Using the Retail Distribution of Sellers to Impute Expenditure Shares

(Online Appendix)

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A. Table Appendix

Table A.1—: Availability of Chinese Product Prices Scraped from the Mobile Application for 2014

	Laundry Detergent		Personal Wash Items		Shampoo		Toothpaste	
City	EANs	Retailers	EANs	Retailers	EANs	Retailers	EANs	Retailers
Beijing	929	11	1,273	11	1,041	10	1,024	11
Changsha	874	10	1,471	11	1,063	9	960	10
Chengdu	778	8	1,214	7	957	8	560	7
Chongqing	870	10	1,419	10	998	11	880	9
Dalian	661	6	986	4	775	5	655	3
Guangzhou	902	14	1,524	16	1,071	12	826	13
Hangzhou	805	8	1,210	8	975	8	788	8
Harbin	729	6	1,063	5	902	6	555	6
Hefei	968	10	1,325	10	1,090	9	1,069	8
Jinan	731	8	1,092	8	901	8	621	7
Kunming	579	5	978	5	773	5	422	5
Ningbo	676	7	1,074	8	842	7	569	7
Shanghai	999	12	1,456	12	1,226	10	1,032	12
Shenyang	929	10	1,383	10	1,084	11	847	10
Shenzhen	966	9	1,674	9	1,195	9	868	9
Suzhou	754	7	1,159	7	956	8	581	7
Tianjin	873	7	1,298	7	1,076	7	900	7
Wuhan	933	11	1,270	12	1,030	10	992	12
Wuxi	798	7	1,164	7	908	7	932	7
Xiamen	896	9	1,551	9	1,067	9	873	9
Xi'an	946	8	1,334	7	1,075	7	-	-

Table A.2—: US Nielsen Product Modules Selection that Matches GCC Nielsen Data

No	Product Module Description	Product Group Code	Department Description
1	FRUIT DRINKS & JUICES-CRANBERRY	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
2	CIDER	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
3	FRUIT JUICE - GRAPEFRUIT - OTHER CONTAINERS	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
4	FRUIT JUICE - APPLE	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
5	FRUIT JUICE - GRAPE	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
6	FRUIT JUICE-GRAPEFRUIT-CANNED	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
7	FRUIT JUICE - LEMON/LIME	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
8	FRUIT JUICE-ORANGE-CANNED	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
9	FRUIT JUICE - PINEAPPLE	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
10	FRUIT JUICE-PRUNE	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
11	FRUIT JUICE - ORANGE - OTHER CONTAINER	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
12	FRUIT DRINKS-CANNED	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
13	FRUIT DRINKS-OTHER CONTAINER	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
14	FRUIT JUICE-REMAINING	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
15	FRUIT JUICE-NECTARS	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
16	CLAM JUICE	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
17	VEGETABLE JUICE - TOMATO	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
18	VEGETABLE JUICE AND DRINK REMAINING	JUICE, DRINKS - CANNED, BOTTLED	DRY GROCERY
19	VEGETABLES-BEANS-GREEN-CANNED	VEGETABLES - CANNED	DRY GROCERY
20	VEGETABLES-BEANS-WAXED-CANNED	VEGETABLES - CANNED	DRY GROCERY
21	VEGETABLES-BEANS-WHITE/NORTHERN/NAVY-CANNED	VEGETABLES - CANNED	DRY GROCERY
22	VEGETABLES-BEANS-VEGETARIAN-SHELF STABLE	VEGETABLES - CANNED	DRY GROCERY
23	VEGETABLES-BEANS-REMAINING-CANNED	VEGETABLES - CANNED	DRY GROCERY
24	VEGETABLES-BEANS-GARBANZO - CANNED	VEGETABLES - CANNED	DRY GROCERY
25	VEGETABLES-BEANS-LIMA-CANNED	VEGETABLES - CANNED	DRY GROCERY
26	VEGETABLES-BEETS-SHELF STABLE	VEGETABLES - CANNED	DRY GROCERY
27	VEGETABLES - RED CABBAGE - CANNED	VEGETABLES - CANNED	DRY GROCERY
28	VEGETABLES-CARROTS-SHELF STABLE	VEGETABLES - CANNED	DRY GROCERY
29	VEGETABLES-CORN-CREAM STYLE-CANNED	VEGETABLES - CANNED	DRY GROCERY
30	VEGETABLES-CORN-WHOLE KERNEL-CANNED	VEGETABLES - CANNED	DRY GROCERY
31	VEGETABLES-CORN ON THE COB-CANNED	VEGETABLES - CANNED	DRY GROCERY
32	VEGETABLES-HOMINY-CANNED	VEGETABLES - CANNED	DRY GROCERY
33	VEGETABLES-OKRA-CANNED	VEGETABLES - CANNED	DRY GROCERY
34	VEGETABLES-BEANS-KIDNEY/RED-CANNED	VEGETABLES - CANNED	DRY GROCERY
35	VEGETABLES-PEAS-REMAINING-CANNED	VEGETABLES - CANNED	DRY GROCERY
36	VEGETABLES-PEAS-CANNED	VEGETABLES - CANNED	DRY GROCERY
37	VEGETABLES-PEAS & CARROTS-CANNED	VEGETABLES - CANNED	DRY GROCERY
38	VEGETABLES-MIXED-CANNED	VEGETABLES - CANNED	DRY GROCERY
39	VEGETABLES-BEANS-PINTO-CANNED	VEGETABLES - CANNED	DRY GROCERY
40	VEGETABLES-BEANS-CHILI-CANNED	VEGETABLES - CANNED	DRY GROCERY
41	SALAD AND COOKING OIL	SHORTENING, OIL	DRY GROCERY
42	BOUILLON	SOUP	DRY GROCERY
43	MILK - POWDERED	PACKAGED MILK AND MODIFIERS	DRY GROCERY
44	CEREAL - READY TO EAT	CEREAL	DRY GROCERY
45	CEREAL - GRANOLA & NATURAL TYPES	CEREAL	DRY GROCERY
46	TEA - HERBAL - INSTANT	TEA	DRY GROCERY
47	TEA - HERBAL BAGS	TEA	DRY GROCERY
48	TEA - PACKAGED	TEA	DRY GROCERY
49	TEA - BAGS	TEA	DRY GROCERY
50	TEA - MIXES	TEA	DRY GROCERY
51	TEA - INSTANT	TEA	DRY GROCERY
52	TEA - LIQUID	TEA	DRY GROCERY
53	TEA-HERBAL PACKAGED	TEA	DRY GROCERY
54	SOFT DRINKS - CARBONATED	CARBONATED BEVERAGES	DRY GROCERY
55	WATER-BOTTLED	SOFT DRINKS-NON-CARBONATED	DRY GROCERY
56	GUM-CHEWING	GUM	DRY GROCERY
57	CANDY-CHOCOLATE	CANDY	DRY GROCERY
58	SOFT DRINKS - LOW CALORIE	CARBONATED BEVERAGES	DRY GROCERY
59	CHEESE-NATURAL-MUENSTER	CHEESE	DAIRY
60	CHEESE - NATURAL - MOZZARELLA	CHEESE	DAIRY
61	CHEESE - NATURAL - BRICK	CHEESE	DAIRY
62	CHEESE - NATURAL - REMAINING	CHEESE	DAIRY
63	CHEESE - NATURAL - AMERICAN COLBY	CHEESE	DAIRY
64	CHEESE - NATURAL - AMERICAN CHEDDAR	CHEESE	DAIRY
65	CHEESE - GRATED	CHEESE	DAIRY

Table A.3—: US Nielsen Product Modules Selection that Matches GCC Nielsen Data (Continued Table A.2)

No	Product Module Description	Product Group Code	Department Description
66	CHEESE - PROCESSED SLICES - REMAINING	CHEESE	DAIRY
67	CHEESE - PROCESSED - LOAVES	CHEESE	DAIRY
68	CHEESE - PROCESSED - SNACK	CHEESE	DAIRY
69	CHEESE-PROCESSED SLICES-AMERICAN	CHEESE	DAIRY
70	CHEESE-NATURAL-SWISS	CHEESE	DAIRY
71	CHEESE - SPECIALTY/IMPORTED	CHEESE	DAIRY
72	CHEESE - NATURAL - VARIETY PACK	CHEESE	DAIRY
73	CHEESE - SHREDDED	CHEESE	DAIRY
74	DAIRY-FLAVORED MILK-REFRIGERATED	MILK	DAIRY
75	CHEESE - PROCESSED - CREAM CHEESE	CHEESE	DAIRY
76	DAIRY-MILK-REFRIGERATED	MILK	DAIRY
77	DAIRY-BUTTERMILK-REFRIGERATED	MILK	DAIRY
78	DAIRY-CREAM-REFRIGERATED	MILK	DAIRY
79	REMAINING DRINKS & SHAKES-REFRIGERATED	MILK	DAIRY
80	DETERGENTS-PACKAGED	DETERGENTS	NON-FOOD GROCERY
81	DETERGENTS - LIGHT DUTY	DETERGENTS	NON-FOOD GROCERY
82	DETERGENTS - HEAVY DUTY - LIQUID	DETERGENTS	NON-FOOD GROCERY
83	AUTOMATIC DISHWASHER COMPOUNDS	DETERGENTS	NON-FOOD GROCERY
84	DISHWASHER RINSING AIDS	DETERGENTS	NON-FOOD GROCERY
85	FABRIC SOFTENERS-LIQUID	LAUNDRY SUPPLIES	NON-FOOD GROCERY
86	FABRIC SOFTENERS-AEROSOL	LAUNDRY SUPPLIES	NON-FOOD GROCERY
87	FABRIC SOFTENERS-DRY	LAUNDRY SUPPLIES	NON-FOOD GROCERY
88	INSECTICIDE - ANT -TRAPS	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
89	INSECTICIDE - ROACH - TRAPS & MOTELS	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
90	INSECTICIDE - HOUSE & GARDEN - AEROSOL	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
91	INSECTICIDE - FLEA & TICK - AEROSOL	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
92	INSECTICIDE - FLEA & TICK - FOGGER	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
93	INSECTICIDE - MISCELLANEOUS FLY PRODUCTS	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
94	INSECTICIDE - MISCELLANEOUS ROACH PRODUCTS	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
95	PESTICIDES - TOMATO & VEGETABLE	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
96	INSECTICIDE-FLYING INSECT-AEROSOL	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
97	INSECTICIDE-FLYING/CRAWLING INSECT-STRIP SOLID	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
98	INSECTICIDE-FLYING INSECT-LIQUID	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
99	INSECTICIDE-ANT & ROACH-REGULAR AEROSOL	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
100	INSECTICIDE-ANT & ROACH-CRACK & CREVICE-SPRAY	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
101	INSECTICIDE-ANT & ROACH-LIQUID	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
102	INSECTICIDE - ANT & ROACH - OTHER CONTINUOUS PRODUCTS	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
103	PESTICIDES - REMAINING	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
104	INSECTICIDE-ANT & ROACH-POWDER	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
105	INSECTICIDE-INDOOR FOGGER	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
106	INSECTICIDE - HOUSE &/OR GARDEN - OTHER FORMS	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
107	INSECTICIDE - FLEA & TICK - LIQUID	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
108	INSECTICIDE-OUTDOOR FOGGER	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
109	INSECTICIDE - REMAINING MISCELLANEOUS PRODUCTS	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
110	INSECTICIDE-WASP & HORNET	INSECTICDS/PESTICDS/RODENTICDS	GENERAL MERCHANDISE
111	ORAL HYGIENE BRUSHES	ORAL HYGIENE	HEALTH & BEAUTY CARE
112	TOOTH CLEANERS	ORAL HYGIENE	HEALTH & BEAUTY CARE
113	DENTURE CLEANSERS	ORAL HYGIENE	HEALTH & BEAUTY CARE
114	SUNTAN PREPARATIONS - SUNSCREENS & SUNBLOCKS	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE
115	SUNTAN PREPARATIONS - LOTIONS/ OILS/ ETC.	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE
116	DEODORANTS - PERSONAL	DEODORANT	HEALTH & BEAUTY CARE
117	FACE CLEANSERS & CREAMS & LOTIONS	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE
118	HAND & BODY LOTIONS	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE
119	SKIN BLEACHING/TONING PRODUCTS	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE
120	SHAMPOO-AEROSOL/ LIQUID/ LOTION/ POWDER	HAIR CARE	HEALTH & BEAUTY CARE
121	SHAMPOO-BARS/ CONCENTRATES/ AND CREAMS	HAIR CARE	HEALTH & BEAUTY CARE
122	RAZOR BLADES	SHAVING NEEDS	HEALTH & BEAUTY CARE
123	HAND CREAM	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE
124	SKIN CREAM-ALL PURPOSE	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE
125	SKIN CREAM-SPECIAL PURPOSE	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE
126	ACNE REMEDIES	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE
127	DEODORANTS - COLOGNE TYPE	DEODORANT	HEALTH & BEAUTY CARE
128	SHAMPOO-COMBINATIONS	HAIR CARE	HEALTH & BEAUTY CARE
129	SUN EXPOSURE DETECTOR PRODUCT TOPICAL	SKIN CARE PREPARATIONS	HEALTH & BEAUTY CARE

