

Seasonality and Prepackaged Software Price Indexes

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Motivation

- Accounting for seasonality when measuring price-change is a well-recognized problem.
- Here, we focus on winter-holiday seasonality and what it implies for cost-of-living price indexes.
- We argue: standard seasonality treatment (Mudgett-Stone) is not appropriate.
- Introduce a variation on the existing matched-model technique to account for seasonality when constructing a price index.



Overview of the Paper

1. Winter holiday seasonality plays a large role in the prepackaged software market
2. Claim: seasonality caused by existence of 2 types of consumers (regular and holiday shoppers)
3. Construct a price index that explicitly accounts for heterogeneous types of consumers
4. Compare to standard method, which is based on a representative consumer framework. Get different results about decline in prices.



Literature Review

1. papers on measuring price change for prepackaged software
 - (1) ignore seasonality and (2) some use small samples of market (e.g. spreadsheets and word processors).
 - Robert McCahill (1997), Prud'homme, Sanga, and Yu (2005), Abel, Berndt, White (2003), Oliner and Sichel (1994), Grimm and Parker (2000), Aizcorbe and Pho (2005)
2. Diewert's seasonality stuff (1996); Alterman, Diewert, Feenstra (1999)
3. Price indexes and heterogenous consumers
 - Aizcrobe and Copeland (2007), Aizcorbe, Bridgman, and Nalewaik (2007), Griliches and Cockburn (1994), Fisher and Griliches (1995)
 - Pakes (1993) and Nevo (2003)



Outline of Talk

1. Data
2. Methods
3. Results



Data Sources

1. Scanner data from NPD Group. Monthly data on revenue and unit sales at the national level. Record is a product (e.g. Turbo Tax 2006).
2. Data are purchases from US retail outlets (office superstores, club stores, internet retailers, etc.) NPD Group claims to cover 84 % of market
3. Time frame: Jan 1997 to Aug 2004



Table 1: **Seasonality**, % of Units Sold and Revenue Generated by Month

Month	Units Sold	Revenue Generated
Jan	8.98	9.08
Feb	8.85	8.90
Mar	9.42	9.64
Apr	6.66	6.66
May	5.51	5.72
Jun	7.55	7.91
Jul	5.81	5.97
Aug	6.15	6.32
Sep	7.60	7.92
Oct	6.23	6.67
Nov	8.76	8.43
Dec	18.47	16.78

Note: Results computed using data from Jan 1997 to Dec 2003



Seasonality

Which products are seasonal? Difficult b/c lots of turnover in market.

- Category median lifespan ranges [9,35], with overall average of 17.
- 75% of revenue generated within first 12 months.

Use x-12-ARIMA (statistical software) to produce seasonally-adjusted units sales for subcategories of software products. Provides measure of units sold due to seasonal variation.



Nature of Seasonality

- In Q4, see spike in unit sales and, at most, slight rise in price. This common empirical puzzle is an active area of research in IO (“What happens to prices during periods of high demand?”).
- For durable goods like prepackaged software, a leading explanation is change in mix of consumers (who are heterogenous in their sensitive to price). Nevo and Hatzitaskos (2005), Bils (1989)
- NYT - report on video game industry mentioned importance of new/casual gamers shopping over the holiday season.



Standard matched-model method for seasonality

- Mudgett-Stone index is a standard method for addressing winter holiday type of seasonality seen here.
- Year-over-year method; product is defined by title *and* quarter.
- Based on representative consumer, which different tastes in each quarter.
- Approach misses nature of seasonality—doesn't account for regular shoppers appearing each quarter.
- costly – high turnover in software products. M-S index only matches 32 percent of products on average (weighted by revenue).
Quarter-to-quarter index matches 84 percent.



Proposed index

- Create 2 price indexes, one for each type of consumer.
- Type 1, regular shopper: construct maximum overlap Laspeyres/Paasche annual price indexes using all four quarters
- Type 2, holiday shopper: construct year-over-year Laspeyres/Paasche price indexes using only fourth quarter.
- Combine type 1 and type 2 Laspeyres indexes using revenue weights at subcategory level.
- Do same with Paasche indexes, and then aggregate up and combine to create an annual Fisher price index.



