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The Dynamics of Product Differentiation in the British Record Industry

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Abstract. The paper conducts a statistical analysis of the dynamics of the sale of new music (product differentiation innovation) in the record industry. In pursuing this goal the paper generates new data and analyses a previously unutilized data set. The paper finds that there is a strong correlation between new music innovation in the audio singles and albums market. This is found to be mainly concurrent in the same quarter and to have a reasonably short product life. The paper discovers that these features also characterise the dynamics of record company performance. The research indicates that record companies are willing to sell singles at a loss due to advertising rather than learning externalities. At the industry level, the paper finds that new music innovation does not effect market size significantly and mainly causes 'business stealing' effects between record companies, with exceptional cases of multiplier effects.

Key words: music industry, product differentiation, econometric methodology, demand

1. Introduction

A perusal of any music media magazine ranging from "New Musical Express" in the United Kingdom, to "Rolling Stone" in the United States will highlight a common perception, namely that product differentiation innovation (i.e. the current popularity of artists and their recordings) is the main determinant of economic performance in the record industry.[1] One will further note that prices across record companies are generally homogenous so that the performance of record companies is almost exclusively determined by the appeal of the unique characteristics of their output. (A similar state of affairs also appears to apply to other entertainment industries such as film and video). However, despite this central role there has been very little empirical analysis of the theory of product differentiation in this industry. For example, we do not know whether successful product differentiation innovation of a particular firm generates multiplier or "business stealing" effects for the industry as a whole. We also do not know the extent to which successful product differentiation in the audio singles market implies that the same product has commercial viability in the albums market. Further, if this is significant, does it generate information and advertising externalities? In addition, we are unaware of the commercial durability of recordings of music. This paper aims to meet these goals and thereby provides an empirical assessment of the dynamics of the record

industry. The methodology entails the generation of new data, an analysis of a previously unutilized data set and the application of cointegration techniques to the demand for records equation of an earlier publication, Burke (1994a).

The paper is divided into four sections. Section 2 investigates the relationship between successful product differentiation innovation in the audio singles and albums markets. It examines the correlation between the success of a particular tune in the singles market and of the same tune and artist in the albums market. It also investigates the temporal dynamics of such a relationship. Section 3 analyses the importance of product differentiation innovation at the level of the firm. It examines the correlation between company market share in the singles and albums markets. It also tests for causality i.e. whether evidence of market externalities exist and whether a spill-over flows from the singles to the albums market, or vice versa.

Finally, Section 4 investigates the importance of product differentiation innovation for demand at the industry level.[2] It produces a proxy of the success of product differentiation innovation at the industry level using the methodology outlined in Burke (1994a). However, in this paper we employ cointegration techniques which are more appropriate when ascertaining whether product differentiation innovation plays a significant role in the determination of the long-run path of the demand for records. In so doing, the analysis will identify whether product differentiation innovation by firms have net multiplier or "business stealing" effects when aggregated to the industry level.

2. The Interrelationship Between the Audio Singles and Albums Markets

A casual inspection of the weekly singles and albums Top 100 selling music titles will generally reveal that many tunes are featured in both charts simultaneously. However, while it is a common perception that if a tune is successful in the singles market it will also be successful in the albums market (and vice versa), there has been no quantification of this possible relationship. In particular, issues such as the consistency of the correlation between the markets, the dynamics of such spill-overs and related aspects such as the durability of tunes have not been examined. The explanation for this appears to be the fact that while music charts are available, the tedious process of cross referencing titles has not occurred so that the relevant data do not exist. In this section we generate this data and conduct the necessary analysis.

The first step of the data generation process involved tracing the cross-correlation between music titles in the singles and albums market on an annual basis. The data was produced using the annual Top 100 singles and albums charts from the British Phonographic Industry (BPI) yearbooks for the years in which the charts were collated i.e. 1983–1990. The data collection process entailed cross-checking each title featured in the singles market of a particular year, against the albums charts of the previous two years, the present year and subsequent years.

Table I. The number of titles in the annual Top 100 singles charts that also featured in the annual Top 100 albums charts

Albums charts	Singles charts							
	1983	1984	1985	1986	1987	1988	1989	1990
1983	42	4	0	–	–	–	–	–
1984	21	44	6	0	–	–	–	–
1985	7	19	37	3	0	–	–	–
1986	1	2	26	41	3	0	–	–
1987	0	0	4	25	39	3	1	–
1988	0	0	0	1	3	29	37	2
1989	0	0	0	2	6	22	55	4
1990	0	0	0	0	0	4	31	31

In each case the actual song featured in the singles charts was referenced in the Music Master "Tracks Catalogue" to identify the name of the album (or albums) which featured the song. Then a search was conducted to locate this album in the albums charts. The data is presented in Table I. It is immediately apparent from the table that only in exceptional cases are singles released a year after their album has been in the Top 100 charts. Over the period, an average of 40 per cent of the singles featured in the annual Top 100 singles charts were featured on albums in the annual Top 100 albums charts in the same year. The number is still significant in the subsequent year, but drops dramatically in the next year and almost without exception is zero thereafter. These results indicate that a particular tune has in general a commercial life of about two years in the albums market. It highlights the low durability of a particular tune and the persistent need for successful product differentiation innovation in order to survive in this market.