Table A.4—: Examples of Products that Fit the Same ICP PPP Product Description

	Cornflakes Kellogg's 500 gram, range 250-600 gram, milled corn (maize) pre-packed, ready to eat cereals, sugar and(or) other ingredients		**Tooth paste, tube, 80 mL, range 50-100 mL, Colgate, Classic Total, exclude whitening**
1	KELLOGG'S CORNFLAKES 375GR (F)(ARABIC)	1	COLGATE 100ml TOTAL
2	KELLOGG'S CORNFLAKES 500GR (F) (ARABIC)	2	COLGATE 100ml TOTAL PUMP
3	KELLOGG'S CRUNCHY NUT CORNFLAKES 500GR(F	3	COLGATE 50ML TOTAL 12 CLEAN MINT (FAC)
4	KELLOGG'S HONEYNUT CORNFLKE.375GR(F)(ARA	4	COLGATE 50ml TOTAL
5	KELLOGGS 375g CORN FLAKES	5	COLGATE 50ml TOTAL 12 CLEAN MINT
6	KELLOGGS 375g CRUNCHY NUT CORN FLAKES	6	COLGATE TOTAL 100 ML
7	KELLOGGS 375g HONEY NUT CORN FLAKES	7	COLGATE TOTAL 100ML
8	KELLOGGS 500g CORN FLAKES	8	COLGATE TOTAL 100ML PD
9	KELLOGGS 500g HEALTH WISE BRAN FLAKES	9	COLGATE TOTAL 100ML PD(M.BEN/FL)
10	KELLOGGS ALL BRAN FLAKES 375 GM PKT	10	COLGATE TOTAL 100ML PUMP
11	KELLOGGS C/F 250G (F)	11	COLGATE TOTAL 100ml PD
12	KELLOGGS C/F 375G (F)	12	COLGATE TOTAL 12 100ML PUMP
13	KELLOGGS C/F 500G (F)	13	COLGATE TOTAL 12 50ML
14	KELLOGGS CHOCO CF 375g (ARABIC)	14	COLGATE TOTAL 12 50ml
15	KELLOGGS CORN FLAKES 250GR PKT	15	COLGATE TOTAL 12 CLEAN MINT 50ML GUM
16	KELLOGGS CORN FLAKES 375GR PKT	16	COLGATE TOTAL 12 CLEAN MINT 50ML(FAC)
17	KELLOGGS CORN FLAKES 500 GR PKT	17	COLGATE TOTAL 12 CLEANMINT 50ML (COS)
18	KELLOGGS CORNFLAKES 375g ARABIC	18	COLGATE TOTAL 50ML
19	KELLOGGS CORNFLAKES 500g BOX ARABIC	19	COLGATE TOTAL 50ML (GUM)
20	KELLOGGS CRUMBS CORN FLAKES 595GR(A)ENG	20	COLGATE TOTAL 50ML CLEAN MINT PROT. GUM
21	KELLOGGS CRUNCHYNUT CORNFLAKES 375g ARAB	21	COLGATE TOTAL 50ML(GUM)
22	KELLOGGS FROSTED FLAKES 496GR (ENG)(C)	22	COLGATE TOTAL 50ml
23	KELLOGGS FROSTED FLAKES CORN 397GR(CRT)C	23	COLGATE TOTAL CLEAN MINT 50ml
24	KELLOGGS HONEY NUT C/F 375GR (A)	24	COLGATE TOTAL FRESH STRIPE 100ML
25	KELLOGGS HONEY NUT CORN FLAKES 375GR		
26	KELLOGGS HONEY NUT CORN FLAKES 375g BOX		
27	KELLOGGS M.GRAIN CORNFLAKES 375G(A)CRT(E		
28	KELLOGGS MULTIGRAIN C/FLAKES 375GR PKT		
29	KELLOGS C.F 250GM		
30	KELLOGS C.F 375GM		
31	KELLOGS C.F 500GM		
32	KELLOGS C.F ARABIC 250GM		
33	KELLOGS C.F ARABIC NEW 375GM		
34	KELLOGS C.F. ARABIC 375GM		
35	KELLOGS C.F. ARABIC 500GM		
36	KELLOGS CRUNCHY NUT C.F.500GM		
37	KELLOGS HONEY NUT C.F.375GM		

Table A.5—: Regression Summary by Product Category : GCC Region and the U.S.

(i) Distribution Measure: NUM Distribution			(ii) Distribution Measure: PCV Distribution		
	GCC Average	U.S.		GCC Average	U.S.
	$\hat{b}$	$\hat{b}$		$\hat{b}$	$\hat{b}$
Pooled data	4.9	5.2	Pooled data	5.0	5.3
By Category			By Category		
Beans	6.7	5.4	Beans	5.6	5.3
Blades	5.2	5.0	Blades	7.2	4.9
Bouillon	3.7	5.7	Bouillon	4.7	5.6
Cereals	6.8	5.8	Cereals	5.2	5.7
Cheese	5.0	5.7	Cheese	4.6	5.6
Chewing gum	5.1	5.8	Chewing gum	5.0	5.9
Chocolate	4.9	5.6	Chocolate	5.3	5.4
Cigarette	4.5	n.a	Cigarette	4.8	n.a
Cooking oil	5.8	5.4	Cooking oil	5.2	5.3
Carbonated soft-drinks	4.1	6.3	Carbonated soft-drinks	4.4	6.2
Deodorant	9.6	4.9	Deodorant	4.9	4.8
Detergents	4.8	4.9	Detergents	5.2	4.8
Dish washer	7.3	5.0	Dish washer	6.3	4.9
Energy drinks	5.0	6.4	Energy drinks	5.2	6.3
Fabric conditioner	5.8	4.8	Fabric conditioner	4.8	4.7
Insecticides	4.9	5.3	Insecticides	4.6	5.3
Juices	5.0	4.3	Juices	4.8	4.4
Liquid cordials	6.6	5.2	Liquid cordials	6.6	4.8
Male grooming	5.5	5.4	Male grooming	5.2	5.1
Milk	4.9	5.3	Milk	4.9	5.3
Milk powder	4.6	5.0	Milk powder	4.8	4.9
Powder soft-drink	6.5	4.9	Powder soft-drink	6.0	4.8
Shampoo	6.6	4.7	Shampoo	5.1	4.7
Skincare	5.5	5.6	Skincare	4.7	5.3
Skin cleansing	6.0	4.7	Skin cleansing	5.3	4.6
Sun-care	5.2	5.0	Sun-care	3.9	4.8
Tea	6.0	5.5	Tea	5.9	5.4
Toothbrush	8.1	4.5	Toothbrush	5.5	4.5
Toothpaste	4.9	4.8	Toothpaste	5.0	4.9
Water	6.4	5.6	Water	5.6	5.4
Summary Statistics			Summary Statistics		
Min	3.7	4.3	Min	3.9	4.4
Max	9.6	6.4	Max	7.2	6.3
Mean	5.7	5.3	Mean	5.2	5.2
Median	5.4	5.3	Median	5.1	5.1

Table A.6—: By Country and Category Regressions: Numeric Distribution

	$\hat{b}$ (slope)							
	U.S.	KUW	QTR	BAH	OMN	UAE	KSA	Average $\hat{b}$
Pooled data	5.2	4.7	3.8	4.5	5.2	4.8	5.0	4.6
By Category								
Beans	5.4	7.0	4.7	8.7	7.4	7.0	5.5	6.5
Blades	5.0	9.9	3.0	4.0	4.4	5.9	4.2	5.2
Bouillon	5.7	5.1	3.2	2.3	3.3	5.5	2.6	3.9
Cereals	5.8	7.3	4.4	6.3	7.2	6.7	9.1	6.7
Cheese	5.7	6.3	3.5	5.1	5.0	5.1	5.1	5.1
Chewing gum	5.8	4.8	3.7	4.5	8.1	5.0	4.3	5.2
Chocolate	5.6	5.6	3.3	4.6	6.4	4.5	5.1	5.0
Cigarette	n.a	4.1	4.1	4.5	4.8	4.8	4.5	4.5
Cooking oil	5.4	8.6	3.9	4.4	6.2	4.6	7.2	5.8
Carbonated soft-drinks	6.3	4.2	3.5	4.7	4.3	3.6	4.1	4.4
Deodorant	4.9	7.2	8.2	7.6	12.1	10.1	12.2	8.9
Detergents	4.9	4.3	3.2	4.1	6.6	4.5	5.8	4.8
Dishwasher	5.0	8.6	4.2	4.9	11.5	6.1	8.3	6.9
Energy drinks	6.4	5.4	4.2	4.7	5.5	5.7	4.6	5.2
Fabric conditioner	4.8	6.2	4.5	3.7	8.2	4.4	7.8	5.6
Insecticides	5.3	5.7	3.1	4.4	6.2	4.8	5.1	4.9
Juices	4.3	4.6	3.8	4.5	5.5	5.5	5.9	4.9
Liquid cordials	5.2	7.1	4.9	6.3	6.4	6.5	8.4	6.4
Male grooming	5.4	6.0	3.3	4.4	5.0	8.7	5.5	5.5
Milk	5.3	5.7	4.0	4.8	5.2	5.3	4.3	4.9
Milk powder	5.0	4.7	3.5	3.4	6.1	5.0	5.1	4.7
Powder soft-drink	4.9	7.4	6.8	5.0	6.2	6.2	7.4	6.3
Shampoo	4.7	6.3	4.5	5.6	6.3	5.7	11.0	6.3
Skincare	5.6	5.1	3.5	4.5	6.4	6.0	7.8	5.5
Skin cleansing	4.7	7.5	4.5	5.5	6.6	5.7	6.3	5.8
Sun-care	5.0	7.8	4.4	4.4	3.9	6.4	4.6	5.2
Tea	5.5	6.1	4.9	5.2	7.4	6.6	5.9	5.9
Toothbrush	4.5	15.5	2.8	4.1	5.0	10.6	11.0	7.6
Toothpaste	4.8	6.1	3.1	4.2	5.5	5.1	5.6	4.9
Water	5.6	6.5	5.0	6.3	5.1	5.2	10.3	6.3
Summary Statistics								
Min	4.3	4.1	2.8	2.3	3.3	3.6	2.6	3.9
Max	6.4	15.5	8.2	8.7	12.1	10.6	12.2	8.9
Mean	5.3	6.5	4.1	4.9	6.3	5.9	6.5	5.6
Median	5.3	6.1	4.0	4.6	6.2	5.6	5.7	5.3

