

## **DIGITAL COPYING AND THE SUPPLY OF SOUND RECORDINGS**

### **Abstract**

One concern with digitization in the cultural sector is that unauthorized, digital copying will disrupt cultural supply. This paper discusses the evidence for an impact of digital copying on the commercial supply of new, copyrighted sound recordings in Germany. The method is an intervention analysis for short time series. In spite of a severe recession in the primary market for sound recordings with the diffusion of digital copying technology, the annual number of new titles released to the market continued to expand. There is no significant deviation from a long-term upward trend. Further empirical research is needed on the impact of digital copying on the supply of protected works, as well as on intervening factors fostering the supply of copyright works. According to the findings of this paper, it is questionable whether more extensive public expenditure on copyright protection is desirable.

# DIGITAL COPYING AND THE SUPPLY OF SOUND RECORDINGS

*“It's all about supply and demand. If there is not demand, there will eventually be no supply.”*

Sheryl Crow, singer songwriter<sup>i</sup>

*“Every copyright infringement has to be prosecuted clearly, otherwise we lose cultural diversity and markets.”*

Dieter Gorny, chairman of the Federal Association of the Music Industry,  
Germany<sup>ii</sup>

*“In short, given the speed and low cost of copying, as well as the difficulty of employing private measures to prevent copying, we would expect a decrease in the number of new works created in the absence of copyright protection.”*

Landes 2002, 13

## 1. Introduction

One concern with digitization is that unauthorized, digital copying will disrupt cultural supply. The three quotes presented above – one by a musician, one by a music industry lobbyist, and one by a leading scholar on the economics of copyright – illustrate this worry well.

The emergence of file-sharing networks in the summer of 1999 marked a major shift

in the intensity of unauthorized copying and thus in the de facto level of copyright protection. Reforms to adapt the copyright system to this aspect of technological change have been hotly debated ever since. So far, econometric studies on the impact of unauthorized, digital copying have focused on rights holder revenues. Such studies are not sufficient to make the case for public investments in copyright protection because they do not fully account for user interests in access to a diverse supply.

The focus of this paper is the effect of digital copying on the supply of copyrighted, cultural products. Econometric research on this topic is restricted by a lack of data on the supply of copyright works and by a lack of statistical tools to analyze the short time series of annual observations that are available. This paper analyzes a time series on the number of new, copyrighted sound recordings released commercially in Germany. The method applied is an intervention analysis for short time series developed by Tryon (1982).

## **2. The supply of creative works and the economic case for copyright**

A copyright system tries to ensure that creators enjoy temporary, exclusive rights to the output of their work in the ‘literary, scientific and artistic domain’ (WIPO 1971). The predominant, economic understanding of the welfare implications of unauthorized copying (and its countermeasure copyright) invokes a trade-off between ‘under-utilization’ and the ‘underproduction’ of such products (Novos and Waldmann 1984). In this perspective, a rational copyright policy seeks to resolve that trade-off in order to maximize social welfare. One way to structure the argument is that copyright needs to strike a balance between rights holder interests in maximizing profits and user interests in access to a diverse supply.

*Ceteris paribus*, unauthorized copying harms rights holders where it displaces demand

for authorized copies. Even regarding only the consequences for suppliers of creative works, unauthorized use is not universally harmful, however. On the one hand, copyright can exclude creators who are deterred from building upon prior works because they are unwilling to incur the total costs of obtaining the necessary permissions (Landes and Posner 1989). It follows that “Paradoxically, too much copyright protection can reduce the number of new works created” (Landes 2002, 13). On the other hand, business models based on indirect appropriability, the benefits of sampling, or perhaps even network effects could offset adverse effects of copying for rights holders (Liebowitz 1985; Takeyama 1994; Varian 2005).<sup>iii</sup>

Regarding user welfare, unauthorized copying is also ambiguous. Copying facilitates access to the existing stock of reproducible copyrighted works. In the long run, unauthorized copying may diminish the diversity or quality of supply, however, so that the short-run benefits of copying may be unsustainable (Johnson 1985). The latter argument concerning the long-run costs of unauthorized copying is key to the conventional, economic case for copyright. It suggests that a socially efficient level of copyright protection could increase total rights holder welfare and consumer welfare simultaneously subject to the elasticity of supply to unauthorized copying.<sup>iv</sup>

