

House Price Expectations and Inflation Expectations: Evidence from Survey Data

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This Paper

- We examine the relationship between house price expectations and inflation expectations.
- Our work contributes to the role of salience in influencing inflation expectations of households – novel channel through house price expectations.
- What is salience?
 - *“A stimulus is salient when it attracts the decision maker’s attention bottom up, that is, automatically and involuntarily.”* Bordalo et al. (2022)
 - Two immediate candidates: food prices (D’Acunto et al., 2021) and gasoline prices (Coibion and Gorodnichenko, 2015).

Motivation: Salience of large changes

- Contrasting, surprising, or prominent stimuli automatically drive the attention of the decision-maker and distract them from their original goals. (Bordalo et al., 2022)
- Insights from psychology and memory research reveal that people tend to focus more on large changes.
- Amidst cognitive and informational constraints, there is reliance on personal experiences to form inflation expectations.

Implication of these heuristics: Individuals could focus disproportionately more on items for which large price changes have been observed, even if those items account for low weights in the official inflation measurement.

Role of house prices

Why do people pay attention to house prices?

- House is one of the largest purchases and a major financial decision for a household.
- One of the biggest assets in the households' portfolio, collateral and wealth effects, hedge against inflation.
- High geographic mobility in the US: an average person moves residences more than eleven times in their lifetime.
- Extensive media attention to housing, especially after the GFC.
- Preoccupation of US households with housing markets.

What we do

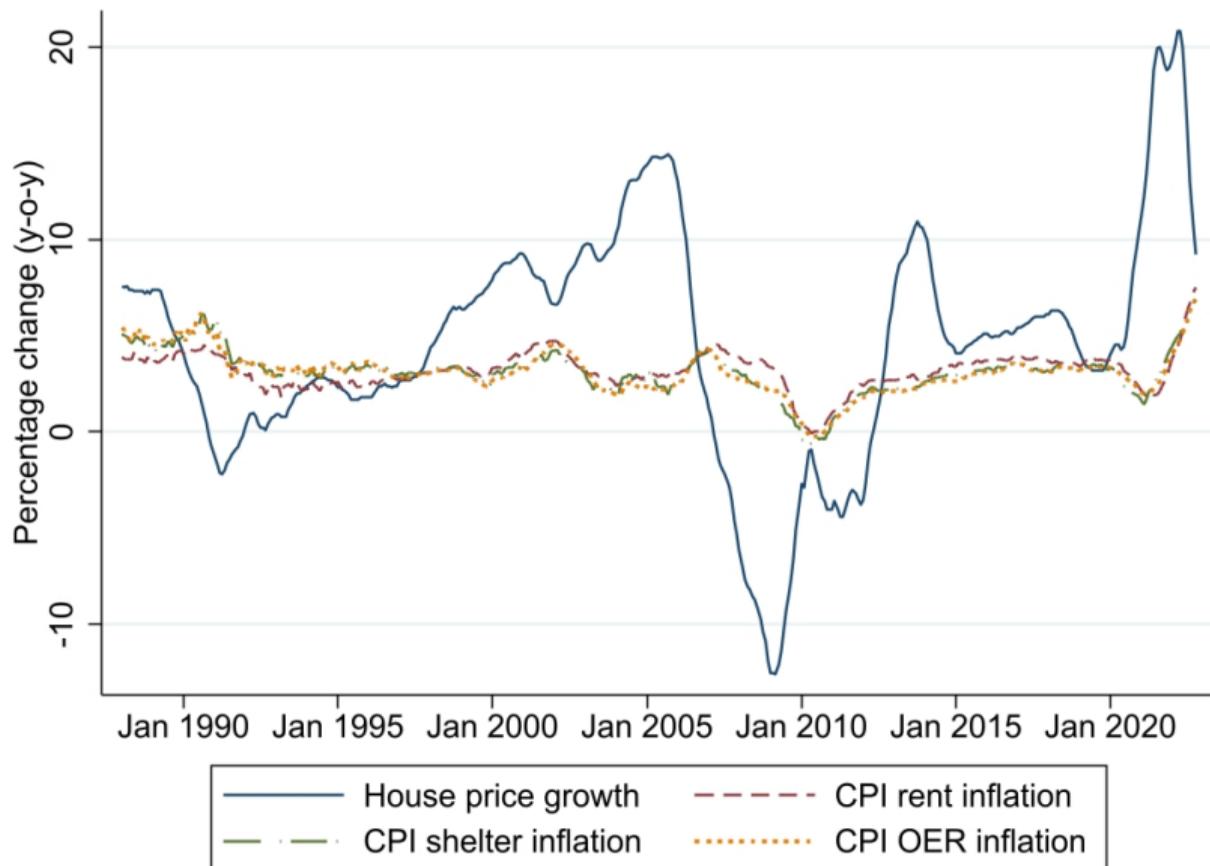
1. Find an 'accounting benchmark' to assess the impact of house price inflation on aggregate inflation.
2. Using household survey data, establish the relationship between house price expectations and inflation expectations.
3. Link the empirical observations to a two-sector NK model.