Since Table I indicated that a significant proportion of successful tunes tend to be released in both single and album form during the same year, it seems prudent to examine the cross-correlation on a quarterly basis in order to get a better understanding of the dynamics of the markets. The data generation process involved the construction of quarterly singles and albums charts. This was carried out by listing all titles featured in the New Musical Express weekly Top 30 singles charts over a quarter. This usually amounted to a quarterly singles chart of around 200 titles. Four quarterly singles charts were constructed for the third quarter of 1985 through to the second quarter of 1986. We decided not to take quarters for a calender year because it would prevent the abberation of singles in the fourth quarter being featured in the subsequent quarter. We felt that this was necessary since roughly 40 per cent of annual record sales occur in the Christmas quarter and hence this quarter encounters a significantly high level of new record releases.

Quarterly album charts were constructed in the same manner as the singles charts except that the 50 best selling albums were counted from the New Musical Express Top 50 albums charts each week. The Top 50 were chosen because the

Table II. The number of titles featured in the quarterly cumulative Top 30 singles charts that also featured in the quarterly cumulative Top 50 albums charts

Singles	Albums	1985				1986			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1985	Q3	10	26	39	31	22	16	10	7
	Q4	8	13	26	48	31	21	17	11
1986	Q1	5	13	19	36	44	36	25	14
	Q2	2	5	7	15	14	38	43	21

album market entailed more inertia than the singles market. Therefore, it was necessary to include the titles from positions 31–50 in order to generate a quarterly album chart of a similar size to the singles charts. The cross referencing procedure was the same as that for Table I.

The cross referencing data for the quarterly charts are presented in Table II. The data illustrate that the correlation between tunes featured in both charts mainly occurs in the same quarter. Comparing subsequent and preceding quarters, it is not so apparent that success in the singles charts generally precedes that of the albums charts.

3. Product Differentiation Innovation and Record Company Performance

We have established that there is a significant proportion of successful tunes in the singles market which are also successful in the albums market. However, this does not necessarily imply that record company market share in the two markets should be correlated as the data in the previous section also illustrated that a significant number of tunes are unique to each of the singles and albums markets. This implies that record company performance would only be expected to be correlated across markets if a significant proportion of their record releases featured titles with commercial potential in both markets. The aim of this section, therefore, is firstly to identify record companies whose innovation strategies are predominantly based on artists with commercial potential in both markets, and then to use this cohort of companies to identify the interaction between the singles and albums markets.

In order to carry out this analysis, we used data on record company albums and singles market share. The procedure initially entailed a test to see if there was a correlation between a company's market share in both markets. We then used company market share for companies where a correlation did exist, to conduct Granger causality tests between the singles and albums markets. For these purposes we used quarterly record company market share data supplied by the BPI. The data were extracted from issues of Music Week magazine over an available period of 1983 to 1993. We used data from the six largest record companies over the sample period. Summary statistics are presented in Table III. Over the sample period the

Table III. The top 6 record companies' market share in the UK albums and singles market: 1983 Q1–1993 Q4

Record company	Mean	Std. dev.
BMG albums	7.58	2.27
BMG singles	9.01	3.43
Sony albums	13.26	2.84
Songle singles	12.77	2.80
Virgin albums	7.68	1.85
Virgin singles	8.16	2.58
PolyGram albums	17.93	4.79
PolyGram singles	16.88	5.17
WEA albums	12.31	2.72
WEA singles	11.18	2.85
EMI albums	12.57	2.13
EMI singles	10.50	2.88
Total albums	71.34	3.66
Total singles	68.50	5.06

Source: Calculated from data in Music Week magazines 1983–1993.

six firm concentration ratio accounted for an average of 71 per cent of the albums market and 69 per cent of the singles market. In each of the top six firms, record company album market share was of similar magnitude to the same company's singles market share.

Tables IV and V illustrate the results of simple regressions, where record company album market share is regressed against the same company's singles market share in the same quarter and the three previous quarters. The results indicate that, apart from BMG, all of the top six firms sell music which has commercial scope in both markets simultaneously. It also appears that most of this music is successful in both markets within the same quarter. The singles share variable is significant at the 1 per cent level for Polygram, WEA, EMI and Virgin and is significant above the 5 per cent level for Sony. The lagged singles share variables are not as influential. In the cases of EMI and Virgin they appeared insignificant. However, they were significant at the 1 per cent, 10 per cent and 5 per cent levels for Polygram, WEA and Sony respectively. None of the two period lagged singles share variables were significant and only in the case of Sony, is a three period lagged singles market share variable significant.