Table A.7—: By Country and Category Regressions: Product Category Volume

	$\hat{b}$ (slope)							
	U.S.	KUW	QTR	BAH	OMN	UAE	KSA	Average $\hat{b}$
Pooled data	5.3	4.8	4.7	5.0	5.1	5.0	5.0	4.9
By Category								
Beans	5.3	5.9	5.5	5.6	5.6	5.8	5.1	5.5
Blades	4.9	7.2	6.1	7.1	6.3	7.3	9.0	6.8
Bouillon	5.6	6.3	4.3	3.3	4.3	5.9	4.1	4.8
Cereals	5.7	4.8	5.6	5.3	5.5	4.7	5.2	5.3
Cheese	5.6	4.6	4.6	4.8	4.4	4.6	4.9	4.8
Chewing gum	5.9	5.1	4.1	4.9	6.6	4.8	4.6	5.1
Chocolate	5.4	5.6	4.8	5.1	6.1	4.5	5.5	5.3
Cigarette	n.a	4.7	4.5	5.0	4.8	4.6	5.0	4.8
Cooking oil	5.3	5.3	4.6	5.2	5.1	4.9	5.9	5.2
Carbonated soft-drinks	6.2	4.9	3.7	4.7	4.6	4.2	4.3	4.6
Deodorant	4.8	3.4	4.9	5.8	5.5	5.1	5.0	4.9
Detergents	4.8	5.3	4.1	5.3	5.8	5.3	5.6	5.2
Dishwasher	4.9	6.4	5.4	7.6	6.3	5.6	6.4	6.1
Energy drinks	6.3	5.1	4.6	5.1	5.1	6.1	5.0	5.4
Fabric conditioner	4.7	5.2	5.2	4.4	5.1	4.4	4.7	4.8
Insecticides	5.3	4.1	3.7	4.6	5.2	4.9	5.3	4.7
Juices	4.4	4.8	4.5	4.3	5.0	5.0	5.1	4.7
Liquid cordials	4.8	6.5	6.0	6.0	7.4	6.3	7.5	6.4
Male grooming	5.1	5.1	4.4	5.8	5.6	5.8	4.5	5.2
Milk	5.3	5.5	4.7	4.6	5.0	5.2	4.5	5.0
Milk powder	4.9	4.8	4.5	4.4	5.6	5.0	4.5	4.8
Powder soft-drink	4.8	5.8	7.1	5.8	6.2	5.7	5.6	5.9
Shampoo	4.7	4.8	5.1	5.3	4.8	4.7	5.8	5.0
Skincare	5.3	4.2	4.4	5.1	5.3	4.8	4.6	4.8
Skin cleansing	4.6	4.8	5.6	6.0	5.1	5.3	5.3	5.2
Sun-care	4.8	4.4	3.7	2.5	4.2	4.2	4.4	4.0
Tea	5.4	5.8	5.9	5.7	6.2	6.0	5.7	5.8
Toothbrush	4.5	5.1	5.8	5.7	5.9	5.7	5.0	5.4
Toothpaste	4.9	4.4	5.0	5.2	5.1	5.7	4.9	5.0
Water	5.4	5.7	6.0	6.0	4.9	4.7	6.6	5.6
Summary Statistics								
Min	4.4	3.4	3.7	2.5	4.2	4.2	4.1	4.0
Max	6.3	7.2	7.1	7.6	7.4	7.3	9.0	6.8
Mean	5.2	5.2	4.9	5.2	5.4	5.2	5.3	5.2
Median	5.1	5.1	4.8	5.2	5.2	5.1	5.1	5.1

B. Figure Appendix

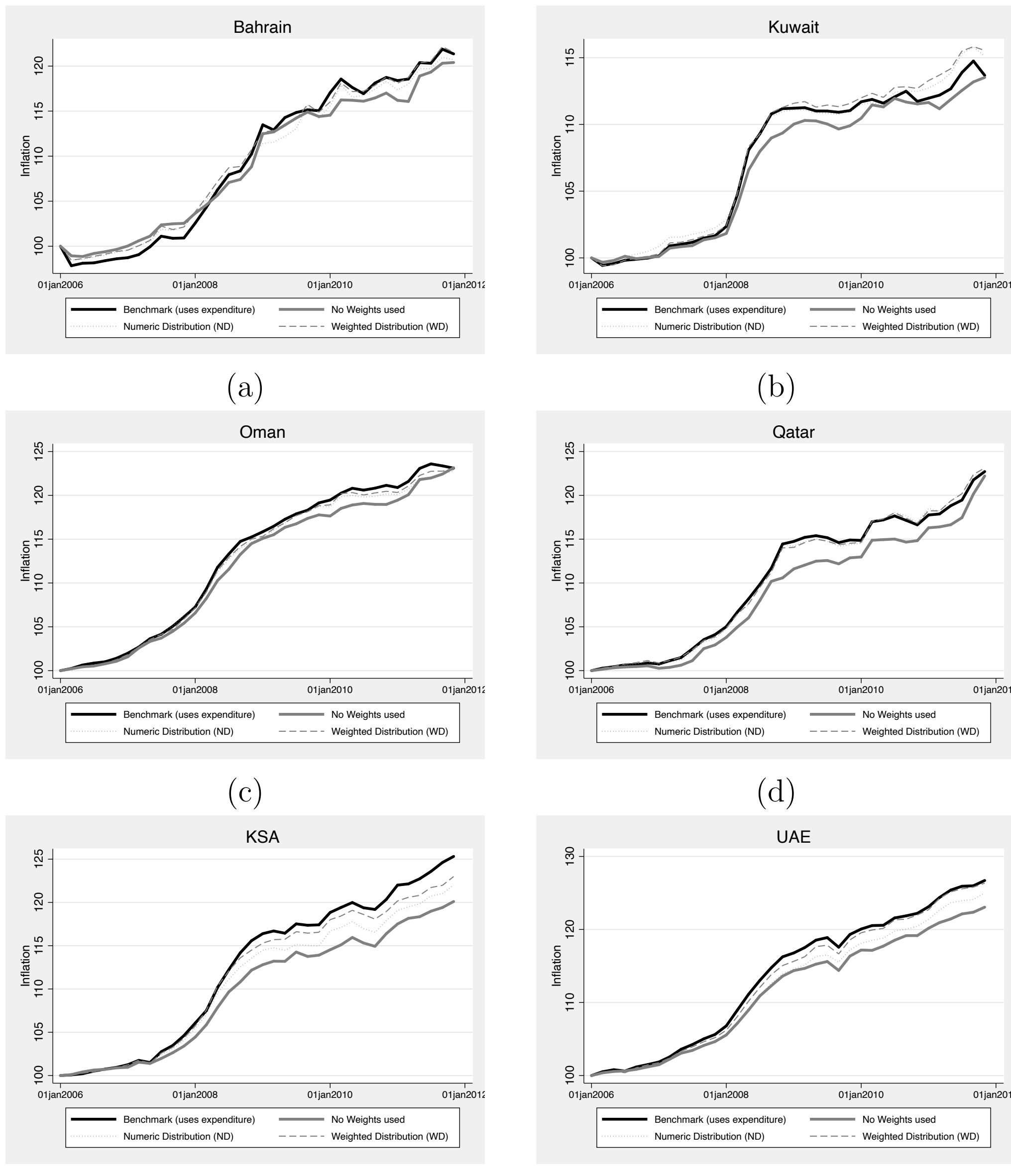
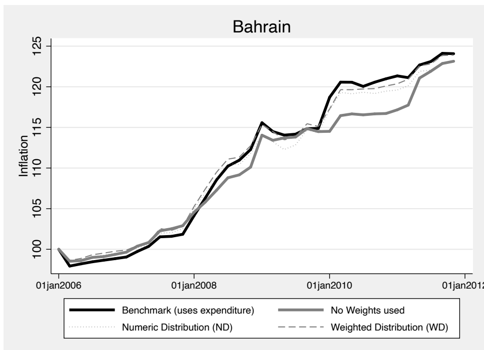


Figure B.1. : Alternative Aggregate GCC Inflation Measures (No Weights)



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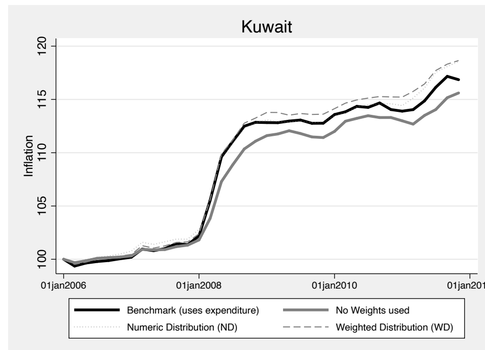

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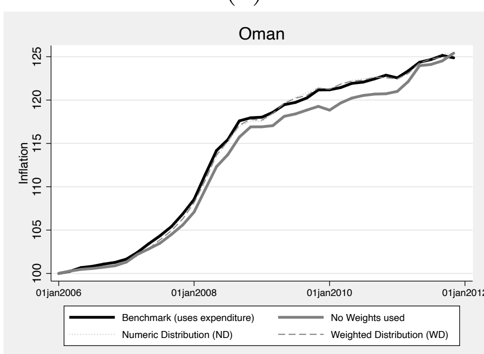

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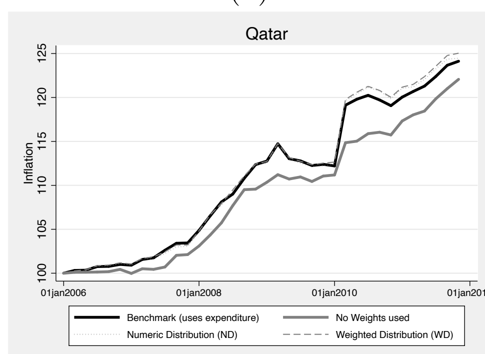

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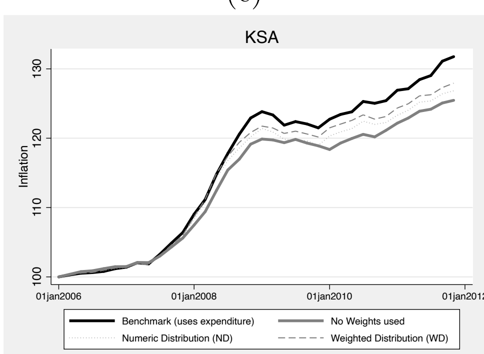

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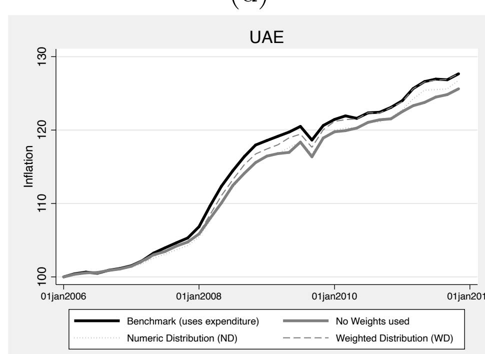
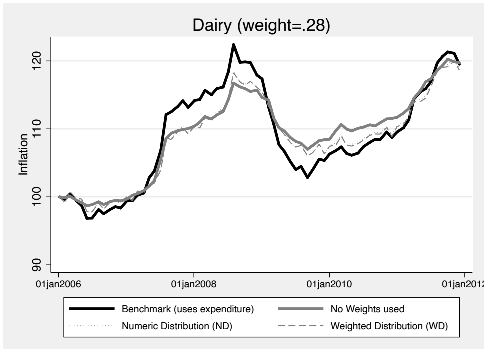


