Optimal in ation measures for targeting under sectoral heterogeneity

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Overview

I present my analysis for the Australian economy in three parts.

1. Approximate factor model
   - Establish an empirical case for heterogeneous sectors with

Approximate factor model

Data

The data in the large panel X_t covers the period 1989Q3-2014Q4 and is comprised of

1. 146 macroeconomic variables
   - Real output, labour market, housing, inventories, stock market, exchange rates, foreign sector, interest rates, money and credit.
2. 72 expenditure class price indices
   - 77.1% of the CPI by expenditure weight

Seasonally adjusted data is used when available.

Variables are transformed to induce stationarity where required.

Approximate factor model

Estimation

The factor model is estimated with principal components techniques.

A structural break is found in the factor loadings at 2001Q3. Analysis using the Quandt-Andrews unknown break point test shows that this is related to the introduction of the Goods and Services tax in 2000Q3.

I correct for this breakpoint by estimating the factor loadings in each regime separately.

The number of common factors is chosen based on the information criterion of Bai & Ng (2002). This results in 3 common factors that explain 21.8% of the variation in X_t.

Approximate factor model

Estimation

Sectoral in ation (x_{it}) is decomposed into a common ($_i C_t$) and idiosyncratic component (e_{it}).

$$x_{it} = {}_i C_t + e_{it}$$

Volatility of sectoral in ation and its components are estimated by their standard deviation.

The dynamic behaviour of each is estimated with an AR model, with lags chosen by information criterion. The sum of AR terms provides a measure of the persistence in each sectoral in ation process.

Approximate factor model

Heterogeneity and sticky prices

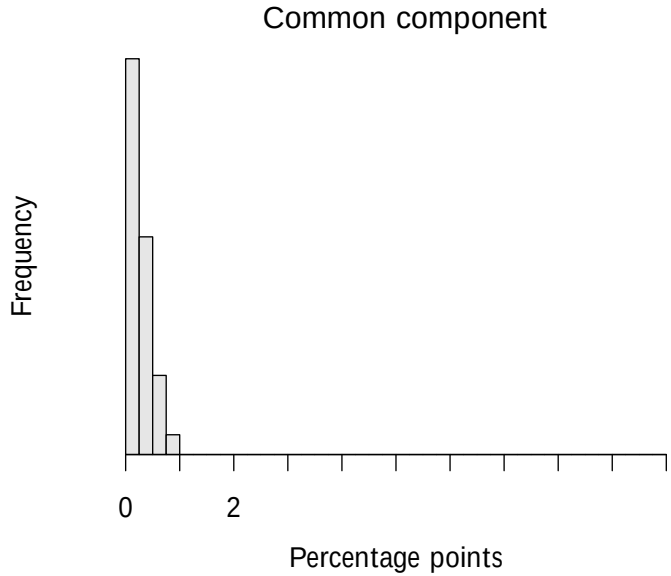
I claim that consumer prices:

- are heterogeneous across expenditure classes, and
-

Approximate factor model

Approximate factor model

Volatility



Approximate factor model

However, without information on the frequency of price changes, this is not a strong result.

In particular, Kaufmann & Lein (2013) state that we should expect to find a positive correlation between the frequency of sectoral price changes and the

- speed of response to a macroeconomic shock,
- standard deviation of the common component, and
- standard deviation of the idiosyncratic component.

Despite this, the factor model does present evidence that significant heterogeneity does exist across sectors, and that sectoral prices are likely to be sticky.

Multisector New-Keynesian DSGE Model

Introduction

To simulate sectoral in ation processes that resemble those decomposed in the approximate factor model I use a multisector New-Keynesian DSGE model, with agents

- households,
- nal goods producing rms,
- intermediate goods producing rms, and
- a monetary authority.

Multisector New-Keynesian DSGE Model

Shocks

Four shocks drive the model:

- a household preference shock,
- an aggregate technology shock for intermediate goods producers,
- a within-sector technology shock for intermediate goods producers,
- a monetary policy shock.