Although the regression results identify a correlation, this does not necessarily imply causation. The results merely indicate that when music sells well in one market, it is likely to perform well in the other market in the same quarter. An inter-

Table IV. Dependent variable: record company album market share 1983 Q1–93 Q4

Variables:	PolyGram	WEA	EMI
Constant	3.331	2.06	7.61
	(2.34)[b]	(0.83)	(3.81)[a]
Singles	0.439	0.473	0.352
Share	(3.81)[a]	(4.07)[a]	(3.05)[a]
Singles	0.350	0.217	0.016
Share (–1)	(2.76)[a]	(1.82)[c]	(0.13)
Singles	0.010	0.154	0.012
Share (–2)	(0.07)	(1.32)	(0.10)
Singles	0.086	0.082	0.089
Share (–3)	(0.70)	(0.71)	(0.76)
R^2	0.78	0.41	0.23
F-Stat	31.61[a]	6.15[a]	2.72[b]
DW	1.37	1.13	1.71

[a] = significant at 1% level,
[b] = significant at 5% level and
[c] = significant at 10% level.

Table V. Dependent variable: record company album market share 1983 Q1–93 Q4

Constant	4.522	–0.433	5.015
	(3.78)[a]	(–0.18)	(4.10)[a]
Singles	0.115	0.308	0.352
Share	(0.96)	(2.33)[b]	(3.22)[a]
Singles	0.141	0.283	0.100
Share (–1)	(1.08)	(2.14)[b]	(0.92)
Singles	0.081	0.168	–0.059
Share (–2)	(0.61)	(1.27)	(–0.53)
Singles	–0.012	0.300	–0.044
Share (–3)	(–0.10)	(2.38)[b]	(–0.41)
R^2	0.18	0.47	0.29
F-Stat	2.01	8.06[a]	3.60[b]
DW	0.93	1.37	1.80

[a] = significant at 1% level,
[b] = significant at 5% level and
[c] = significant at 10% level.

esting feature of the audio software market is that record companies are apparently willing to sell singles even though they make negative profits from this activity. The BPI (1989) estimate that on average in 1988 record companies lost twenty pence on each single sold. This behaviour would seem to imply that there is some external benefit derived from selling singles and this is most likely to be derived from the albums market. There are two, not necessarily exclusive, explanations:

(1) *Advertising externalities:* A common view in the industry is that the release of singles generates media attention (particularly radio airplay) and hence promotes the sale of albums featuring the same tunes and artists. For example, Leadbeater (1994) claims: "At the moment, singles sales make up only 12 per cent of record companies' business. They do, however, encourage LP/CD sales. So, companies release singles, hoping that they will be played on the radio and provide publicity for albums."[3]

(2) *Information costs:* In a market with a high level of product differentiation innovation, record companies can only estimate the demand for music in the audio software market. Since, on average, only 10 per cent of album releases are profitable, it implies that record companies have great difficulty in forecasting consumer tastes. Since the cost of producing an album is greater than the cost of producing a single and since artists who perform well in the singles market are likely to succeed in the albums market, it might be prudent to incur information/forecasting costs in the singles, rather than the albums market. If this is the case then we would not be surprised to learn that record companies continue to sell singles at a loss.

These two explanations for a spill-over from the singles to the albums market might differ in terms of the timing of the spill-over. The "advertising" explanation implies that singles are being sold as a promotional device to cultivate albums sales. They aid album sales mainly by generating radio and television airplay and would, therefore, be most effective when the album itself is on sale. Thus, the advertising explanation would tend to imply that a spill-over from the singles to the albums market would occur in the same time period.

On the other hand, the "information costs" explanation might suggest that an intertemporal relationship exists between the singles and albums market. The purpose of the information cost strategy is to avoid incurring the costs of recording and manufacturing an album before the record company is sure that the album will be profitable. Thus, in this process, a particular artist would only get the "green light" to release an album once she has had a success in the singles market. Since recording, manufacturing, marketing and design take a significant time to complete (on average five months), one would expect a lagged effect between success in the singles market and success in the albums market.

The differences in timing of the market spill-overs suggested by the "advertising" and "information costs" theories, implies that we can at least test the relative importance of information gathering behaviour, using Granger causality tests on

Table VI. Granger tests for causality between the albums and singles markets: EMI record company

Dependent variable	EMI	
	Albums	Singles
Regressors:		
Constant	9.102	8.257
	(2.78)[a]	(1.99)[c]
Singles (–1)	0.120	0.434
	(0.76)	(2.17)[b]
Singles (–2)	–0.063	–0.208
	(–0.36)	(–0.94)
Singles (–3)	0.043	–0.102
	(0.27)	(–0.49)
Albums (–1)	0.068	–0.189
	(0.33)	(–0.72)
Albums (–2)	0.137	0.331
	(0.62)	(1.19)
Albums (–3)	–0.012	–0.065
	(–0.06)	(–0.24)
R^2	0.05	0.17
F-Stat	0.31	1.13
DW	1.97	1.95
Wald singles	0.59	5.94
Wald albums	0.65	1.63

[a] = significant at 1% level,
[b] = significant at 5% level and
[c] = significant at 10% level.

record company market share. If information gathering is important, then one would expect company share in the singles market to Granger cause company share in the albums market.