(f)

Figure B.2. : Alternative Aggregate GCC Inflation Measures (Expenditure Weights)



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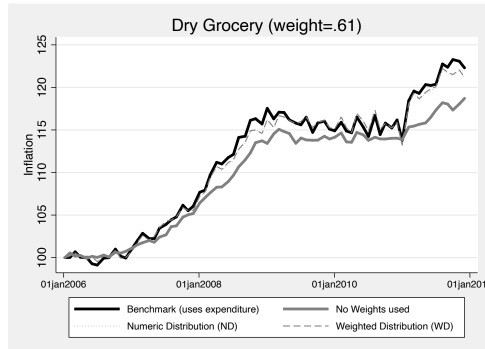

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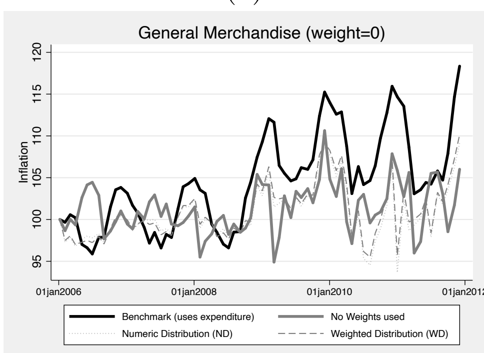

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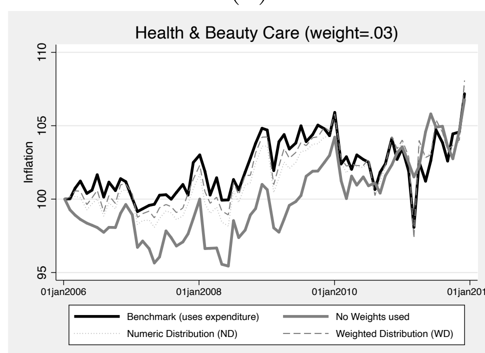

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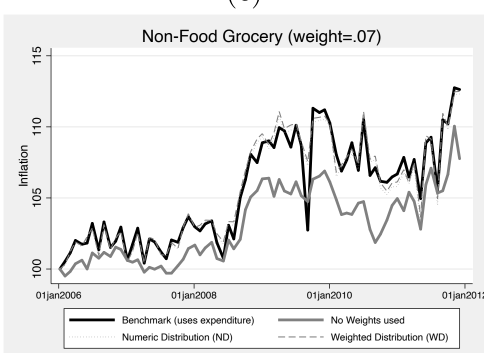

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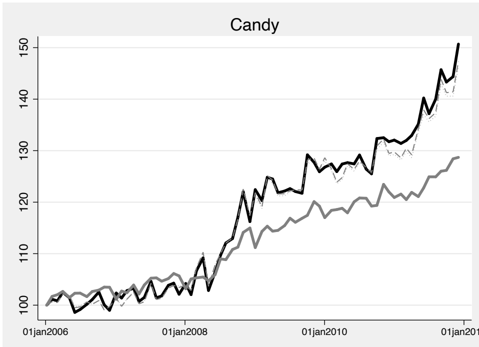
Figure B.3. : US Inflation by Department



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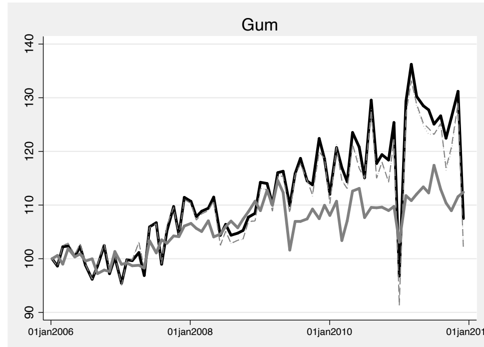

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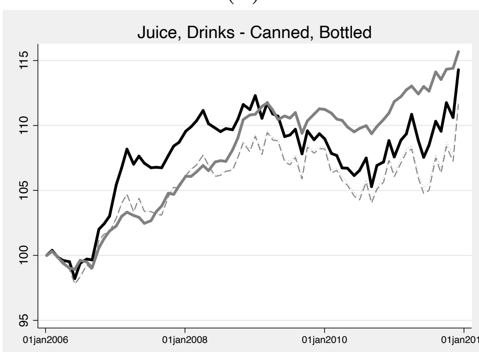

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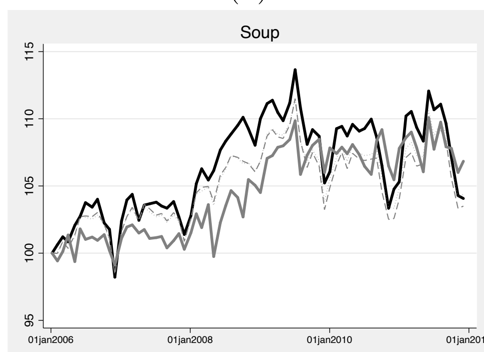

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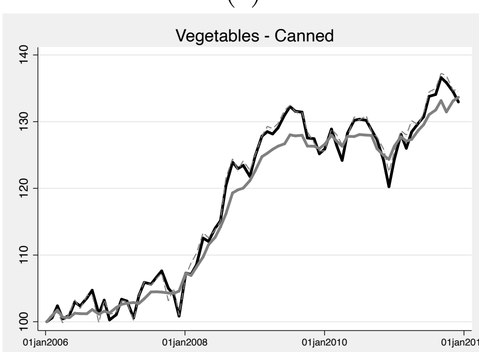

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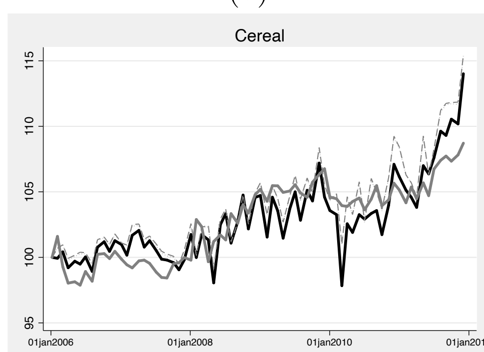

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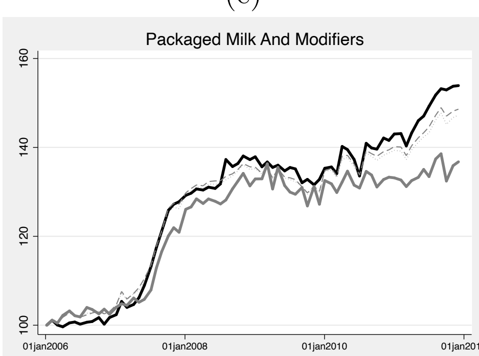

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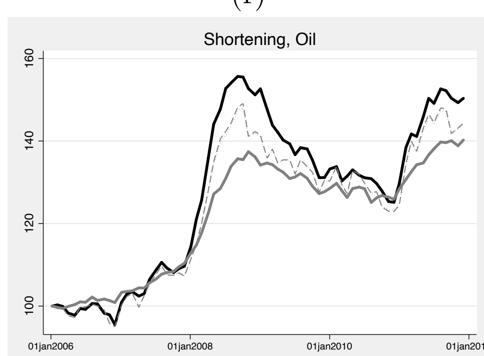
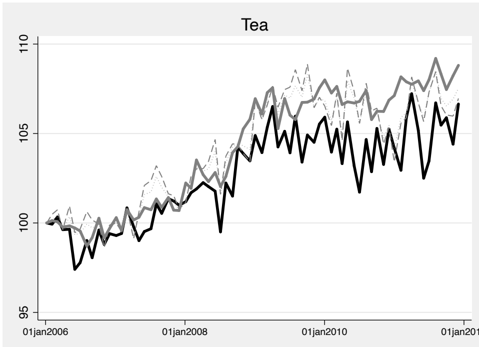


(h)

Figure B.4. : US Inflation by Group (Part I)



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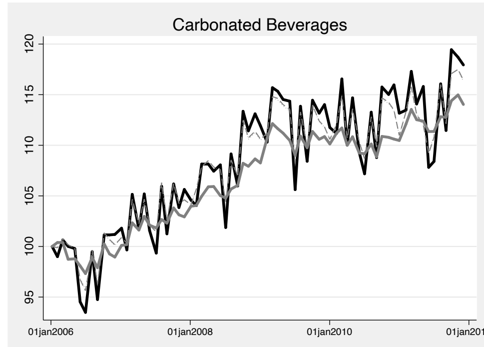

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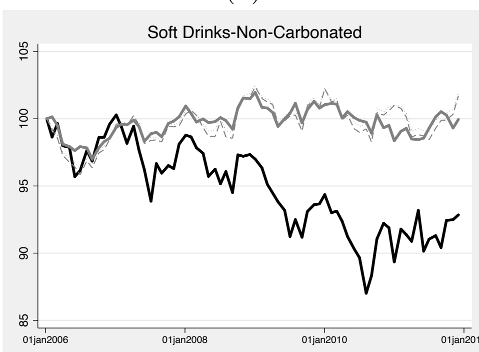

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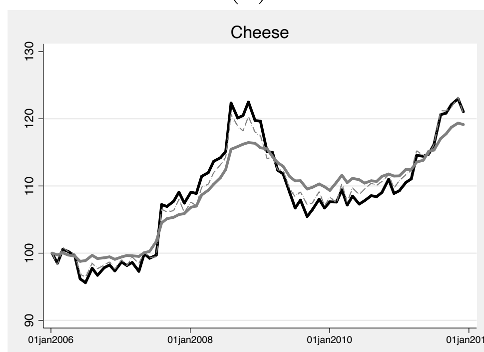

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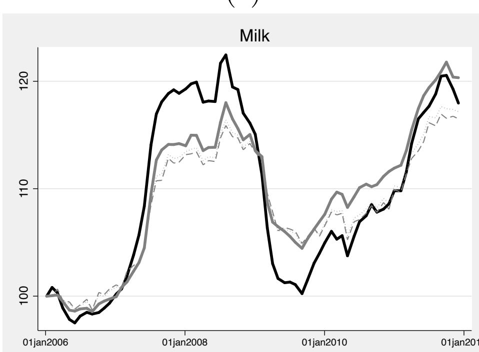

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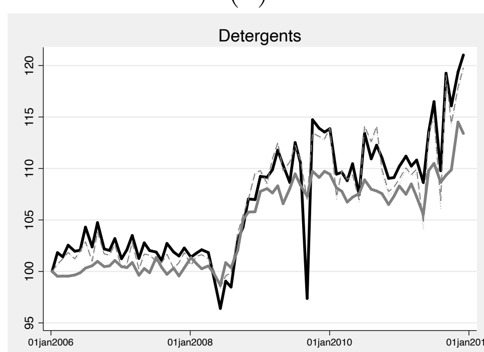

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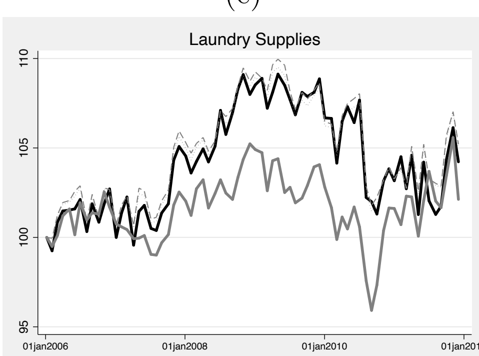