Year	Operating System		PC Games		Personal Productivity		System Utilities	
	MS	Het.	MS	Het.	MS	Het.	MS	Het.
1998	94.0	95.9	64.0	67.3	81.0	81.0	71.5	73.0
1999	97.8	99.4	68.2	72.6	77.3	82.9	63.7	69.4
2000	97.0	95.3	70.4	73.5	81.7	81.6	74.8	99.0
2001	101.3	99.3	76.7	80.0	82.2	89.2	88.1	96.9
2002	97.4	95.8	77.1	77.9	84.1	84.2	88.2	93.4
2003	98.1	97.8	71.8	72.0	77.8	85.3	88.4	96.1
Average	97.6	97.2	71.1	73.6	80.6	83.9	77.9	86.2

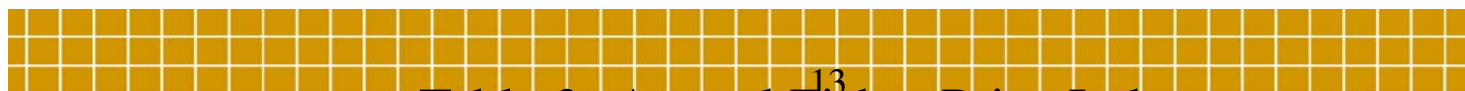
Note: MS stands for Mudgett-Stone index, Het. stands for our proposed heterogenous price index. The average price relative is the harmonized mean of annual price relatives

Table 2: Type-specific Fisher Price Indexes

Year	Price Deflators		Price Indexes	
	Mudgett-Stone	Het.	Mudgett-Stone	Het.
1997	100	100	.	.
1998	78.4	78.2	0.784	0.782
1999	62.0	64.2	0.791	0.821
2000	49.8	52.9	0.802	0.824
2001	42.3	46.0	0.849	0.868
2002	35.4	39.4	0.837	0.856
2003	29.2	33.4	0.825	0.848
Average	.	.	0.814	0.832

Note: Het. stands for our proposed heterogenous price index.

The average price relative is the harmonized mean of
annual price relatives



Conclusion

- Seasonality plays a large role in prepackaged software
- If you believe heterogenous consumer story, then M-S provides misleading results.
- Proposed index better approximates consumer behavior, states that M-S overstates the price decline in the industry by an average of almost 2 percent a year.
- Our result should matter for all infrequently-purchased durable goods.
- Standard errors around M-S will be larger b/c relies on small sample of data – worth computing/showing?



Category	Mean	Median
Business	15.5	10
Education	27.8	26
Finance	23.0	19
Imaging/Graphics	19.3	14
Operating System	16.1	13
PC Games	34.5	35
Personal Productivity	27.7	26
System Utilities	13.7	9
All	22.0	17

Table 4: Prepackaged Software Life (Months)



Category	Subcategories	Unit sales (millions)	Revenue (millions)
Business	23	133	12,940
Education	30	449	9,633
Finance	3	262	11,985
Imaging/Graphing	16	195	8,861
Operating System	3	71	7,032
PC Games	13	1,482	34,505
Personal Productivity	33	183	5,910
System Utilities	25	207	9,754
Total	146	2,983	100,619

Table 5: Data Summary



Category	Seasonal Component (fraction)
Business	0.07
Education	0.31
Finance	0.36
Imaging/Graphics	0.18
Operating System	0.12
PC Games	0.34
Personal Productivity	0.21
System Utilities	0.15
All	0.28

Table 6: Seasonal Magnitude of Fourth-Quarter Revenue



Data Prep

- Need revenue and price series for each type of consumer
- Assume type 2 only shows up Q4, type 1 shows up in all quarters
- For subcategories w/o seasonality, only have type 1 consumers.
- Price: assume both types pay the same price in Q4
- Revenue: assume units sold to type 1 in Q4 is equal to the average of units sold over Q1 through Q3. Average is computed at the subcategory level. Ratio of type 1 to type 2 in Q4 is computed at subcategory level and then applied to each product.

Steps to construct Type 1 index: Personal Finance Software

		Type 1				Type 2		
Date		Lasp	Paas	Chained Lasp	Chained Paas	Lasp	Paas	Rev. Wgt
1998	1	0.99	1.00					
1998	2	0.99	0.98					
1998	3	1.01	1.02					
1998	4	1.00	1.00	0.99	1.00	0.97	1.01	0.252
1999	1	1.00	1.00					
1999	2	0.95	1.01					
1999	3	0.96	0.98					
1999	4	0.95	0.96	0.87	0.95	0.86	0.96	0.237