The welfare economic case for publicly financed countermeasures to digital copying thus depends upon the relative weight of two effects: first, any adverse effects of copying on rights holder revenues under specific market conditions; second, on the long-run effects of copying on the supply of creative works and thus on user welfare.<sup>v</sup>

So far, the economic literature on digital copying has focused on the extent to which unauthorized copying displaces demand for authorized copies, harming rights holders. The case of the record industry has received particular attention (for example Liebowitz 2006; Zentner 2006; Oberholzer-Gee and Strumpf 2007). By contrast, the purpose of this paper is to discuss the empirical evidence regarding the long-run effects of digital copying on the supply

of copyright works.

### **3. Basic information on the German market for sound recordings**

The primary market for sound recordings in Germany (in which copies are sold to end consumers for private use) is currently the fourth largest worldwide after the USA, Japan and the United Kingdom. Similar to all other major markets, it exhibited substantial falls in turnover over recent years (IFPI 2009; BV Phono 2006).

The main source of data on the German market is the ‘Bundesverband der Phonographischen Wirtschaft’ (BV Phono)<sup>vi</sup> that assembles and publishes an annual report on the German record industry.<sup>vii</sup> According to BV Phono (1995) data, real turnover in the German market for phonograms (including VAT and at retail value)<sup>viii</sup> had grown rapidly during the mid-1980s and early 1990s. At 2000 prices, it almost doubled from DM2.85 billion (€1.46 billion) in 1984 to DM5.63 billion (€2.88 billion) in 1994. Casual explanations include the emergence of the CD as the dominant and highly valued sound carrier (IFPI 2004). A specific factor to the German market was German unification adding roughly 18 million individuals to the domestic market now encompassing about 82 million. Real turnover in the German market for phonograms has been roughly stable at this high level between 1993 and 1997 (see figure 1 and table 1).

[ADD IN FIGURE 1 AND TABLE 1]

In 1998 this picture began to change. Since that year, real turnover has fallen by more than 2% annually.<sup>ix</sup> The years 2001, 2002 and 2003 exhibit dramatic falls of up to 20.9% in 2003

alone (BV Phono 2006). Important representatives of the record industry identified the explosive growth of so-called ‘piracy’ – CD-burning and p2p-file-sharing ignoring intellectual property – as the reason for a downward shift in demand for authorized copies. As figure 1 illustrates, in Germany a period of rapid growth in the unit sales of blank CDs since 1998, of unauthorized downloading via p2p-file-sharing networks since 1999, and of unit sales of blank DVDs since 2003 coincides with falling turnover in the market for authorized phonograms. Due to similar observations in other major markets, most importantly in the US, developments in the primary market for sound recordings came to be perceived as *the* copyright story of late (Liebowitz 2005).

#### **4. Preparation of the time series analysis**

In order to assess the impact of digital copying on the supply of sound recordings, this paper discusses a time-series on the variety of supply in the German market for sound recordings. The statistical method is a basic version of an intervention analysis. The process entails the following steps. First, a pre-period and post-period is defined by investigating data on unauthorized copying. Second, the nature of the intervention and its likely effects on the time series’ behavior is specified, and a hypothesis is formulated. Third, any trend in the sub-series for the pre-period needs to be removed by adequate data transformation. The fourth and final step is the comparison of the time-series’ behavior before and after the intervention.

##### *4.1. Defining the pre- and post-period*

Prior to the year 1998, unauthorized copying was well contained in Germany. In 1998, it became apparent that a sizable number of end-consumers used CD-burners for unauthorized

copying of copyrighted content. In June 1999, Napster began to popularize file-sharing. Whether to include the year 1998 into the boom period or into the recession period requires a degree of judgment.<sup>x</sup> File-sharing is probably the more important of these two developments. The time period studied is thus partitioned into two segments as follows.