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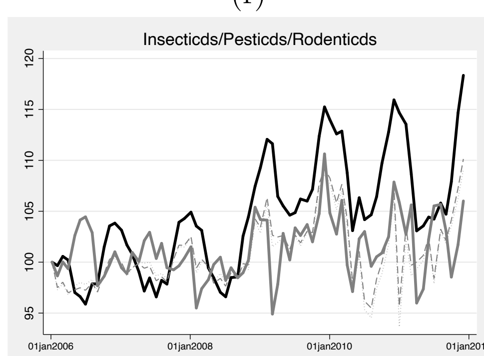
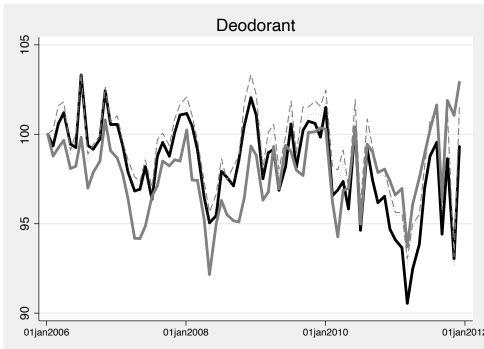


(h)

Figure B.5. : US Inflation by Group (Part II)



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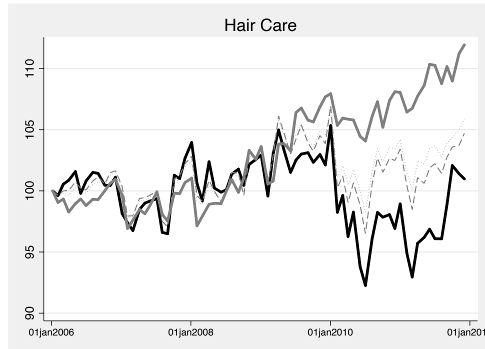

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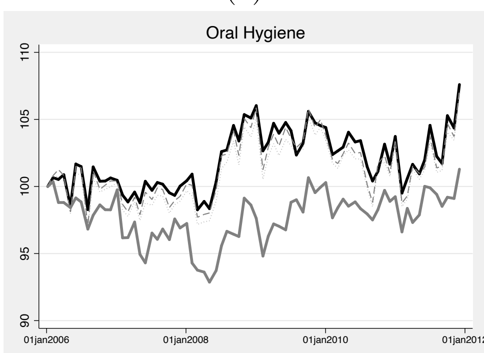

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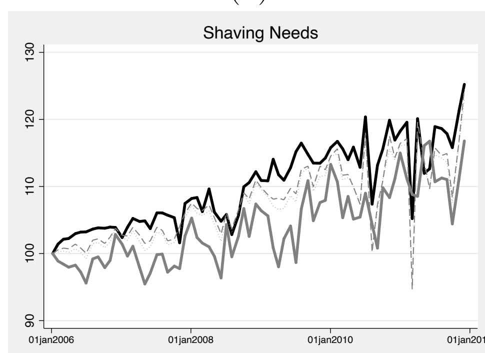

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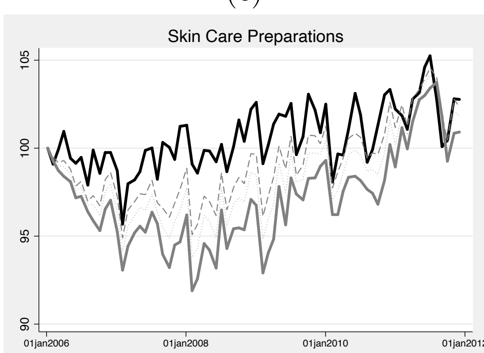


(e)

Figure B.6. : US Inflation by Group (Part III)

C. Theory Appendix

C1. Theoretical Foundation of Convexity

Having reviewed evidence from the literature and the data for the convex relation between market share and the retail distribution, in this section we propose a theoretical model that provides some micro-foundations to account for such a pattern. The theory, based on a standard set of assumptions building on the Melitz (2003) model, characterizes both manufacturers' and retailers' decisions under alternative market structure settings. As featured in the model, it is the interaction between heterogeneous firms and varying "slotting fee" that yields the convex relation that is observed in the data. We show that assuming heterogeneity in the slotting fee incurred by manufacturers is sufficient to generate the convex relation between sales and the distribution measure, which is robust to alternative market structures.

The Consumer

We study a closed economy, but our analysis could readily be extended to an open economy. The consumer's utility depends on the consumption of differentiated varieties, which are purchased from a set of retailers. Each manufacturer produces a single variety for simplicity, and they choose to which retailers they sell their product. We index manufacturers with j or ϕ, and retailers with r. The utility function follows Hottman, Redding and Weinstein (2016); Feenstra, Xu and Antoniades (2020), and is assumed to be nested CES, as follows:

$$U = \left(\int_{r \in \Omega} X_r^{\frac{\eta - 1}{\eta}} \right)^{\frac{\eta}{\eta - 1}}, \ X_r = \left(\int_{j \in J_r} x_{rj}^{\frac{\sigma - 1}{\sigma}} \right)^{\frac{\sigma}{\sigma - 1}}, \ \sigma > \eta \tag{1}$$

where η and σ denote the elasticity of substitution across retailers and across varieties within retailers. The collection of varieties within retailer r is J_r, and the set of retailers is denoted as Ω. The demand for variety j served in r is,

$$x_{rj} = p_{rj}^{-\sigma} P_r^{\sigma - \eta} P^{\eta - 1} Y. \tag{2}$$

The term $P_r^{\sigma-\eta} P^{\eta-1} Y$ reflects the total demand (in terms of market size) of retailer r, which will depend on the economy-wide total income (Y), as well as the price indexes given by:

$$P_r = \left(\int_{j \in J_r} p_{rj}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \ P = \left(\int_{r \in \Omega} P_r^{1-\eta} \right)^{\frac{1}{1-\eta}} \tag{3}$$

The Suppliers

Two types of firms function as suppliers: manufacturers and retailers. Each manufacturer produces a single product and sells it to retailers, as already noted, while consumers purchase consumption goods from retailers. In the subsequent analysis, both retailers and manufacturers are assumed to be profit maximizers that employ their optimal strategies simultaneously.

Manufacturers and retailers are heterogeneous in the model, and we denote them as ϕ and r, respectively. The manufacturers differ in productivity (ϕ).

Retailers differ in terms of the slotting fee, which we call the *slotting fee.* For simplicity, we treat the slotting fee as exogenous (i.e., not chosen by retailers) so that it becomes a slotting fee and paid by manufacturers.[29] Both manufacturers' productivity and retailers' slotting fees are exogenous in the model. The total measure of manufacturers is M, and their productivities are *i.i.d.* distributed with a *c.d.f.* of $G(\phi)$.

There are many retailers, and the measure of retailers serving the economy is fixed and denoted by N. We line up retailers and rank them in order of their slotting fees from low to high. To simplify the following analysis, we treat retailers as if they are continuous, and we index them in relative terms (i.e., $r \in [0,1]$) where a retailer of $r = 0$ has the lowest slotting fee and a retailer of $r = 1$ has the highest slotting fee ($\partial f / \partial r > 0$). We study the equilibrium in which manufacturers will prefer to sell in retailers with lower slotting fee. That is, we assume that manufacturers go to retailers with the lowest slotting fee first and then to those with increasing higher slotting fee until it is no longer profitable to sell to other retailers. Let $r_\phi \in [0,1]$ denote the scope of the retailers to which manufacturer ϕ is possibly able to sell, and we formalize this assumption as follows.[30]

Assumption 1: *The manufacturer lines up retailers according to their slotting fees and sells to the lower-slotting-fee retailers* $[0, r_\phi]$ *until the manufacturer's additional profit goes to zero at* r_ϕ.

[29]The marketing literature refers to the slotting fee ($f(r)$) as the *slotting fee* (or fixed trade spending), a fee charged to manufacturers by retailers in order to have manufacturers' products placed on retailers' shelves. It has also been well established that slotting fees differ across retailers (Rao and Mahi (2003); Kuksov and Pazgal (2007)). Retailers' slotting fees could reflect some other factors out of their control that affect manufacturers' willingness to sell goods in them (e.g., poor locations, traffic or logistics could increase such fixed costs), and we assume those obstacles are borne by the manufacturers.

[30]In the general scenario, multiple equilibria are possible, and we need this assumption for tractability in the analysis of the model.

The *numeric distribution* of the product produced by manufacturer ϕ is exactly $r_\phi \equiv N_\phi/N$, where N_ϕ denotes the largest discrete index of retailers that manufacturer ϕ could serve. We assume retailers and manufacturers make their optimal decisions simultaneously to maximize profits; that is, retailers set retail prices taking wholesale prices as given, and manufacturers choose wholesale prices taking retailers' markups as given.

Manufacturers observe the pricing rule of the retailers and are aware that their pricing rule will affect the market outcome. Given the production efficiency ϕ, the marginal cost of this manufacturer is w/ϕ where w is labor wages. Manufacturer ϕ maximizes profit by choosing its prices $q_{r\phi}$ for the retailers $[0, r_\phi]$ to which it sells its product:

$$\pi_\phi \equiv \max_{q_{r\phi}} \int_0^{r_\phi} \pi_{r\phi} dr = \max_{q_{r\phi}} \int_0^{r_\phi} \left(q_{r\phi} x_{r\phi} - f\left(r\right)\right) dr, \tag{4}$$

where $\pi_{r\phi}$ is manufacturer ϕ's profit collected from retailer r, $x_{r\phi}$ is the demand for product ϕ by retailer r, $f\left(r\right)$ denotes the slotting fee charged by retailer r to allow a manufacturer to sell on its shelves, and r_ϕ indicates the scope of the retailers that manufacturer ϕ is possibly able to serve. Manufacturers set wholesale prices taking retailers; markups as given. As shown in (4), $q_{r\phi}$ denotes the wholesale price, and the final price paid by consumers would be $p_{r\phi} = \mu_r q_{r\phi}$ where μ_r is the markup charged by retailer r. The pricing rule of retailers is specified later, and manufacturers take it as given and are aware that their wholesale prices will affect the market price $p_{r\phi}$. The first order condition with respect to $q_{r\phi}$ solves for the optimal prices:

$$q_{r\phi} = \frac{\sigma}{\sigma - 1} \frac{w}{\phi}, \ \forall r \in [0, r_\phi]. \tag{5}$$

We solve for the profit generated by selling to retailer r as:

$$\pi_{r\phi} = \frac{1}{\sigma - 1} \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma} Y P^{\eta - 1} w^{1-\sigma} \times \mu_r^{-\sigma} P_r^{\sigma - \eta} \times \phi^{\sigma - 1} - f(r).$$

The cutoff productivity ϕ_r of the manufacturer just able to make a profit by selling to retailer r while paying the slotting fee $f(r)$ is computed by setting $\pi_{r\phi}$ equal to zero:

$$\frac{1}{\sigma - 1} \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma} Y P^{\eta - 1} w^{1-\sigma} \times \mu_r^{-\sigma} P_r^{\sigma - \eta} \times \phi_r^{\sigma - 1} = f(r). \tag{6}$$

As multiple equilibria are possible in the general scenario, we employ Assumption 1 to focus on the equilibrium in which the retailers embedded with lower slotting fees always host more manufacturers (i.e., if $f(r_1) < f(r_2)$ then $\phi_{r_1} < \phi_{r_2}$).[31] Then in equilibrium, only manufacturers with productivity ϕ greater than ϕ_r sell to retailer r. With the mass of manufacturers denoted as M, the measure of manufacturers serving retailer r is $M(1 - G(\phi_r))$.