Granger causality tests were carried out for EMI, Polygram, WEA, Virgin and Sony record companies and the results are presented in Tables VI to VIII. The Wald tests clearly indicate that for all of the record companies, market share in the singles market did not Granger cause market share in the albums market. In other words, in the case of these record companies, current album market share is not a function of singles market share in earlier periods. Thus, the results do not find intertemporal evidence of record companies concentrating information costs in the singles market.

However, the Granger tests also reveal why information costs do not appear to be important. The results indicate that there is not much evidence of inertia in the singles and albums markets. Among the albums equations, the Wald statistic

Table VII. Granger tests for causality between the albums and singles markets: PolyGram and WEA record companies

Dependent variable	PolyGram		WEA	
	Albums	Singles	Singles	Albums
Regressors:				
Constant	2.579	0.628	4.943	10.213
	(1.40)	(0.27)	(2.02)[c]	(3.15)[a]
Singles (–1)	0.302	0.379	0.095	–0.001
	(1.73)[c]	(1.73)[c]	(0.61)	(–0.01)
Singles (–2)	0.050	–0.077	–0.035	–0.025
	(0.27)	(0.34)	(–0.22)	(–0.12)
Singles (–3)	0.062	–0.079	–0.139	–0.064
	(0.36)	(0.37)	(–0.90)	(–0.32)
Albums (–1)	0.358	0.002	0.265	0.162
	(1.77)[c]	(0.01)	(1.29)	(0.60)
Albums (–2)	–0.119	0.325	0.268	0.158
	(0.56)	(1.22)	(1.42)	(0.59)
Albums (–3)	0.253	0.096	0.130	–0.146
	(1.36)	(0.41)	0.69	(–0.58)
R^2	0.73	0.65	0.32	0.04
F-Stat	15.01[a]	10.51[a]	2.67[b]	0.24
DW	1.96	1.93	1.73	1.95
Wald singles	3.71	3.83	1.19	0.11
Wald albums	4.57	2.50	9.36[b]	0.94

[a] = significant at 1% level,
[b] = significant at 5% level and
[c] = significant at 10% level.

indicates that a record company's album market share in previous quarters has very little impact on its current album market share. In the case of EMI, Polygram, and Virgin, album market share in the current period was not found to be determined by album market share in earlier periods. In the case of WEA and Sony, the Wald test found album market share in earlier periods to determine current album market share at the 5 per cent and 10 per cent significance levels respectively.

There also appeared to be little evidence of inertia in the singles market. In the case of all of the record companies, except Virgin, the Wald test indicated that record company singles market share in previous quarters did not significantly affect the company's singles market share in the current quarter.

Thus, the evidence suggests that there is a reasonably fast turnover of titles in the singles and albums markets and that the popularity of particular titles occurs in both markets simultaneously. Therefore, the audio software market illustrates a short commercial life for most music. In such a market, record companies would need to be as flexible as possible in terms of corporate strategy. In other words,

Table VIII. Granger tests for causality between the albums and singles markets: Virgin and Sony record companies

Dependent variable	Virgin		Sony	
	Albums	Singles	Singles	Albums
Regressors:				
Constant	10.922	7.213	1.034	5.891
	(3.86)[a]	(1.94)[c]	(0.45)	(2.21)[b]
Singles (–1)	0.175	0.401	0.193	0.063
	(1.25)[c]	(2.19)[b]	(1.31)	(0.37)
Singles (–2)	0.202	0.394	0.026	–0.220
	(1.37)	(2.03)[b]	(0.18)	(–1.30)
Singles (–3)	0.020	–0.182	0.240	0.029
	(0.12)	(–0.86)	(1.68)	(0.18)
Albums (–1)	–0.312	–0.537	0.365	0.193
	(–1.56)[c]	(–2.04)[b]	(2.11)[b]	(0.96)
Albums (–2)	–0.343	0.137	–0.000	0.068
	(–1.35)	(0.41)	(–0.00)	(0.31)
Albums (–3)	–0.176	–0.131	0.098	0.363
	(–0.77)	(–0.44)	0.59	1.88[c]
R^2	0.16	0.33	0.49	0.29
F-Stat	1.11[a]	2.73[b]	5.41[a]	2.33[c]
DW	1.62	1.91	2.00	2.10
Wald singles	5.36	12.52[a]	3.92	1.82
Wald albums	3.39	5.27	6.36[c]	7.42

[a] = significant at 1% level,
[b] = significant at 5% level and
[c] = significant at 10% level.

when a record company realises that a particular artist's tunes are in demand, it needs to exploit this promptly before consumer demand changes and the tunes lose their value. Therefore, in this environment, record companies are not afforded much opportunity to conduct a "wait and see" approach in using the singles market to test out the value of an artist at a low cost. If an artist is successful in the singles market the album ought to be available at the same time. In practice, this is evidenced by the fact that virtually all artists who are signed by record companies are awarded an advance on royalties to finance the recording of an album.