Accounting benchmark: Why do we need this?

- CPI accounts for the value of 'housing services' and not actual house prices.
- Current practice: housing services captured by CPI Shelter (32.706% weight in CPI¹). This in turn has four sub-components.
- House price movements per se are not directly reflected in CPI, only indirectly through rents.
- We need an 'accounting' benchmark to understand the relationship between house price expectations and inflation expectations in the survey data.

¹Weights as on October 2022, Bureau of Labour Statistics

Price of house vs housing services



Establishing an accounting benchmark

- We use the following cases where we regress:
 1. **CPI inflation** directly on house price growth
 2. **CPI shelter inflation** on house price growth
 3. **Components of CPI shelter** on house price growth
 4. **CPI OER** on house price growth
- Multiply the above coefficients with the average weight of the component(s) over the sample period to get the following coefficients: [▶ More](#)

Table 1: Benchmark coefficients

Period	Case 1	Case 2	Case 3	Case 4
1987-2019	0.02	0.02	-	0.01
1997-2019	0.03	0.02	0.02	0.01

- This reflects the impact of actual house price growth on actual inflation over this period.

Empirical framework

What is the relationship between house price expectations and inflation expectations?

⇒ We analyse this in a linear framework:

$$\pi_{it}^e = \alpha + \beta\pi_{it}^{he} + \delta X_{it} + \gamma I_t + \epsilon_{it}, \quad (1)$$

where π_{it}^e , is the one-year ahead inflation expectations for respondent i at time t ,

π_{it}^{he} is the one-year ahead house price expectations for respondent i at time t ,

X_{it} are the individual characteristics and I_t are the time fixed effects.

⇒ We use two datasets:

- Survey of Consumer Expectations, Federal Reserve Bank of New York (2013-2019)
- Survey of Consumers, University of Michigan (2007-2019) [▶ Data](#)

Instrumental variable approach

- Instrument house price expectations with Wharton Residential Land Use Regulatory Index (Wharton Index), as in Stroebel and Vavra (2019).
 - This is a measure of housing supply elasticity developed by Gyourko et al. (2008), Gyourko et al. (2019) based on a national survey of local residential land use restrictions pertaining to housing.
 - Higher values of this index indicate a stricter regulatory environment.
- Alternatively, we use six-month lagged interviews as instruments, as in Bachmann et al. (2015).

▶ More

Summary of empirical results

- The estimated accounting benchmark coefficients lie in the range of 0.01 to 0.03.
- From the two surveys, after controlling for possible endogeneity, we find that our estimated coefficient of house price expectations across different specifications is in the range of 0.2 to 0.4. [▶ More](#)
- This suggests that there is overweighting from house price expectations.
- Cognitive abilities captured through numeracy and education have a significant impact on the extent of this overweighting. [▶ more](#)

Two-sector NK model

To understand the monetary policy implications of our empirical results, we build a two-sector NK model:

- Extension of the one-sector model of Galí (2015) in a stylized framework.
- The model has two non-durable sectors – *representative of any two sectors where one is overweighted*.
- We abstract from the channel of durability and uncover the impact of overweighting in the simplest framework, affording analytical insights.
- The framework applies more generally to the modelling and monetary policy implications of overweighting in any good.