We are now more specific about the distribution of manufacturers' pro-

[31] In the equilibrium we studied, the market power (markup) of low-slotting-fee supermarkets cannot be large enough to overturn the advantage for manufacturers to sell products in them (due to low slotting fees). Otherwise, there may not exist a positively monotone pattern between $(\phi_r, f(r))$. That is, manufacturers may choose supermarkets with slightly higher slotting fees to avoid the profit reduction resulting from the high markup of a low-slotting-fee supermarket.

ductivity ϕ in the economy. We assume that ϕ follows a Pareto distribution with a *c.d.f.* of $G(\phi) = 1 - \left(\bar{\phi}/\phi\right)^k$, $\phi \geq \bar{\phi}$, with $k > \sigma - 1$. We can use this distribution to solve for the price index P_r as defined in (3):

$$
\begin{aligned}
P_r &= \left[M \int_{\phi_r}^{+\infty} p_{r\phi}^{1-\sigma} g(\phi)\, d\phi\right]^{1/(1-\sigma)} \\
&= \frac{\sigma}{\sigma-1}\left(\frac{k}{k-\sigma+1}\right)^{\frac{1}{1-\sigma}} \bar{\phi}^{\frac{k}{1-\sigma}} M^{\frac{1}{1-\sigma}} w \times \mu_r \phi_r^{\frac{k-\sigma+1}{\sigma-1}}, \qquad (7)
\end{aligned}
$$

Substituting (7) back to (6), we could solve the cutoff of productivity ϕ_r:

$$
\phi_r^{\epsilon_1} = A_1 f(r) \mu_r^{\eta}, \qquad (8)
$$

where ϵ_1 and A_1 are defined as:

$$
\begin{aligned}
\epsilon_1 &\equiv \frac{(k-1)(\sigma-\eta)+\sigma\eta+1}{\sigma-1}, \\
A_1 &\equiv (\sigma-1)\left(\frac{\sigma}{\sigma-1}\right)^{\eta}\left(\frac{k}{k-\sigma+1}\right)^{\frac{\sigma-\eta}{\sigma-1}} \bar{\phi}^{\frac{k(\sigma-\eta)}{\sigma-1}} M^{\frac{\sigma-\eta}{\sigma-1}} w^{\eta-1} P^{1-\eta} Y^{-1}.
\end{aligned}
$$

The observed sales ($p_{r\phi}x_{r\phi}$) of product ϕ through retailer r would be:

$$
R_{r\phi} = \sigma \phi^{\sigma-1} A_1^{\frac{1-\sigma}{\epsilon_1}} f(r)^{\epsilon_2} \mu_r^{1-\frac{\eta(\sigma-1)}{\epsilon_1}}, \qquad (9)
$$

where the equality uses (8). It can be easily shown that $\epsilon_2 \equiv 1 - \frac{\sigma-1}{\epsilon_1} > 0$ given the imposed restriction that $k > \sigma - 1$. As the last step, we derive the total sales of product ϕ in the economy, where we also change notation from r_ϕ to n to denote the numeric distribution:

$$
\begin{aligned}
R_\phi &= \int_0^{r_\phi} R_{r\phi} dr \\
&= \int_0^{n} R_{r\phi} dr \\
&= \sigma \phi^{\sigma-1} A_1^{\frac{1-\sigma}{\epsilon_1}} \int_0^{n} f(r)^{\epsilon_2} \mu_r^{1-\frac{\eta(\sigma-1)}{\epsilon_1}} dr. \qquad (10)
\end{aligned}
$$

PROPOSITION 1: *Under Assumption 1, and if retailers charge the same markups to consumers* ($i.e.$, $\mu_r = \mu, \forall r \in [0,1]$), *product sales are convex in the numeric distribution, defined as* $n \equiv N_\phi / N$.

Proposition 1 is easily proved by taking the first and second derivatives of product sales R_ϕ with respect to the *numeric distribution* n (see Appendix C2). It corresponds to a preliminary scenario in which retailers do not take their market shares into consideration when setting their retail prices, i.e. they do not see themselves as *multi-product* sellers. We next examine the case in which retailers optimally charge differing markups.

Product Sales with Variable Retailer Markups

In the more general case, the markups charged by retailers will differ. Retailers choose their prices for the range of products, taking into account that a change in any prices will affect their market shares for all their products. We first consider the case in which retailers fail to realize that the pricing rules could also affect the entry of manufacturers and hence profits. Let us call this case a "shortsighted" retailer. Manufacturers have to overcome the exogenous slotting fee to sell to a retailer, which implies that only manufacturers with productivity above the threshold can sell in that retailer. The profit maximization problem for retailer r is:

$$\max_{p_{rj},j\in J_r}\left[\sum_{j\in J_r}\left(p_{rj}-q_{rj}\right)x_{rj}\right]\Leftrightarrow\max_{p_{r\phi},\phi>\phi_r}\left[M\int_{\phi_r}^{+\infty}\left(p_{r\phi}-q_{r\phi}\right)x_{r\phi}g(\phi)d\phi\right] \tag{11}$$

where $p_{r\phi}$ is the retail price and $q_{r\phi}$ is the wholesale price of product ϕ. This problem is solved in Feenstra, Xu and Antoniades (2020), and the pricing rule of retailer r is:

$$p_{r\phi}=\mu_r q_{r\phi},\ \ with\ \ \mu_r\equiv 1+\frac{1}{(\eta-1)\left(1-s_r\right)},\ \forall\phi>\phi_r, \tag{12}$$

where s_r is the market share of retailer r over all its products sold and μ_r is retailer r's markup, which is equal across products sold by that retailer. Bigger retailers (larger s_r) would charge a higher markup.

PROPOSITION 2: *When retailers are shortsighted, retailers' markups positively depend on their market shares as in* (12)*, and product sales are convex in the numeric distribution if:*

$$k\geq 1+\frac{\eta\left(\sigma-1\right)^2-\sigma\eta-1}{\sigma-\eta}.$$

The proof of Proposition 2 is in Appendix C3, and the above condition is sufficient for convexity. For cases outside the range as indicated in Proposition 2, we find that the convex relation between market sales and the *numeric distribution* still holds empirically, as we shall demonstrate below.

Next, we study the case of farsighted retailers; that is, retailers who are aware that their retail prices would affect both the intensive margin of sales (the sales conditional on the measure of manufacturers selling in those retailers) and the extensive margin of sales (the measure of the manufacturers selling in those retailers). Retailer r chooses a retail markup to maximize profit:

$$\max_{\mu_r}\left[M\int_{\phi_r}^{+\infty}\left(p_{r\phi}-q_{r\phi}\right)x_{r\phi}g(\phi)d\phi\right].$$

Given that $p_{r\phi}=\mu_r q_{r\phi}$ and$p_{r\phi}q_{r\phi}=\sigma f(r)\phi_r^{1-\sigma}\phi^{\sigma-1}$, with $g(\phi)=k\bar{\phi}^k\phi^{-k-1}$, we can integrate retailer r's profit to obtain:

$$\max_{\mu_r}\left[\frac{\sigma kM\bar{\phi}^k}{k-\sigma+1}f\left(r\right)\left(\mu_r-1\right)\phi_r^{-k}\right],$$

which could be further simplified given (8) as:

$$\max_{\mu_r}\left[\frac{\sigma kM\bar{\phi}^k A_1^{-\frac{k}{\epsilon_1}}}{k-\sigma+1}f\left(r\right)^{1-\frac{k}{\epsilon_1}}\left(\mu_r-1\right)\mu_r^{-\frac{\eta k}{\epsilon_1}}\right]. \tag{13}$$

The first order condition of (13) with respect to μ_r implies that:[32]

$$\mu_r=1+\frac{1}{\eta k/\epsilon_1\left[\eta-\left(\eta-1\right)s_r\right]-1}, \tag{14}$$

where $\epsilon_1\equiv\frac{(k-1)(\sigma-\eta)+\sigma\eta+1}{\sigma-1}$. To guarantee a meaningful markup $\mu_r>1$, we

[32]The derivation also takes into account that $\partial\ln P/\partial\ln\mu_r$=$\partial\ln P/\partial\ln P_r=s_r$, given that $\partial\ln P_r/\partial\ln\mu_r=1$.

require $\eta k/\epsilon_1 > 1$, which implies that:[33]

$$k > 1 + \frac{\eta + 1}{\sigma(\eta - 1)}. \tag{15}$$

Similar to the pricing rule for shortsighted retailers in (12), the markup of a farsighted retailer also positively depends on its market share. Therefore, we derive a proposition similar to Proposition 2.[34]

PROPOSITION 3: *When retailers are farsighted, retailers' markups positively depend on their market shares as in* (14)*, and product sales are convex in the numeric distribution if:*

$$k \geq 1 + \frac{\eta(\sigma - 1)^2 - \sigma\eta - 1}{\sigma - \eta}$$

The proof of Proposition 3 follows the similar steps in the proof of Proposition 2. Thus, we have completed the theoretical foundation to explain the observed sales pattern, which however provides with sufficient conditions. Nevertheless, we can go beyond model parameters and develop some inferences about the convex relationship between product sales and the numeric distribution based on data.

PROPOSITION 4: *Under Assumption 1, and when markups positively depend on market shares, if retailers' sales rank satisfies $s_{r_2} < s_{r_1}$ for $r_2 > r_1 \in [0, 1]$ so that retailers hosting more products also have bigger total sales, product sales are convex in the numeric distribution.*

The proof of Proposition 4 is in Appendix C4. The condition in Propo-

[33] In the extreme case in which there is only one retailer, the markup is $\mu_r = \eta k/\epsilon_1/(\eta k/\epsilon_1 - 1)$.

[34] Proposition 3 implicitly assumes that model parameters satisfies (15).

sition 4 that retailers hosting more products also have bigger total sales is not trivial, though it is the case on average in the data (see Figure 2). Conditional on entry, incumbent manufacturers will sell more to overcome higher slotting fee. In the case in which there is a substantial number of big manufacturers, the deterring effect of a high slotting fee on entry would be mitigated. In turn, the high slotting fee would bring more sales that are generated by incumbent manufacturers, and this would potentially break the positive relationship between the number of products a retailer hosts and its total sales.

Model Simulation

To provide an overview of how well the model generates the convex relation between product market share and the retail distribution, we perform a simulation exercise for the case in which retailers are shortsighted.[35] In the simulation, we simulate the sales and the *numeric distribution* of a large number of products under three scenarios, and one of them ($k = 16$) corresponds to the case in which restriction of model parameters in Proposition 2 and 3 is satisfied. Our purpose is to demonstrate how our model can replicate the convex relationship between sales and the *numeric distribution*, and investigate whether the convex relationship is robust to various candidate parameters of the distribution of productivity k with the minimum constraint $k > \sigma - 1$.

To give a brief idea of the procedure, setting parameters to satisfy the restriction, we simulate the economy in which consumers, manufacturers and retailers are specified by (1), (4), and (11). In practice, we specify the

[35]The pattern for farsighted retailers remains similar, as is also discussed in Proposition 3. The detailed procedure for simulation is provided in Appendix C5.

slotting fee as $f(r) = \gamma e^{\theta r}$ ($\gamma > 0$ and $\theta > 1$) and simulate 10,000 draws u from a uniform distribution from zero to one. The corresponding Pareto productivity draws are $\phi = (1-u)^{-\frac{1}{k}}\bar{\phi}$. Given the functional forms, we solve the model by solving for the equilibrium retailer markups. Figure C.1 presents the simulation results by values of k. In all three scenarios, we observe a convex relationship between product market share and the *numeric distribution*.[36]

To summarize, in this analysis, we present a micro-foundation for the observed convexity in the sales-distribution measure relation. Our model is based on the standard assumptions in the literature. We show that the implied convexity pattern is robust to various market structure settings, as long as the slotting fee incurred by manufacturers to sell in retailers vary across retailers. Our theoretical results further corroborate the robustness of using the retail distribution to approximate product sales when they are absent.