- (1) The pre-period ranges from the early 1980s to 1998. Throughout this period, the German market was characterized by relatively low rates of unauthorized copying. During the 1980s and the early 1990s, the German record industry had grown rapidly and it continued to hum along at historically high, if stagnating, levels of turnover up to the late 1990s. For convenience, the pre-period is also referred to as the ‘boom period’ in the following.
- (2) The post-period ranges from 1999 to 2006. During these eight years, unauthorized copying occurred on a massive scale using file-sharing and CD-burning technology. Real turnover fell by more than 2% annually in the post-period, with the exception of the year 2006. The post-period is also referred to as the ‘recession period’.

The beginning and the end of the entire time series studied are defined by data availability. The implications will be discussed below.

#### *4.2. The nature of the intervention*

Digital copying coincides with falling revenues in the primary market for sound recordings. This study does not elaborate on any causal link between unauthorized copying and copyrights holder revenues. *Ceteris paribus*, incentives to supply copyright works should decrease during the recession period.

The diffusion of digital copying technology is a permanent intervention in the sense that there are no years covered after 1998 in which digital copying would have subsided. The intervention is gradual, which renders the analysis somewhat more challenging. Digital

copying diffused over a longer time period and changed nature with a number of alterations to copying technology and regulations during the recession period. For example, file-sharing platforms were closed and replaced by newer versions. In the recession period covered, CD-burners were complemented by DVD burners, USB-sticks and mp3-players. Several new types of files to store music were introduced. A number of legal initiatives extended and adapted copyright law to cover new types of use of protected works. There were also several measures aimed at enforcing copyright more effectively, often initiated by private parties. These include a number of technical measures to inhibit unauthorized use or to identify it in order to instigate court cases against copyright infringers. Many of these enforcement efforts were adapted repeatedly or abandoned altogether, as few of them proved to be effective without serious unintended consequences.

What is more, it is very likely that much of the effect that unauthorized copying might have on the supply of copyright works transpires with some delay. Suppliers probably adapt their level of investments to the recession with a lag. This lag depends on suppliers' expectations, their financial reserves, and the costs of changing to a different type of product, as well as their opportunity costs. Suppliers can be assumed to be heterogeneous in these respects and therefore differ in their willingness to participate in the market.

Both the gradual nature of the intervention as well as the potential lag complicates the assessment of the intervention's impact. Assuming heterogeneity of suppliers, an adverse effect of unauthorized copying on supply will show up almost immediately. The expectation would be that time-plots of supply indicators would exhibit a gradual downwards shift in slope (cf. Cook and Campbell 1979). Some existing suppliers should reduce output; some should not be able to cope with falling sales for longer periods of time and exit the market; some potential market entrants should be deterred by the recession. When the full impact of the recession has transpired and how severe the accumulated effect will be is more difficult to



predict.

#### *4.3. The hypothesis*

This leads to one hypothesis regarding the supply of copyrighted, cultural products to be tested in this paper.

HYPOTHESIS: The supply of copyright works grows less rapidly in the presence of digital copying than before.

The time-series discussed covers eight consecutive recession years. Furthermore, falls in turnover (as a good proxy for suppliers' revenues) have accumulated to more than 41% during the recession period. At the outset, the recession seems long and severe enough to expect an observable effect on the rate of output growth.

#### *4.4. The data*

This paper analyzes time series data on the number of new, long-play titles released on the physical sound-carrier format that accounted for most releases (for later years CDs) in Germany. This time series will be referred to as 'new titles' below. The source of the data is the BV Phono (various issues). The data does not include imports and the second hand market. According to the BV Phono management, the counts cover all releases that are handled by one of the major distributors. They also cover retail outlets that use a bar-code scanning system. That is, the data accounts for titles that are marketed through the more professional/commercial end of the market for sound-recordings. Releases by smaller suppliers are not fully captured.<sup>xi</sup>

Several measures are taken to avoid double-counting of the same content – say of an identical recording marketed on a single and on an album. First, only long-play releases are counted. Substantial fluctuations in the number of compilations that rebundle works

previously released on another title would create a distortion.<sup>xii</sup> Second, only titles on the predominant sound-carrier format are counted rather than the sum of releases on all sound-carrier formats. The underlying assumption is that most titles were marketed on the predominant sound-carrier format (i.e. the CD after 1988) and that relatively few titles were released exclusively on other formats. Counting titles on the predominant sound format might create a downwards bias for earlier years up to the beginning 1990s, during which the market was more evenly split between vinyl LPs, music-cassettes and CDs.<sup>xiii</sup> The BV Phono data does not cover sound-recordings that are only made available online (as streams or downloads). This should create a downwards bias for later recession years if there were many releases that are only available as downloads.