Households (1)

The representative infinitely-lived household chooses a composite consumption good, C and supplies labour, L to maximize the present discounted value of the expected utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, L_t), \quad (2)$$

where $\beta \in (0, 1)$ is the discount factor and

$$U(C_t, L_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\phi}}{1+\phi}, \quad (3)$$

where σ is the inverse of inter-temporal elasticity of substitution and ϕ is the inverse of Frisch elasticity of labour supply.

Households (2)

- Aggregate consumption, C_t depends on consumption of goods O and N , $C_{O,t}$, and $C_{N,t}$, according to a Cobb-Douglas technology

$$C_t \equiv \frac{(C_{N,t})^{1-\omega} (C_{O,t})^\omega}{\omega^\omega (1-\omega)^{1-\omega}}, \quad (4)$$

where $0 < \omega < 1$ is the share of the overweighted good in total consumption.

- Aggregate price index, P_t , is defined as

$$P_t = (P_{N,t})^{1-\omega} (P_{O,t})^\omega, \quad (5)$$

where $P_{N,t}$ is the price of non-overweighted good and $P_{O,t}$ is price of the overweighted good.

Overweighting by households

Empirical observation: households focus disproportionately more on one sector when forming their inflation expectations.

Let $\tilde{\mathbb{E}}_t \pi_{t+1}$ be one-period-ahead inflation expectations affected by overweighting, δ denote the excess weight to the overweighted sector.

Then,

$$\begin{aligned}\tilde{\mathbb{E}}_t \pi_{t+1} &= \mathbb{E}_t \tilde{\pi}_{t+1} = (1 - \omega - \delta) \mathbb{E}_t \pi_{N,t+1} + (\omega + \delta) \mathbb{E}_t \pi_{O,t+1}, \\ &= \mathbb{E}_t \pi_{t+1} + \underbrace{\delta (\mathbb{E}_t \pi_{O,t+1} - \mathbb{E}_t \pi_{N,t+1})}_{\text{impact of overweighting}},\end{aligned}\tag{6}$$

where $\mathbb{E}_t \pi_{j,t+1}$ with $j = N, O$ is the expected sectoral inflation rate, and $\mathbb{E}_t \pi_{t+1}$ is the undistorted expected inflation rate.

Perceived price index

Define \tilde{P} as the overweighted 'perceived' price index for the households

$$\begin{aligned}\mathbb{E}_t \tilde{P}_{t+1} &= \mathbb{E}_t P_{N,t+1}^{1-\omega-\delta} P_{O,t+1}^{\omega+\delta} \\ \tilde{P}_t &= P_{N,t}^{1-\omega-\delta} P_{O,t}^{\omega+\delta}\end{aligned}\tag{7}$$

Household's optimization problem gives the Euler equation

$$\beta Q_t^{-1} \mathbb{E}_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{\tilde{P}_t}{\tilde{P}_{t+1}} \right\} = 1.\tag{8}$$

With $\delta = 0$, we are back to the two-sector NK model without any overweighting.

Firms

- Two distinct sectors in the economy, O and N , produce overweighted and non-overweighted goods, respectively.
- Continuum of firms within each sector which produce differentiated goods using common production technology: $Y_{j,t}(i) = A_{j,t}L_{j,t}(i)$.
- Staggered price setting following Calvo (1983), where re-setting firms choose a price, P_{jt}^* .
- The FOC that determines the price is

$$\mathbb{E}_t \sum_{k=0}^{\infty} \theta_j^k \left[\beta^k \left(\frac{C_{t+k}}{C_t} \right)^{-\sigma} \frac{\tilde{P}_t}{\tilde{P}_{t+k}} \left(\frac{P_{j,t}^*}{P_{j,t+k}} \right)^{-\varepsilon_j} Y_{j,t+k} \left(P_{j,t}^* - \frac{\varepsilon_j}{1 - \varepsilon_j} MC_{j,t+k|t}^n \right) \right] = 0, \quad (9)$$

where $MC_{j,t+k|t}^n$ is the nominal marginal cost.