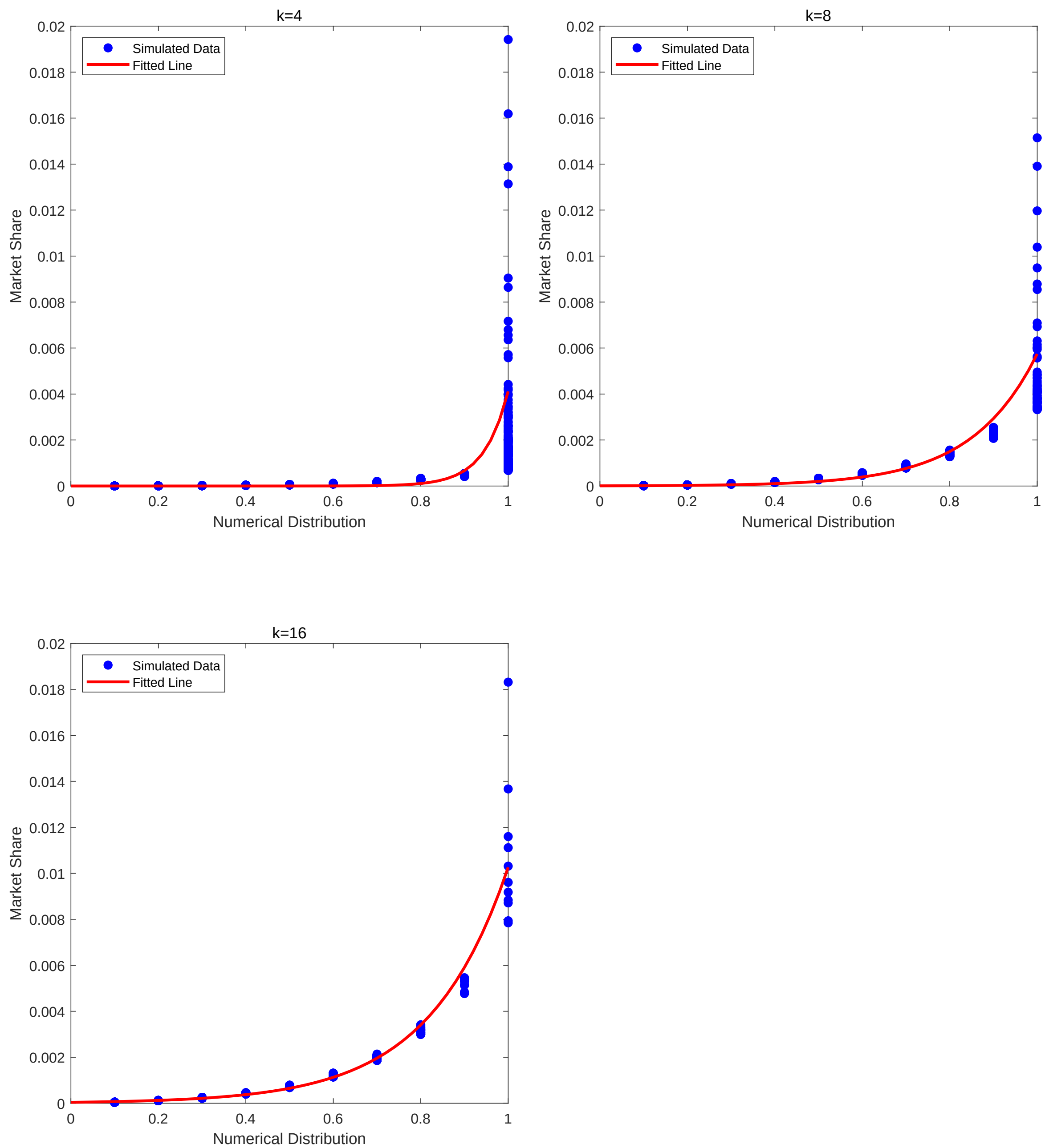
C2. Proof of Proposition 1

Since retailers charge the same markups, we denote it as $\mu_r = \mu\ \forall r \in [0,1]$. Product sales of ϕ can be written as:

$$R_\phi = \sigma\phi^{\sigma-1}A_1^{\frac{1-\sigma}{\epsilon_1}}\mu^{1-\frac{\eta(\sigma-1)}{\epsilon_1}} \times \int_0^n f(r)^{\epsilon_2}\,dr.$$

The first and second derivative of R_ϕ with respect to n are ($\epsilon_2 > 0$):

[36]In Figure C.2 and C.3, we also simulate the model with different functional forms for the slotting fee $f(r)$, and the convex relationship between product market share and the *numeric distribution* remains robust. Analogously, the alternative measure of the *weighted distribution* could be shown to perform similarly to the *numeric distribution.* As the *numeric distribution* requires less information than the *weighted distribution* in practice, implementing it is more feasible.



Note: Parameter value $k = 16$ satisfies parameter restriction in Proposition 2 and 3.

Figure C.1. : Convexity between Sales and Numeric Distribution

$$\frac{\partial R_\phi}{\partial n} = \sigma\phi^{\sigma-1} A_1^{\frac{1-\sigma}{\epsilon_1}} \mu^{1-\frac{\eta(\sigma-1)}{\epsilon_1}} f(n)^{\epsilon_2} > 0, \quad \frac{\partial^2 R_\phi}{\partial n^2} = \epsilon_2\sigma\phi^{\sigma-1} A_1^{\frac{1-\sigma}{\epsilon_1}} \mu^{1-\frac{\eta(\sigma-1)}{\epsilon_1}} f(n)^{\epsilon_2-1} \frac{\partial f(n)}{\partial n} > 0,$$

where the first inequality holds given that there is no negative term, and the second inequality holds given that slotting fee $f(r)$ increase in r.

C3. Proof of Proposition 2

We rewrite (10) as:

$$\begin{aligned} R_\phi &= \sigma\phi^{\sigma-1} A_1^{\frac{1-\sigma}{\epsilon_1}-\frac{1}{\eta}\left[1-\frac{\eta(\sigma-1)}{\epsilon_1}\right]} \times \int_0^n f(r)^{\epsilon_2-\frac{1}{\eta}\left[1-\frac{\eta(\sigma-1)}{\epsilon_1}\right]} \phi_r^{\frac{\epsilon_1}{\eta}\left[1-\frac{\eta(\sigma-1)}{\epsilon_1}\right]} dr \\ &= \sigma\phi^{\sigma-1} A_1^{\frac{1-\sigma}{\epsilon_1}-\frac{1}{\eta}\left[1-\frac{\eta(\sigma-1)}{\epsilon_1}\right]} \times \int_0^n f(r)^{1-\frac{1}{\eta}} \phi_r^{\frac{\epsilon_1}{\eta}\left[1-\frac{\eta(\sigma-1)}{\epsilon_1}\right]} dr, \end{aligned}$$

where the first equality uses $\mu_r = A_1^{-\frac{1}{\eta}} f(r)^{-\frac{1}{\eta}} \phi_r^{\frac{\epsilon_1}{\eta}}$ as implied by (8), and the second equality uses $\epsilon_2 \equiv 1 - \frac{\sigma-1}{\epsilon_1}$. The first and second derivative of R_ϕ with respect to n satisfy:

$$\frac{\partial R_\phi}{\partial n} = \phi^{\sigma-1} A_1^{\frac{1-\sigma}{\epsilon_1}-\frac{1}{\eta}\left[1-\frac{\eta(\sigma-1)}{\epsilon_1}\right]} f(n)^{1-\frac{1}{\eta}} \phi_n^{\frac{\epsilon_1}{\eta}\left[1-\frac{\eta(\sigma-1)}{\epsilon_1}\right]} > 0, \quad \frac{\partial^2 R_\phi}{\partial n^2} > 0,$$

where first inequality holds given there is no negative term, and the second inequality holds given that slotting fee $f(r)$ and ϕ_r increase in r, $\eta > 1$ and $1 - \frac{\eta(\sigma-1)}{\epsilon_1} > 0$ (implied by $k > \frac{\eta(\sigma-1)^2-\sigma\eta-1}{\sigma-\eta}$).

When $k = \frac{\eta(\sigma-1)^2-\sigma\eta-1}{\sigma-\eta}$, we can rewrite (8) as $\mu_r\phi_r^{1-\sigma} = A_1^{-1/\eta} f(r)^{-1/\eta}$

(as an intermediate step, one can show that the equality $\epsilon_1 = \eta(\sigma - 1)$ holds). We substitute the new term into $R_{r\phi} = \sigma\phi^{\sigma-1} f(r) \mu_r \phi_r^{1-\sigma}$ to obtain $R_{r\phi} = \sigma A_1^{-1/\eta} \phi^{\sigma-1} f(r)^{1-1/\eta}$. Product sales of ϕ will be:

$$R_\phi = \sigma A_1^{-1/\eta} \phi^{\sigma-1} \int_0^n f(r)^{1-1/\eta} \, dr$$

The first and second derivative of R_ϕ with respect to n satisfy:

$$\frac{\partial R_\phi}{\partial n} = \sigma A_1^{-1/\eta} \phi^{\sigma-1} f(n)^{1-1/\eta} > 0, \quad \frac{\partial^2 R_\phi}{\partial n^2} = \sigma A_1^{-1/\eta} \phi^{\sigma-1} \left(1 - \frac{1}{\eta}\right) f(n)^{-1/\eta} \frac{\partial f(n)}{\partial n} > 0$$

where the first inequality holds given that there is no negative term, and the second inequality holds given that slotting fee $f(r)$ increase in r.

Under the example $k = \frac{\eta(\sigma-1)^2 - \sigma\eta - 1}{\sigma - \eta}$, when $f(r)$ is exponential, i.e., $f(r) = \gamma e^{\theta r}$ ($\gamma > 0$ and $\theta > 1$), the sales of product ϕ become

$$\begin{aligned} R_\phi &= \sigma A_1^{-\frac{1}{\eta}} \phi^{\sigma-1} \gamma^{1-\frac{1}{\eta}} \int_0^n e^{\theta\left(1-\frac{1}{\eta}\right)r} dr \\ &= \frac{\sigma A_1^{-\frac{1}{\eta}} \phi^{\sigma-1} \gamma^{1-\frac{1}{\eta}}}{\theta\left(1 - \frac{1}{\eta}\right)} \left[e^{\theta\left(1-\frac{1}{\eta}\right)n} - 1\right]. \end{aligned}$$

As long as $\theta > 0$, product sales are a convex function of the *numeric distribution n.*

C4. Proof of Proposition 4

In case of $1 - \frac{\eta(\sigma-1)}{\epsilon_1} \geq 0$ (which implies $k \geq \frac{\eta(\sigma-1)^2 - \sigma\eta - 1}{\sigma - \eta}$), the proof follows the same steps as Proposition 2. So consider the case in which $1 - \frac{\eta(\sigma-1)}{\epsilon_1} < 0$. Given the observed sales of product ϕ in (10), the first derivative of $R_\phi$with respect to n is:

$$\frac{\partial R_\phi}{\partial n} = \sigma \phi^{\sigma-1} A_1^{\frac{1-\sigma}{\epsilon_1}} f\left(n\right)^{\epsilon_2} \mu_n^{1-\frac{\eta(\sigma-1)}{\epsilon_1}} > 0.$$

Given that sales decrease in retailer index r in the equilibrium studied, retailer markups also decrease in retailer index r where retailer markup is given in (12) or (14). This implies that both $f\left(n\right)^{\epsilon_2}$ and $\mu_n^{1-\frac{\eta(\sigma-1)}{\epsilon_1}}$ increase in n, which confirms convexity:

$$\frac{\partial^2 R_\phi}{\partial n^2} > 0$$

C5. Model Simulation Procedures

Table C.1 displays the parameters used in the simulation. Given the parameters, we simulate the economy in which consumers, manufacturers, and retailers are specified by (1), (4), and (11). The slotting fee is specified as $f\left(r\right) = \gamma e^{\theta r}$ ($\gamma > 0$ and $\theta > 1$). We simulate 10,000 draws u from a uniform distribution from 0 to 1. The corresponding Pareto productivity draws are $\phi = \left(1-u\right)^{-\frac{1}{k}} \bar{\phi}$. Then we solve the model by solving for the equilibrium retailer markups by the following procedures (i denotes the i-th loop):

Step 1: Set the initial value of retailers' markups as $\eta_r^{(1)} = \frac{\eta}{\eta-1}$ if it is the start of loop ($i = 1$); otherwise set $\eta_r^{(i)} = \eta_r^{(i-1)}$, where $\eta_r^{(i-1)}$ is obtained from *Step 4* of the last loop ($i \geq 2$).