4. Product Differentiation Innovation and Industry Demand

In this section we want to examine the audio software market at the industry level. We set out to apply cointegration techniques to the estimation procedure of an earlier paper (Burke, 1994a) which estimated the demand for vinyl albums while accounting for the impact of product differentiation innovation. The cointegration

approach is particularity appropriate if one hopes to assess the relative importance of product differentiation innovation as a determinant of the long-run path of the audio software market. In this sphere, we are interested to learn whether product differentiation innovation by record companies has, in general, competition or multiplier effects for the industry as a whole. Competition or "business stealing" effects arise if a record company releases tunes that superannuate those of other artists so that audio software sales gained by the new tunes occur at the expense of lost sales in existing tunes. Multiplier effects may occur if the new tunes draw new expenditure into the market so that similar existing music benefits from increased expenditure. We aim to test these propositions in relation to product differentiation innovation which has commercial scope in both the singles and albums markets.

The structure of the section is as follows: sub-section 4.1 outlines a survey of the data and this is followed in sub-section 4.2 with the derivation of an index for product differentiation innovation. Sub-section 4.3 estimates the demand for vinyl albums and assesses the importance of product differentiation innovation.

4.1. THE DATA

We use the quarterly data set from Burke (1994a) and since this is described in some detail in that article we only provide a brief outline here. The most comprehensive record industry data over a statistically useful time is that for the United Kingdom and is published by the BPI. The audio software market has been comprised of different formats at different times e.g. vinyl, compact disc and cassette. It is best to estimate the effect of product differentiation innovation on the vinyl format since this format dominated the audio market over the majority of the years in the data set. During this sub-sample, all new music titles were featured on the vinyl format in both the singles and albums markets. This is important for the econometric methodology which consists of deriving an index of the success (as judged by consumer purchasing) of product differentiation innovation from the residuals of a demand for audio singles equation, and using this as an independent variable in a demand for albums equation. The independent variables employed in the general to specific analysis are taken from Burke (1994a).

Since the data are quarterly, the Dickey-Fuller and Augmented Dickey-Fuller tests are not appropriate since a unit null is often not rejected when a seasonal root is resident in the data. Therefore, we carried out tests outlined by Osborn et al. (1988). The critical value for the t-statistics and the F-statistics are given in Osborn (1990). Thus, in the following list of variables we denote the roots of each variable using a two element set where the first element takes on the value 1 if a non-seasonal unit root cannot be rejected (otherwise zero) and the second element takes on the value 1 if a seasonal root cannot be rejected.

(1) *Vinyl Albums Sales:* This variable is the quarterly trade deliveries of vinyl albums (1,0) and are published by the BPI.

(2) *Income:* Current quarterly income is represented by real GDP (1,0) and a more permanent income is represented by a Koyck lag of the same (1,0).

(3) *Price of pre-recorded audio software:* The prices of audio software in its various formats are taken from the BPI and are all of (1,0) form.

(4) *Product differentiation innovation:* A high incidence of popular artists and tunes in a particular quarter may be expected to boost industry demand if multiplier effects dominate "business stealing" effects. As we have now ascertained in section 2, a significant proportion of product differentiation innovation is successful in both markets simultaneously. In the absence of a variable for this factor, a demand equation for singles will include a residual containing the influence of product differentiation innovation and this may be used to assess its influence as an independent variable in a demand for albums equation.

(5) *Selection of tunes on compatible pre-recorded software*: Briefly, this factor represents the influence of network externalities and associated switching costs. The demand for a particular audio format such as vinyl will be positively related to the range of software available on, and the number of consumers using, the format. As in Burke (1994a) a variable DIFLP, which is a four period moving average of the market share of vinyl (1,0) is used to capture this effect. In Burke (1994a) it was discovered that the consistency in the relative price of vinyl and cassettes over the sample period ensured that this network externality variable does not account for movements in the relative price of audio software formats.

(6) *Price of complements*: No data exist for the price of audio hardware over the sample period and hence a certain degree of mis- specification will result from this omission.

(7) *Durability of vinyl albums*: Vinyl albums are durable goods in terms of their physical resilience. However, it is arguable that the service they provide to consumers quickly satiates tastes for the particular music contained on the record and this has been suggested by the results of sections 2 and 3. The extent to which vinyl albums are durable goods in an economic sense is tested with the inclusion of real interest rates (1,0) and to a lesser extent by the significance of an error correction mechanism.

(8) *Demographic factors*: Since it is generally assumed that the record market is primarily composed of young consumers, in Burke (1994a) this view is tested using the following quarterly population cohorts totals: 10–14 year olds (0,1), 15–19 year olds (0,1), 20–24 year olds (0,0), 25–29 year olds (0,0) and 30–34 year olds (0,0).

(9) *Seasonal factors*: The seasonality of audio consumers' demands are tested by the inclusion of four seasonal dummies. At the outset one would expect the Christmas quarter to be significant given that records are a popular gift item.