- The SDF incorporates household behaviour in the firm's problem.

Equilibrium

- IS equation

$$\hat{y}_t = \mathbb{E}_t \hat{y}_{t+1} - \frac{1}{\sigma} (i_t - \mathbb{E}_t \tilde{\pi}_{t+1} - r_t^n), \quad (10)$$

where $\hat{y}_t \equiv y_t - y_t^n$ is the output gap and r_t^n is the natural real interest rate.

⇒ Overweighting affects the IS equation.

- Sectoral NKPC(s),

$$\pi_{j,t} = \beta \mathbb{E}_t \pi_{j,t+1} + \chi_j \hat{m}c_{j,t}^r + u_{j,t}, \quad (11)$$

where $\chi_j = \frac{(1-\theta_j)(1-\beta\theta_j)}{\theta_j}$ and $u_{j,t}$ are the sector-specific cost-push shocks for $j = N, O$ which follow an exogenous $AR(1)$ process.

⇒ Overweighting does not affect firms' behaviour.

Welfare function

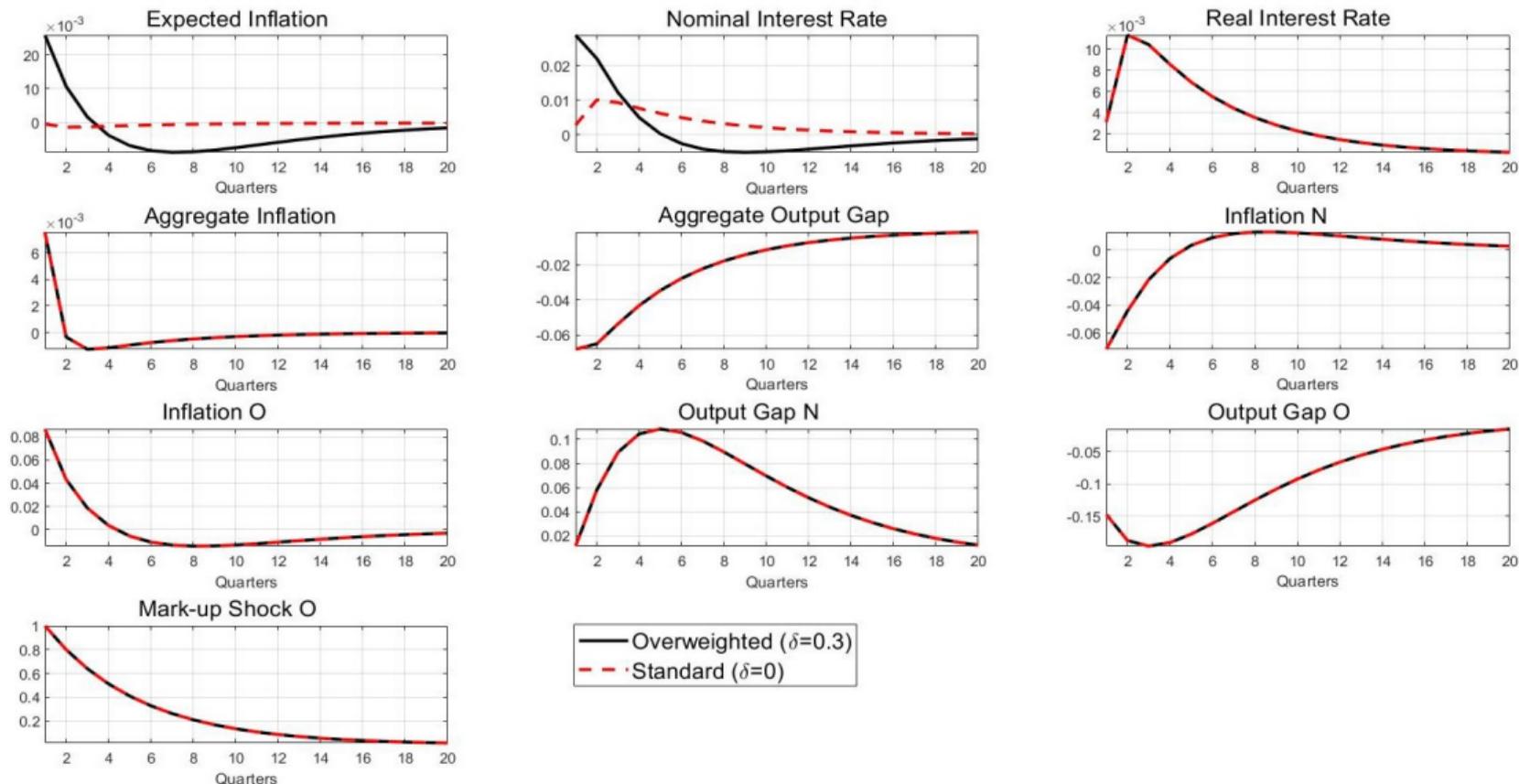
Based on Woodford (2003) and Galí (2015), the second-order Taylor approximation of the representative consumer's lifetime utility when the economy remains in a neighborhood of an efficient steady state is