## **5. Method**

A time series intervention analysis typically compares the series' level and trend during two or more, consecutive periods of time. In comparison to research that focuses on shorter time periods, intervention analysis is more sensitive to longer-term trends. In particular, an intervention analysis may be more likely to pick up effects that take time to transpire.

Conventional time series intervention analyses require a substantial number of data points. For an application of the autoregressive integrated moving average (ARIMA) approach (Box and Tiao 1976), for example, between 50 and 100 data points are usually recommended per period under study. This requirement renders ARIMA-based intervention analyses impractical for many annual time-series, including the series investigated in the following.

Tryon (1982) proposes a method to test for a significant deviation between

consecutive periods of shorter time series. This method is based on the C statistic as developed by Young (1941) – see Equation 1. The general notation in Young (1941) is adapted to refer to time series in particular. In the formula,  $y$  stands for the expression of the time series at a point in time  $t$ .

$$C = 1 - \frac{\sum_{t=1}^{n-1} (y_t - y_{t+1})^2}{2 \sum_{t=1}^n (y_t - \bar{y})^2} \quad (1)$$

The idea behind the C statistic is to compare two measures of the variance of an ordered set of data: one that depends on the mean like the denominator in Equation 1; and one that does not like the numerator in the same equation. The C statistic provides a measure of the variability relative to its slope (Tryon 1982). It offers a method to determine the probability whether the expressions of a time series vary randomly around their mean (the null hypothesis) or whether the series contains a significant slope or shift in the mean after a specific point time (Tryon 1984; Young 1941; Sheskin 2003).

The standard error for the C statistic depends entirely on the number of observations in the times series and is calculated according to Equation 2.

$$Sc = \sqrt{\frac{n-2}{(n-1)(n+1)}} \quad (2)$$

Finally, the Z statistic is the ratio between the C statistic and its standard error  $Sc$ ; see Equation 3.<sup>xiv</sup>

$$Z = \frac{C}{Sc} \quad (3)$$

The C statistic can be used for an intervention analysis by comparing the result for the pre-period with the entire time series (Tryon 1982). In this application, the question is whether different segments of a time series exhibit a different slope or mean. The null-hypothesis is that there is no significant difference. Rejecting this null hypothesis supports the conclusion that the time series contains a significant change, which in this paper could be due to the impact of unauthorized copying on the supply of copyright works.

In comparison to OLS regression, a test based on the C statistic has the advantages that it often has greater statistical power and that it is less susceptible to bias due to autocorrelation and to non-normality in small data sets (Young 1941; Tryon 1982). A limitation is that the C statistic does not establish the nature of a change. It does not establish whether any non-randomness is due to a change in slope or a sudden shift, it provides no quantification of the effect size, or whether the intervention effect is abrupt, gradual, permanent or temporary.

In order to allow for a comparison, the pre-period time series must not contain a trend. In its initial shape, this does not apply to the time series ‘new titles’. Therefore it is first necessary to transform the pre-period data to create a stationary comparison series in order to prepare the intervention analysis proper.<sup>xv</sup>

## **6. Analysis of the time series on ‘new titles’**

Figure 2 presents a time series for the number of new, long-play titles released on the predominant physical sound-carrier format. The time-series contains 23 observations for as

many years. The 15 observations between 1984 and 1998 are from the boom period as defined above. The 8 observations between 1999 and 2006 are from the recession period. A dashed vertical line separates the two periods.