4.2. DERIVATION OF PRODUCT DIFFERENTIATION INNOVATION INDICES

In this sub-section, we want to derive an index for product differentiation innovation. We utilise the findings of section 2 where we observed that a significant proportion of tunes which are successful in the singles market were also successful in the albums market. Since a proportion of product differentiation innovation is consistent across these two markets, it may be possible to use the singles market to generate an index of product differentiation innovation in the albums market. The procedure involves estimating a demand equation for singles which, in the absence of a product differentiation innovation variable, will generate a residual containing this innovation in the singles market and an error term. Formally:

$$U_t = I_t + e_t \tag{1}$$

where I_t is actual product differentiation innovation, e_t is the real error term, and U_t is the actual error term. Assuming that the real error term has a mean of zero, the error term from the singles equation will approximate a true estimate of product differentiation innovation as time approaches infinity i.e.

$$U_t = I_t \tag{2}$$

However, the product differentiation innovation variable of (2) will include successful music that does not have scope in the albums market. This implies that the product differentiation innovation variable is a proxy rather than an actual variable. Thus, it is likely to be most effective if music innovation unique to the singles market is positively correlated with music innovation with scope in both markets, and most ineffectual if negatively correlated.

We employ a general to specific co-integration estimation procedure. This is based on a supposition of a stable long-run relationship between dependent and independent variables. It allows for the fact that variables may be off their long-run paths due to short-term disequilibrium. In order to avoid such deviations from the long-run relationship generating unreliable regressor coefficients, this approach is usually associated with an error correction model (ECM). In terms of the albums market we intend to use such an ECM. However, in order to generate an innovation variable from a singles equation, such an approach would inevitably capture the effect of product differentiation innovation within the error correction term. Thus, the residuals of an ECM would have already filtered out the impact of product differentiation innovation. Therefore, in the case of the singles equation, we attempt to avoid the spurious regression problem but do not proceed to an error correction model. In effect, the error correction term is the product differentiation innovation proxy.

The results of the general to specific co-integration approach are outlined in Table IX. The dependent variable is the sale of all formats of singles. Equation A estimates a cointegrating regression and finds singles to be a normal good, negative cross-price inelastic with respect to vinyl albums and positively related to the

Table IX. Dependent variable: (A) the log of the quantity of singles and (B) the change in the log of the quantity of singles. Regressors: in levels in equation (A) and first differences in equation (B). Sample: (A) 1976 Q2–1990 Q2 and (B) 1976 Q2–1989 Q2

Variables:	A	B
Constant	–16.27	
	(–2.24)[b]	
Time dummy	0.032	
	(7.20)[a]	
(Time dummy)^2	–0.001	
	(–6.77)[a]	
Log of real GDP	1.627	2.421
	(2.47)[b]	(5.14)[a]
Log of P_S/P_A	–0.558	–0.432
	(–3.11)[a]	(–1.74)[c]
XMAS	0.091	0.104
	(1.98)[c]	(2.83)[a]
Log pop 10–14		4.631
		(2.81)[a]
Log real price singles		0.673
		(1.87)[c]
R^2	0.72	0.72
Adj-R^2	0.69	0.69
F-Stat	26.66[a]	30.33[a]
CRDW	1.23	2.76

[a] = significant at 1% level,
[b] = significant at 5% level, and
[c] = significant at 10% level.

Christmas quarter. Inclusion of time dummy variables were necessary to derive sensible results. The equation passed the Engle-Granger cointegrating Durbin-Watson test. The residual from this equation generated our first product differentiation innovation proxy which we denoted as TUNE A (0,1).

We also adopted a first differences approach where all the variables were stationary. This permitted the inclusion of the population variables. Equation B in Table IX is the specific equation identified. For an equation in differences it exhibits a reasonably high R^2 and does not need time dummy variables. The regressors identify singles as a normal good, cross price inelastic with respect to vinyl albums, increasing in the Christmas quarter and positively related to the 10–14 year old population. The equation finds a positive coefficient on the real price of singles variable which is likely to be due to unaccounted for demand shift parameters e.g. price of audio hardware. An increase in demand due to these factors would be expected to be

correlated with an increase in the price of singles and hence generate a positive coefficient. The residuals of equation B produced our second tune innovation proxy which we denoted as TUNE B (0,1). The variance and magnitude of the product differentiation innovation variables derived here are similar to those derived in Burke (1994a). Correlation coefficients range between 0.72 and 0.85.

4.3. THE DEMAND FOR VINYL ALBUMS:

The cointegration approach implies that the product differentiation innovation variables cannot be regressed against the sale of albums in levels. We therefore differenced the variables so that they were stationary and conducted a general to specific analysis. The resulting specific equation is presented in column A in Table X. The equation does not find any of the product differentiation innovation variables to be significant. The equation identifies vinyl albums to be normal goods, cross-price elastic with respect to albums on a cassette format and positively affected by the Christmas quarter. The equation also identifies the "network externalities" variable (DIFLP) as a positive and significant determinant of album sales, which supports the notion that switching costs are important in a market with non-compatible formats.