$$\begin{aligned} \frac{W}{U'_C C} \approx & -\frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left[(1 - \omega) \hat{y}_{N,t}^2 + \omega \hat{y}_{O,t}^2 + (\sigma + \phi - 1) \hat{y}_t^2 \right. \\ & \left. + \frac{\varepsilon_N}{\chi_N} (1 - \omega) \pi_{N,t}^2 + \frac{\varepsilon_O}{\chi_O} \omega \pi_{O,t}^2 \right] + t.i.p + O \|\xi\|^3, \end{aligned} \quad (12)$$

where *t.i.p* denotes the terms independent of policy and $O \|\xi\|^3$ includes terms of order higher than two.

- Overweighting per se does not introduce an additional policy-trade off for the central bank.

Optimal response to a markup shock in sector O



Conclusion and policy implications

- We find a novel channel of salience from house price expectations: households overweight from house price expectations when forming their inflation expectations.
⇒ This makes a case for the central bank to monitor the housing sector beyond the usual, very important, financial stability concerns.
- We show that movements in expected inflation in the overweighted sector have consequences for optimal monetary policy.
⇒ It is important for the central bank to be aware that some sectors are overweighted by households in order to gauge the appropriate nominal interest rate response.

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Appendix

Finding a Benchmark

Relative weights and estimated coefficients as well as standard errors are:

Table 2: Relative weights of components of CPI and estimated coefficients

CPI component	CPI inflation		Shelter		Rent of primary residence	
	Average weight	Coefficient	Average weight	Coefficient	Average weight	Coefficient
1987 – 2019	1	0.015 (0.017)	0.308	0.054*** (0.01)		
1997 – 2019	1	0.032** (0.017)	0.321	0.068*** (0.009)	0.067	0.036*** (0.009)

CPI component	Lodging away from home		Owners equivalent rent of residences		Tenants and HH's insurance	
	Average weight	Coefficient	Average weight	Coefficient	Average weight	Coefficient
1987 – 2019			0.221	0.044*** (0.01)		
1997 – 2019	0.017	0.193*** (0.036)	0.223	0.053*** (0.008)	0.004	0.009 (0.014)

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Data

1. Survey of Consumer Expectations, Federal Reserve Bank of New York (2013-2019)

- Newer, internet-based survey with density-based questions. [▶ Survey Questions](#)
- Rotating panel: respondents stay in the panel for up to twelve months.
- Respondents include both homeowners and renters.
- Available at the state level. [▶ Summary Statistics](#)

2. Survey of Consumers, University of Michigan (2007-2019)

- One of the oldest surveys, longer sample. [▶ Survey Questions](#)
- Rotating panel: respondents repeated once after six months.
- Respondents include only homeowners.
- Available at the level of four census regions. [▶ Summary Statistics](#)

Survey Questions - MSC (1)

Question: Inflation Expectations

A. During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?

B. By about what percent do you expect prices to go (up/down) on the average, during the next 12 months?

Survey Questions - MSC (2)

Question: House Price Expectations

A. What do you think will happen to the prices of homes like yours in your community over the next 12 months? Will they increase at a rapid rate, increase at a moderate rate, remain about the same, decrease at a moderate rate, or decrease at a rapid rate?