Multisector New-Keynesian DSGE Model

Extending the model

Underlying in ation

Name	Speci cation	Sectors
Headline	$\pi^U_t = \sum_j \frac{P_j}{\sum_j P_j} \pi_{j,t}$	$j = 1, \ldots, N$
Exclusion 1		$j = 1, \ldots, N \mid j \omega_j > 0.10$
Exclusion 2		$j = 1, \ldots, N \mid j \omega_j > 0.25$
Exclusion 3		$j = 1, \ldots, N \mid j \omega_j > 0.50$
Calvo-share	$\pi^U_t = \sum_{j=1}^{N} \frac{P_j \omega_j}{\sum_{j=1}^{N} P_j \omega_j} \pi_{j,t}$	$j = 1, \ldots, N$
Optimal	$\pi^U_t = \sum_{j=1}^{N} \omega_j \pi_{j,t}$	$j = 1, \ldots, N$

Note: ω_j and θ_j are the share and Calvo probability of sector j.

ω_j are the weights assigned when numerically maximising an objective function.

Multisector New-Keynesian DSGE Model

Extending the model

The new (log-linearised) policy rule of the monetary authority.

$$\hat{i}_t = \rho_i \hat{i}_{t-1} + (1 - \rho_i)(\phi_\pi \pi^U_t + \phi_g g_t) + \varepsilon_{it}$$

The construction of aggregate in ation, and the equilibrium relationships for sectoral and aggregate in ation remain.

The monetary authority is the only agent that acts on movements of the underlying measures, leaving aggregate in ation to evolve according to the actions of households and rms.

Multisector New-Keynesian DSGE Model

Calibration

In its original form the model is calibrated for ten broad sectors of the Australian economy. Whilst informative on the interaction between the sectors, there is no correspondence with consumer price expenditure groups or classes.

Sector	Average duration[a]	Calvo probability	Share	Calvo-share weight
Agriculture	4	0.75	0.06	0.04
Construction	$1\frac{1}{3}$	0.25	0.15	0.04
Manufacturing	2	0.50	0.28	0.14
Mining	4	0.75	0.05	0.03
Utilities	4	0.75	0.03	0.02
Wholesale and retail trade	1	0.10[b]	0.20	0.02
Transport and storage	4	0.75	0.08	0.06
Business services	4	0.75	0.08	0.06
Household services	4	0.75	0.05	0.04
Tourism	4	0.75	0.01	0.01

Sources: Park et al. (2010), Cagliarini et al. (2011), Author's calculations.
[a] Measured in quarters.
[b] Calibrated at 0.10 as the sector is empirically close to a flexible price sector.

Multisector New-Keynesian DSGE Model

Monetary Policy Shock

Multisector New-Keynesian DSGE Model

Objective of the monetary authority

Following Woodford (2003) the monetary authority seeks to maximise social welfare.

- Social welfare is de ned as the sum of all household's utility.
- I generalise Woodford's two-sector result for the N sector economy, and the social welfare loss function is

$$L_t = \left[\sum_{j=1}^{N} {}_j \hat{}_{jt}^2 + {}_c \hat{C}_t^2 \right] \tag{2}$$

Multisector New-Keynesian DSGE Model

Welfare analysis

- By responding to in ation in the comparatively stickier sectors, the monetary authority can reduce the social welfare loss.
- The welfare improvement is around 13% when using the calibrated rule, and around 50% when optimising the policy rule parameters.

	Welfare loss		Optimal rule parameters		
	Calibrated	Optimal rule	i		g
Headline	-7.532	-3.973	0.491	6.839	1.140
Exclusion 1	-7.337	-4.045	0.551	4.270	0.732
Exclusion 2	-7.072	-3.879	0.999	8.108	0.941
Exclusion 3	-6.814	-3.989	0.999	6.713	0.666
Calvo x share	-6.866	-3.882	0.864	8.165	1.072
Optimal	-6.539	-3.723	0.999	19.907	1.033

