.1 shows the summary statistics for CPI surprises both before and after 2012. The standard deviation of the Bloomberg core inflation surprises is equal to 0.07 prior to 2012 and 0.06 thereafter. Furthermore, the surprises in both samples are not significantly skewed nor do we find evidence that they are non-normal as the Jarque-Bera statistic falls below its critical value. The most notable difference between the two samples is the presence of an average downside inflation surprise after 2012. From the viewpoint of our regression model, this change in the distribution of inflation surprises has the potential to impact the intercept \( \delta^0 \), but not the slope coefficient \( \delta^\pi \). However, Table 1 of the main text shows that we find no statistically significant evidence of a change in the regression intercept across the two sample periods.

B.2 Robustness to Dropping the Global Financial Crisis

In Section 3.1.3, we discuss that, if we drop the precipice of the global financial crisis, we find evidence indicating the presence of a single structural break in early 2010. For our baseline inflation compensation model, Table B.2 shows that we estimate the exact same break date of May 2010 for the core inflation coefficient if we drop the fourth quarter of 2008 and first quarter of 2009 from the estimation. The blue dotted lines in Panel’s A and B of Figure 3 of the main text plot the time series of the Chow statistics for samples that exclude the financial crisis. For both the inflation compensation and forward rate models, the presence of a peak in the time series of the break statistics in 2010 is insensitive to the inclusion or exclusion of the financial crisis. After excluding the precipice of the financial crisis, Table B.3 shows that the estimated break date for the forward rate model is February of 2010 and
that break is estimated to be statistically significant using the Andrews-Quandt test and the Andrews-Ploberger test. This finding suggests that the source of instability in the response of forward bond yields to inflation surprises occurring around 2010 is not simply a reflection of financial market volatility but, instead, is likely due to deeper structural change.

References


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<th>Parameter</th>
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<tr>
<td>$\phi_\pi$</td>
<td>Central Bank Response to Inflation</td>
<td>1.5</td>
</tr>
<tr>
<td>$\phi_y$</td>
<td>Central Bank Response to Output Growth</td>
<td>0.0</td>
</tr>
<tr>
<td>$\rho_a$</td>
<td>Preference Shock Persistence</td>
<td>0.9097</td>
</tr>
<tr>
<td>$\sigma_a$</td>
<td>Preference Shock Volatility</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Table B.1: Summary Statistics of US Core CPI Inflation Surprises

<table>
<thead>
<tr>
<th></th>
<th>1997-2011</th>
<th>2012-2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.00</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(0.63)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.16</td>
<td>-0.23</td>
</tr>
<tr>
<td></td>
<td>(0.39)</td>
<td>(0.37)</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-0.33</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>(0.38)</td>
<td>(0.69)</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>1.58</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>(0.45)</td>
<td>(0.61)</td>
</tr>
<tr>
<td>Observations</td>
<td>179</td>
<td>96</td>
</tr>
</tbody>
</table>

Note: p-values in parenthesis.
Table B.2: US Inflation Compensation Model: Structural Break Tests Excluding Financial Crisis

<table>
<thead>
<tr>
<th></th>
<th>5-Year, 5-Year Forward Inflation</th>
<th>Andrews-Quandt</th>
<th>Andrews-Ploberger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Date</td>
<td>Test Statistic</td>
<td>Test Statistic</td>
</tr>
<tr>
<td>Constant</td>
<td>2002:08</td>
<td>2.13</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.75)</td>
<td>(0.70)</td>
</tr>
<tr>
<td>Core CPI surprise</td>
<td>2010:05</td>
<td>9.91**</td>
<td>2.13**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.03)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Food &amp; Energy CPI surprise</td>
<td>2010:07</td>
<td>1.20</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.97)</td>
<td>(0.93)</td>
</tr>
<tr>
<td>All Coefficients</td>
<td>2010:05</td>
<td>10.90</td>
<td>2.57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.15)</td>
<td>(0.24)</td>
</tr>
<tr>
<td>Residual Variance</td>
<td>2001:09</td>
<td>2.55</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.65)</td>
<td>(0.37)</td>
</tr>
</tbody>
</table>

Note: Approximate asymptotic p-values from Hansen (1997) in parenthesis.
Observations: 218
*p < 0.10,**p < 0.05
Table B.3: US Forward Rate Model: Structural Break Tests Excluding Financial Crisis

<table>
<thead>
<tr>
<th></th>
<th>1-Year, 9-Year Forward Rate</th>
<th></th>
<th>Andrews-Quandt</th>
<th>Andrews-Ploberger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Date</td>
<td>Test Statistic</td>
<td>Test Statistic</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>2013:11</td>
<td>1.99</td>
<td>0.24</td>
<td>(0.79)</td>
</tr>
<tr>
<td>Core CPI surprise</td>
<td>2010:02</td>
<td>8.45*</td>
<td>1.96*</td>
<td>(0.05)</td>
</tr>
<tr>
<td>GS Agriculture Price Index</td>
<td>2003:09</td>
<td>5.20</td>
<td>1.26</td>
<td>(0.23)</td>
</tr>
<tr>
<td>GS Energy Price Index</td>
<td>2011:05</td>
<td>4.19</td>
<td>0.63</td>
<td>(0.35)</td>
</tr>
<tr>
<td>All Coefficients</td>
<td>2010:02</td>
<td>12.96</td>
<td>3.96</td>
<td>(0.16)</td>
</tr>
<tr>
<td>Residual Variance</td>
<td>2013:11</td>
<td>2.66</td>
<td>0.67</td>
<td>(0.63)</td>
</tr>
</tbody>
</table>

Note: Approximate asymptotic p-values from Hansen (1997) in parenthesis. 2008:10 through 2009:03 are excluded from the sample. Observations: 268

*p < 0.10, **p < 0.05