B. By about what percent do you expect prices of homes like yours in your community to go (up/down), on average, over the next 12 months?

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Survey Questions - SCE (2)

Question: Inflation Expectations

Now we would like you to think about the different things that may happen to inflation over the next 12 months. In your view, what would you say is the percent chance that, over the next 12 months...

<i>rate of inflation will be 12% or higher</i>	<i>.... percent chance</i>
<i>rate of inflation will be between 8% and 12% or higher</i>	<i>.... percent chance</i>
<i>rate of inflation will be between 4% and 8% or higher</i>	<i>.... percent chance</i>
<i>rate of inflation will be between 2% and 4% or higher</i>	<i>.... percent chance</i>
<i>rate of inflation will be between 0% and 2% or higher</i>	<i>.... percent chance</i>
<i>rate of deflation (opposite of inflation) will be between 0% and 2%</i>	<i>.... percent chance</i>
<i>rate of deflation (opposite of inflation) will be between 2% and 4%</i>	<i>.... percent chance</i>
<i>rate of deflation (opposite of inflation) will be between 4% and 8%</i>	<i>.... percent chance</i>
<i>rate of deflation (opposite of inflation) will be between 8% and 12%</i>	<i>.... percent chance</i>
<i>rate of deflation (opposite of inflation) will be 12% or higher</i>	<i>.... percent chance</i>

Survey Questions - SCE (3)

Question: House Price Expectations

In your view, what would you say is the percent chance that, over the next 12 months, the average home price nationwide will have...

- increase by 12% or more percent chance*
- increase by 8% to 12% percent chance*
- increase by 4% to 8% percent chance*
- increase by 2% to 4% percent chance*
- increase by 0% to 2% percent chance*
- decrease by 0% to 2% percent chance*
- decrease by 2% to 4% percent chance*
- decrease by 4% to 8% percent chance*
- decrease by 8% to 12% percent chance*
- decrease by 12% or more percent chance*

Other IVs

- Gas price expectations: **Real gasoline taxes** (as in Davis and Kilian (2011) and Coglianesse et al. (2017))
- Food price expectations: **Real global price of food index** which represents the benchmark prices of the global market (as in Montag (2019), Shwayder (2012))

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Cross-sectional heterogeneity

Table 3: SCE: numeracy and education

Inflation expectations (1Y)	Numeracy	Education
High numeracy * House price expectations (1Y)	0.202*** (0.012)	
Low numeracy * House price expectations (1Y)	0.315*** (0.018)	
Graduate * House price expectations (1Y)		0.206*** (0.013)
Not graduate * House price expectations (1Y)		0.282*** (0.015)
Wald Test (p-values)	0.0000	0.0001
R-squared	0.196	0.194
N	75574	75574

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Baseline results (1)

Table 4: Baseline results using SCE

	(1)	(2)	(3)	(4)
Inflation expectations (1Y)	OLS - 1	OLS - 2	IV - 1	IV - 2
House price expectations (1Y)	0.250*** (0.011)	0.322*** (0.025)	0.471*** (0.062)	0.459*** (0.056)
Demographics	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Other Expectations	Yes	Yes	Yes	Yes
R-squared	0.192	0.254	0.185	0.205
N	75574	6228	6127	5688

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Baseline results using MSC

Table 4: Baseline results using MSC

	(1)	(2)	(3)
Price expectations (1Y)	OLS	IV-1	IV-2
House price expectations (1Y)	0.010** (0.005)	0.183** (0.093)	0.192* (0.104)
First stage F-stat:			
House price expectations (1Y)		41.57	23.93
Time fixed effects	Yes	Yes	Yes
Region fixed effects	Yes	No	No
Demographics	Yes	Yes	Yes
N	49292	44939	44626

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Households (3)

- Demand functions from optimal allocation of the total expenditure between the two sectors:

$$C_{N,t} = (1 - \omega) \left(\frac{P_{N,t}}{P_t} \right)^{-1} C_t \quad (13)$$

$$C_{O,t} = \omega \left(\frac{P_{O,t}}{P_t} \right)^{-1} C_t \quad (14)$$

- Demand function for variety i in sector j from the optimal allocation within each sector yields,

$$C_{j,t}(i) = \left(\frac{P_{j,t}(i)}{P_{j,t}} \right)^{-\epsilon_j} C_{j,t} \quad (15)$$

for $j = N, O$.