Multisector New-Keynesian DSGE Model

Optimal weights

Sector	ω_j^{SW}	ω_j	$l_j = l$	$m_j = m$	α_j	z_j
Agriculture	0.00	0.06	0.05	0.06	0.75	3.91
Construction	0.00	0.15	0.10	0.17	0.25	1.46
Manufacturing	0.00	0.28	0.25	0.30	0.50	0.60
Mining	0.07	0.05	0.03	0.05	0.75	1.71
Utilities	0.30	0.03	0.02	0.03	0.75	0.53
Wholesale and retail	0.00	0.20	0.26	0.17	0.10	0.50
Transport and storage	0.23	0.08	0.07	0.09	0.75	0.61
Business services	0.00	0.08	0.12	0.06	0.75	0.61
Household services	0.35	0.05	0.06	0.05	0.75	0.69
Tourism	0.04	0.01	0.03	0.02	0.75	0.80

Underlying in ation sectoral weights

Multisector New-Keynesian DSGE Model

So targeting underlying in ation is welfare improving, often allowing a more rapid return to steady-state following a shock.

However in practice, central banks place a focus on in ation in the CPI. The ten broad sectors as calibrated before do not translate well to the expenditure groups that comprise the CPI.

In an attempt to apply these ndings to the CPI, I turn to a classi cation technique from the multivariate statistics literature.

Discriminant Analysis

Overview

Discriminant analysis is a statistical technique to predict a categorical variable by one or more continuous or binary variables.

I consider the estimates of volatility, persistence and R^2 from the approximate factor model as observations, and use discriminant analysis to classify their price stickiness.

Discriminant Analysis

Results

In-sample: 100 simulations

The model predicts the correct price stickiness in 79.9% of cases.

Out-of-sample : 50 simulations

The model predicts the correct price stickiness in 79.7% of cases.

The model performs best for the very sticky sectors (95.3%).

Discriminant Analysis

Sector price stickiness

Classi cation results

Sector	Sector price stickiness			
	0.10	0.25	0.50	0.75
Food and non-alcoholic beverages	20	2	3	-
Alcohol and tobacco	1	-	3	-
Clothing and footwear	3	2	2	-
Housing	1	1	1	1
Furnishings, household equipment	6	3	4	-
Health	2	-	1	1
Transport	3	-	3	-
Communication	1	-	1	-
Recreation and culture	5	-	1	-
Education	-	-	-	-
Insurance and nancial services	1	-	-	-
Total	43	8	19	2

Discriminant Analysis

Sector shock persistence

Classi cation results

Sector	Sector shock persistence				
	0.1	0.3	0.5	0.7	0.9
Food and non-alcoholic beverages	1	3	3	8	10
Alcohol and tobacco	-	-	-	3	1
Clothing and footwear	-	-	-	5	2
Housing	-	-	-	3	1
Furnishings, household equipment	1	-	2	3	7
Health	-	-	2	1	1
Transport	1	-	1	1	3
Communication	-	-	-	1	1
Recreation and culture	-	-	-	5	1
Education	-	-	-	-	-
Insurance and nancial services	-	-	-	-	1
Total	3	3	8	30	28

Discriminant Analysis

Sector shock volatility

Classi cation results		
Expenditure class	j	j
Cakes and biscuits	0.74	0.50
Carpets and other oor coverings	0.28	0.50
Cleaning, repair and hire of clothing and footwear	0.12	0.50
Garments for women	1.47	0.50
Hairdressing and personal grooming services	0.90	0.50
Maintenance and repair of motor vehicles	1.67	0.50
Maintenance and repair of the dwelling	2.05	0.50
Other household services	0.69	0.50
Restaurant meals	2.81	0.50
Spare parts and accessories for motor vehicles	0.99	0.50
Spirits	0.91	0.50
Take away and fast foods	2.62	0.50
Telecommunication equipment and services	2.93	0.50
Therapeutic appliances and equipment	0.14	0.50
Tools and equipment for house and garden	0.26	0.50
Urban transport fares	0.74	0.50
Veterinary and other services for pets	0.40	0.50
Wine	1.64	0.50
Beer	2.20	0.75
Dental services	0.56	0.75
Rents	6.71	0.75

Conclusion

Findings

1. There is substantial heterogeneity in consumer prices.
2. Sectoral heterogeneity is important, particularly in price stickiness.
3. Excluding less sticky sectors from the policy rule improves welfare.
4. Many of the expenditure classes that comprise the CPI are not particularly sticky, although classi cation across a grid may not result in the most accurate estimates.