The cointegration approach argues that two variables should be integrated of the same order if a long-run relationship is to exist. However, a possible justification for the inclusion of a stationary independent variable in an equation with a non-stationary dependent variable is suggested by Johansen and Juselius (1992) and applied by Wright (1994). The intuition behind this argument is based on cases where the sample period is reasonably short and the stationary variable acts like an error correction mechanism when the remaining variables are non-stationary. In other words, although there may be no long term stable relationship between the non-stationary dependent variable and the stationary independent variable, the latter may play a role in determining the dependent variable's deviation from equilibrium. Thus in terms of the albums equation, the actual long-run relationship between the non-stationary independent variables and the non-stationary albums variable may be distorted if short-run shocks have not been accounted for. Therefore, in this case a significant product differentiation innovation variable would indicate that a stationary variable may have an impact on a non-stationary variable *if* these effects are small i.e. not sufficient to generate a stationary dependent variable.

In order to test this approach, we included the product differentiation innovation variables and conducted another general to specific analysis of the variables in levels. The results are presented in column B of Table X. The results are similar to column A except that the innovation variable TUNE A is positive and significant, and the relative price of vinyl albums over cassettes is superseded by the nominal price of vinyl albums. Column C conducts a Davidson and Hendry (1978) style re-estimation of the equation, deleting the last eight observations. The equation continues to hold and it is notable that the product differentiation innovation variable

Table X. Dependent variable: (A) and (D) the first difference of the log of the quantity of vinyl albums, (B) and (C) the log of the quantity of albums. Regressors: in levels in (B) and (C) and in first differences in (A) and (D). Sample: (A), (B) and (D) 1977 Q2–1988 Q1, and (C) 1977 Q2–1986 Q1

	A	B	C	D
Constant		–21.356	–13.359	–0.057
		(–4.03)[a]	(–2.37)[b]	(–1.27)
Log real	6.739	2.140	1.415	8.673
GDP	(7.10)[a]	(4.65)[a]	(2.86)[a]	(9.673)[a]
d Log	–1.122			
(P_{LP}/P_{CAS})	(–2.85)[a]			
DIFLP	17.467	1.077	1.059	15.853
	(7.05)[a]	(4.10)[a]	(4.08)[a]	(4.68)[a]
XMAS	0.551	0.694	0.740	0.671
	(7.36)[a]	(19.23)[a]	(21.04)[a]	8.98)[a]
TUNE A		0.444	0.497	0.010
		(3.98)[a]	(4.87)[a]	(0.04)
Log Price LP		–0.917	–0.828	–0.880
		(–7.49)[a]	(–6.23)[a]	(–1.77)[c]
B Residuals (–1)				–2.293
				(–5.68)
R^2	0.88	0.97	0.98	0.92
Adj-R^2	0.87	0.96	0.97	0.91
F-Stat	97.34[a]	237.32[a]	347.82[a]	75.43[a]
CRDW	2.39	2.58	2.46	2.03

[a] = significant at 1% level,
[b] = significant at 5% level, and
[c] = significant at 10% level.

becomes more significant. The latter is probably due to the fact that the scale of product differentiation innovation transfer from the singles to the albums market was beginning to become inhibited in the latter years of the sample as the compact disc started to replace the vinyl format.

Column D conducts an error correction model of Equation B. The ECM deprives the innovation variable of its significance, but this is not too surprising given that the product differentiation innovation variable was effectively acting as an error correction mechanism in Equation B.

Summarising these estimates, the results indicate that there is no long-run relationship between the product differentiation innovation variables and album sales. This implies that if such innovation has been adequately captured by the proxies, then competition effects dominate multiplier effects so that product differentiation