Households (4)

The optimality conditions from the household's problem are:

- Euler equation:

$$Q_t = \beta E_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \right\} \quad (16)$$

- Labour supply equation:

$$\frac{W_t}{P_t} = C_t^\sigma L_t^\phi \quad (17)$$

Equilibrium and Market Clearing

- Aggregating over each variety,

$$C_{j,t}(i) = Y_{j,t}(i) \quad (18)$$

- Aggregating over all firms in each sector,

$$C_{j,t} = Y_{j,t} \quad (19)$$

- Aggregating the sectors,

$$C_t = Y_t \quad (20)$$

- Labour market clearing,

$$L_{j,t} = \int L_{j,t}(i) di \quad (21)$$

and,

$$L_t = L_{N,t} + L_{O,t} \quad (22)$$

New Keynesian Philips Curve

- Inflation in each sector depends on the sectoral output gap, $\tilde{y}_{N,t}$ and $\tilde{y}_{O,t}$ and the relative price ratio gap, \tilde{s}_t :

$$\pi_{N,t} = \beta E_t \pi_{N,t+1} + \chi_N ((\sigma + \phi)\tilde{y}_{N,t} + (1 - \sigma - \phi)\omega\tilde{s}_t) + u_{N,t} \quad (23)$$

$$\pi_{O,t} = \beta E_t \pi_{O,t+1} + \chi_O ((\sigma + \phi)\tilde{y}_{O,t} + (\sigma + \phi - 1)(1 - \omega)\tilde{s}_t) + u_{O,t} \quad (24)$$

- NKPC in aggregate terms is

$$\pi_t = (1 - \omega)\pi_{N,t} + \omega\pi_{O,t}. \quad (25)$$

Steady state

The following relationships hold in the steady state:

$$A_N = A_O = 1$$

$$MC_N = MC_O = W = MC = \frac{\varepsilon - 1}{\varepsilon}$$

$$P_N = \frac{\varepsilon_N}{\varepsilon_N - 1} W$$

$$P_O = \frac{\varepsilon_H}{\varepsilon_H - 1} W$$

$$P_N = P_O = P$$

$$S = 1$$

$$C_N = (1 - \omega)C$$

$$C_O = \omega C$$

$$L = MC\left(\frac{1}{\varphi + \sigma}\right)$$

Flexible Price Equilibrium

The following equations characterize the flexible price/natural level of variables:

$$\hat{y}_t^n = \left(\frac{\sigma + \phi}{1 + \phi} \right) a_t \quad (26)$$

$$\hat{y}_{N,t}^n = a_{N,t} + \hat{y}_t^n - a_t \quad (27)$$

$$\hat{y}_{O,t}^n = a_{O,t} + \hat{y}_t^n - a_t \quad (28)$$

$$s_t^n = a_{N,t} - a_{O,t} \quad (29)$$

Parameters

Table 5: Parameters and standard deviation of shocks

Parameter		Value
Discount factor	β	0.99
Inverse IES	σ	1
Inverse Frisch elasticity of labour supply	ϕ	5
Elasticity of substitution between goods (N)	ε_N	9
Elasticity of substitution between goods (O)	ε_O	9
Price stickiness in sector N	θ_N	0.75
Price stickiness in sector O	θ_O	0.75
Cost-push shock persistence in sector N	ρ_{u_N}	0.8
Cost-push shock persistence in sector O	ρ_{u_O}	0.8
Technology shock persistence in sector N	ρ_{a_N}	0.9
Technology shock persistence in sector O	ρ_{a_O}	0.9
Share of housing in consumption	ω	0.5
Overweighting of housing parameter	δ	0.3
Cost-push shock in N standard deviation	σ_{u_N}	1
Cost-push shock in H standard deviation	σ_{u_O}	1

Optimal response to a markup shock in sector N