Step 2: Solve the productivity cutoff ϕ_r using (8) and the $\eta_r^{(i)}$ obtained from *Step 1*.

Step 3: Given the productivity cutoff for each retailer (obtained from *Step 2*), calculate the sales of each product in each retailer $R_{r\phi}$, using equation (9) (set $R_{r\phi} = 0$ if $\phi < \phi_r$). With manufacturers' sales in each market, we add them up to get total market sales and the corresponding market shares s_r for each retailer r.

Step 4: Calculate retailers' markups using market shares s_r (obtained from *Step 3*) and equation (12). Denote the derived markup as $\eta_r^{(i)}$.

Step 5: If the difference between $\eta_r^{(i)}$ and $\eta_r^{(i-1)}$ is smaller than the tolerance, we stop the loop. Otherwise, we loop over *Step 1* through *Step 5* until markups converge.

Figure C.1 displays the relationship between product shares and the *numeric distribution*. Through all different values of k, the convexity remains robust.

Table C.1—: Simulation Parameters

Parameter	Description	Value
σ	Elasticity of substitution (varieties)	4.5
η	Elasticity of substitution (retailers)	3
k	Shape parameter of productivity distribution	[4,8,16]
$\bar{\phi}$	Shift parameter of productivity distribution	1
M	Number of manufacturers	10,000
γ	Shift parameter of slotting fee	100
θ	Elasticity of slotting fee with distance from the cheapest retailers	4
N	Number of retailers	10
P	Aggregate price index	10
w	labor cost	1
Y	GDP	1,000
Tol	Tolerance for markup convergence	1e-6

Note: $k = 16$ corresponds to the example case (i.e., the sufficient condition to guarantee the convexity between product shares and the numeric distribution).

We also simulate the model with different functional forms for the slotting fee $f(r)$, with all other parameters fixed as displayed in Table C.1. In Figure C.2, we specify $f(r)$ in the form of power function, i.e., $f(r) = \gamma r^{\theta}$ where we choose $\gamma = 100$ and $\theta = 2$. In Figure C.3, we instead specify

$f(r)$ as a concave function of r, i.e., we choose $\gamma = 100$ and $\theta = 0.2$ in the simulation. The relationship between product share and the *numeric distribution* remains convex.

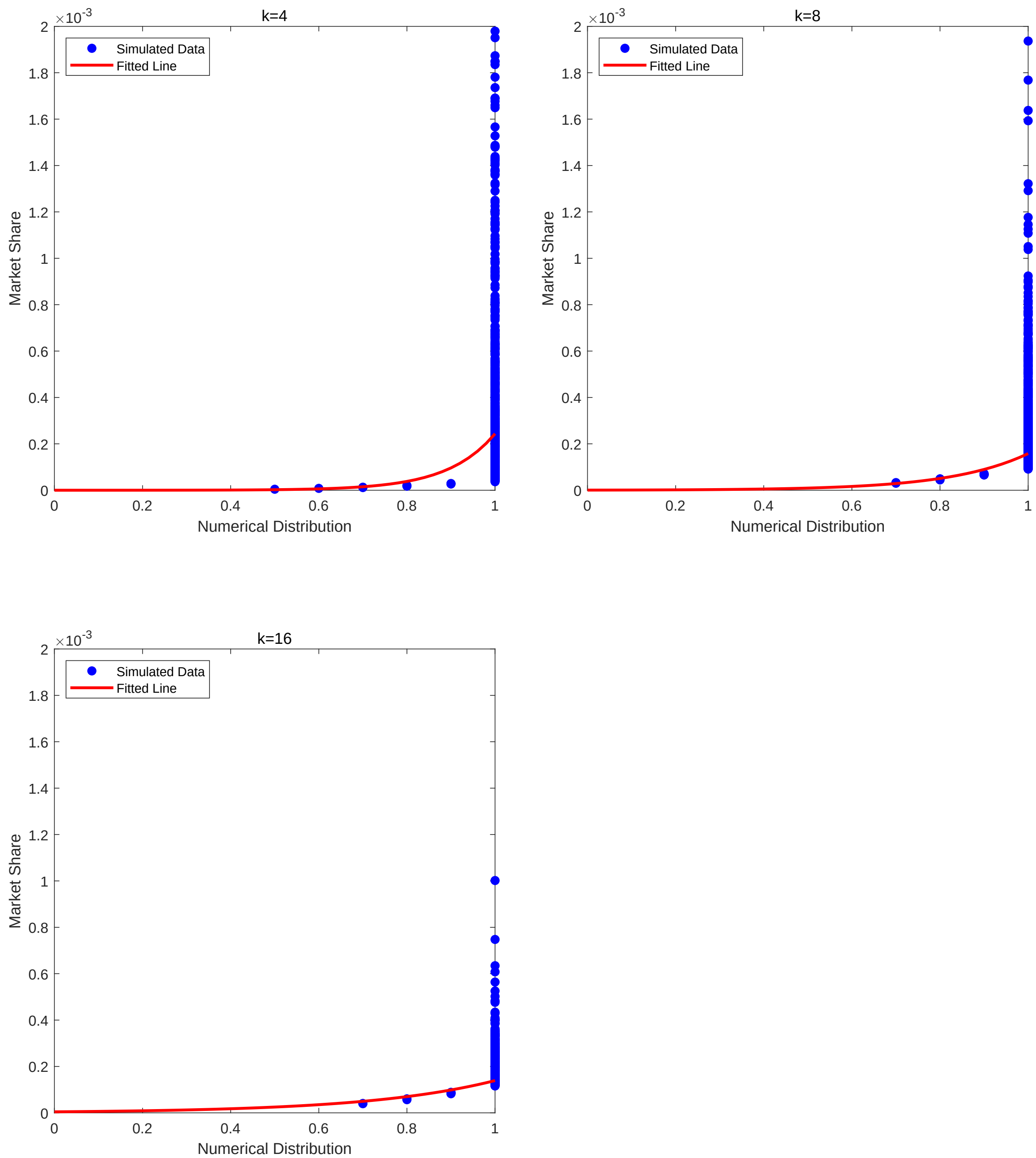


Figure C.2. : Convexity between Sales and Numeric Distribution ($f(r) = \gamma r^{\theta}$, $\theta = 2$)

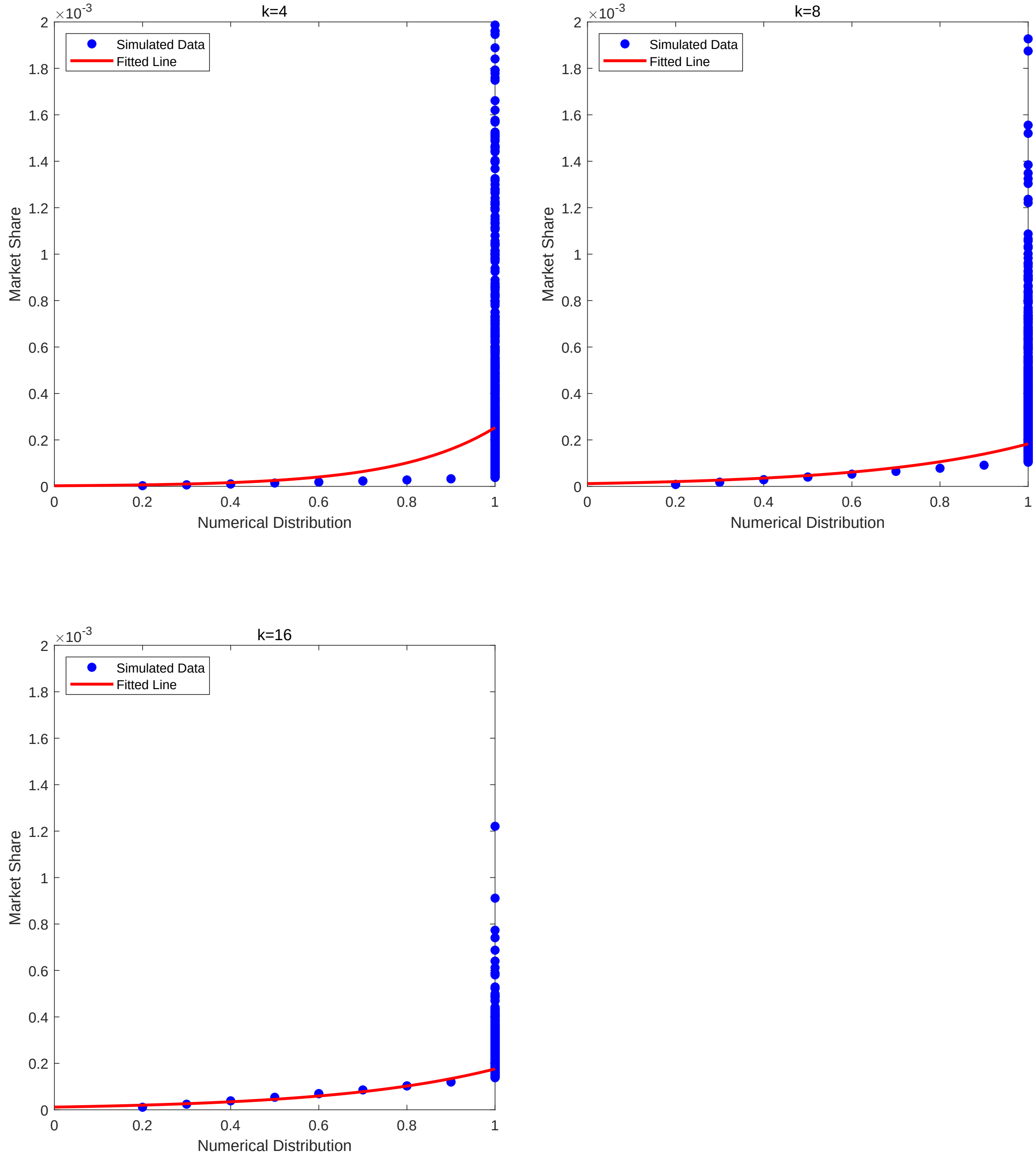


Figure C.3. : Convexity between Sales and Numeric Distribution ($f(r) = \gamma r^{\theta}$, $\theta = 0.2$)