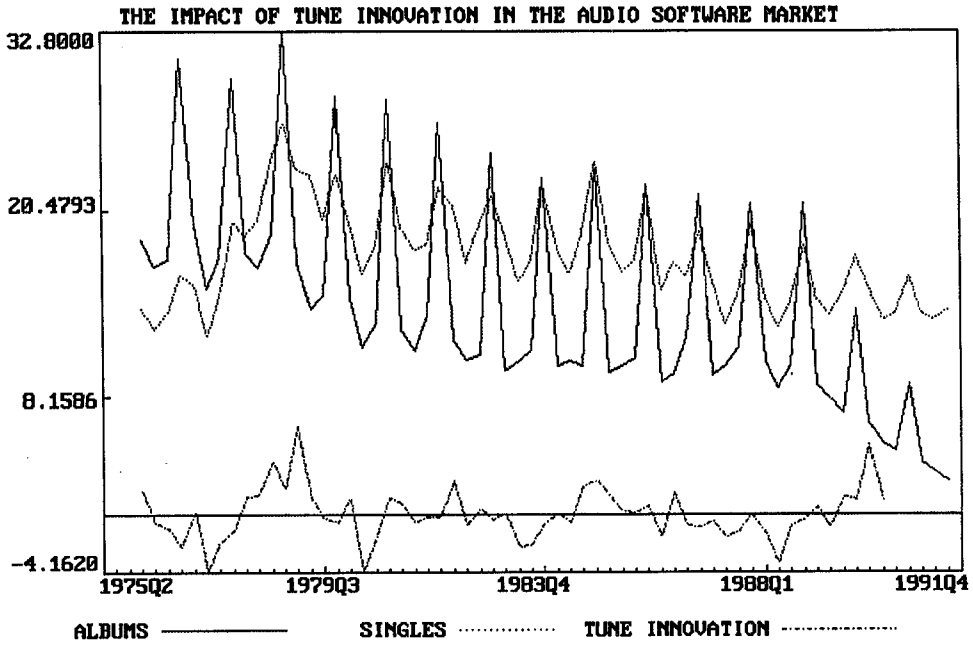

Figure 1.

innovation is seen to have little effect on industry demand; even though it may play a significant role in determining demand at the level of the firm.

We can observe this if we take the coefficient on the TUNE A variable and simulate the effect of product differentiation innovation on deviations in the vinyl album market. Such simulations find that the TUNE A proxy has a mean absolute impact of 1.4 per cent deviation in the percentage of album sales with a standard deviation of 1.2 per cent. The simulation for the 0.5 TUNE A coefficient is plotted in Figure 1 along with the quantity (in millions of units) of singles and vinyl albums sales. It is reasonably clear from the figure that product differentiation innovation was only active in isolated periods. The most notable period was in the late 1970s when such innovation appeared to have been at its zenith. Interestingly, this is a period when music innovation was considered to have been exceptionally successful. For example, the IFPI (1990) in its commentary on world record sales in the 1970s and 1980s stresses:

> "The year 1978 was the peak year for disco music with international 'hits' such as 'Saturday Night Fever' and 'Grease' and sales in most countries reached record heights[4]."

Summarising the analysis of product differentiation innovation in Section 4.3 we find that such innovation generally appears to have a sporadic random shock effect on the demand for albums so that a long- run relationship between these variables would not be expected. In other words, product differentiation innovation

plays a secondary role to other economic variables (such as income, prices and switching costs) to the extent that it does not determine the long-run path of album sales, but merely deviations from this path. This would seem to suggest that in terms of industry demand for albums, product differentiation innovation by artists and record companies generally have "business stealing" effects and only in isolated cases, multiplier effects.

5. Conclusion

The paper investigated the role of product differentiation innovation in the audio software market. Through the generation of new data the paper confirmed a general belief in the industry, that a significant proportion of artists and titles which are successful in the singles market are also successful in the albums market. Examining the charts of top selling records most of this correlation was found to occur in the same quarter.

With this premise the paper then focused on quarterly company market share in the singles and albums market. Since prices are generally homogeneous across record companies, record company share would be expected to be predominately determined by product differentiation innovation. Therefore, using company market share data the analysis found that for five of the six largest record companies, singles and albums market share were correlated in the same quarter. Conducting Granger causality tests the analysis found little inertia in the market which suggests a fairly high turnover and low durability of product differentiation innovation. The fact that record companies were willing to sell singles at a loss appeared to be due to an advertising effect on album sales rather than minimising search costs. Scope for the latter appeared to be severely constrained by the rapid depreciation rate of tunes.

Finally, Section 4 estimated the role of product differentiation innovation at the industry level. Proxies for this innovation were generated from demand for singles equations and these variables appeared to indicate that innovation played a minor role at the industry level. Product differentiation innovation did not determine the long-run equilibrium path of album sales. However, it is possible that it acted like an error correction mechanism in that it explained short-term deviations from the long-term path. Thus, the industry analysis suggested that product differentiation innovation by artists and record companies has had net competition effects.

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Notes

1. The record industry is a component of the music industry, namely sectors relating to the audio software market. The audio software market is in fact made up of two markets; a singles market and an albums market. The singles market comprises of software with generally two titles on each unit whereas the albums market consists of audio software with a larger set of around twelve titles.
2. The issue of the direction of causality between industry demand and successful product differentiation innovation turns out, *ex-post,* to be unimportant, as in Section 3 product differentiation innovation is found to have net competition effects at the industry level. This implies that successful product differentiation by artists/record companies "steals" market share from other artists/record companies so that industry demand is largely unaffected. This prevents a simultaneity problem in the estimation as there is no feed back loop available for successful product differentiation innovation to have an endogenous component. From an analytical perspective this is convenient because a simultaneous least squares approach in stages is not really feasible due the fact that more titles do not necessarily imply more successful product differentiation innovation and that the "lions share" of the determination of the production of new titles by composers is accounted for by non-economic factors (see, Burke 1994b); for which there is no time series data. Degrees of freedom is also another serious impediment to such an approach as generally 52% (see Burke, 1995) of the successful product differentiation innovation in the British audio software market is supplied by (and hence would necessarily have to be accounted for by independent variables relating to) foreign artists.
3. Leadbeater (1994), p. 39.
4. IFPI (1990), p. 64.

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