[ADD IN FIGURE 2]

A visual inspection of the entire time series identifies a relatively consistent upward trend that is not obviously interrupted during the recession period. In 2006 – the last year of the recession period covered – the number of ‘new titles’ released to the market is 54.7% greater than in 1998. The mean score for ‘new titles’ during the recession period is 22.6% greater than the peak level during the boom period. This pattern is complicated by considerable variability and an early peak value of the time series in 2001.

The annual number of new product variants introduced to the market has expanded very substantially between 1984 and 2006. It may be a surprising result that the number of new releases continued to grow in absolute terms during the recession period. Given an upward trend during the entire time period studied, the main question is whether there is any slow-down in the rate of growth during the recession period.

Due to a pronounced trend during the boom period, the original time series is not suitable for an intervention analysis based on the C statistic. Two methods of de-trending are employed in the following. The first method is the identification of a suitable OLS regression model for the pre-period and to study the residuals, as suggested by Tryon (1982). The second type of de-trending is differencing.

### *6.1. Regression model identification*

In preparation of the intervention analysis, the aim is to find a model for which the residuals

of the boom period are randomly distributed around their mean. To do so, first a number of standard regression models are estimated for the 15 observations from the boom period. See table 2 for an overview.

[ADD IN TABLE 2]

The linear model seems favorable (reported first in table 2). Despite of its relative simplicity, it results in one of the highest  $R^2$  and the highest F ratio of all models estimated. Visual inspection of the residuals reveals no obvious pattern (see figure 3). Table 3 displays a statistical comparison of the linear model to the two models that result in the ‘best fit’ in terms of the highest  $R^2$ , i.e. the quadratic model and the cubic model. Since the two more complex models are not significantly superior to the linear model, the linear model has priority in the subsequent analysis.

[ADD IN FIGURE 3 AND TABLE 3]

On a theoretical level, the linear model is problematic since it predicts negative values for the recent past, whereas negative values are invalid for this time series. Arguably, this problem is not of immediate concern in the period under investigation. It serves as a reminder, however, that any regression model is unlikely to provide valid predictions for more than a relatively short time-frame. One implication is that the upward trend in ‘new titles’ between 1984 and 1998 was exceptionally high in comparison to preceding years.

### *6.2. Intervention analysis of regression model residuals*

Figures 4 exhibit the time series ‘new titles’ and the predicted values from the OLS linear

regression model as well as the model's residuals. (Note that the model is calculated from the boom period observations only.) The intervention analysis based on the C statistic and this model is exhibited in detail below to illustrate the procedure.

[ADD IN FIGURES 4a AND 4b]

For each year of the time series – including both the boom and recession period – the expected value  $e_t$  from the regression model is subtracted from the observed value  $y_t$  to generate the value in relation to the linear trend during the boom period  $\hat{\varepsilon}_t$  (see equation 4). In other words, the analysis discusses the residuals of the linear model for the time series of 'new titles'.

$$y_t - e_t = \hat{\varepsilon}_t \quad (4)$$

The numerator of the C statistic becomes the sum of squared first difference values for the residuals. The denominator of the C statistic becomes the sum of the squared differences between the residual for each year and the mean of all residuals in the period multiplied by two, see equation 5.

$$C = 1 - \frac{\sum_{t=1}^{n-1} (\hat{\varepsilon}_t - \hat{\varepsilon}_{t+1})^2}{2 \sum_{t=1}^n (\hat{\varepsilon}_t - \bar{\varepsilon})^2} \quad (5)$$

The C statistic, standard error and Z statistic are calculated in the same way as illustrated in Equations 2 and 3.

Table 4 documents two tests. The test for the boom period is run to establish whether

the residuals of the linear model contain no significant trend. The resulting Z statistic of -0.496 is not significant. Thus, the null hypothesis of no significant deviation from randomness is accepted. This result implies that the newly created comparison series contains no significant trend so that it appears suitable as a reference for the intervention analysis proper.

[ADD IN TABLE 4]

After this preparation, the test of the entire time series establishes whether the observed values deviate significantly from the values extrapolated from the linear regression model of the boom period observations. The mean of the residuals during the recession period is lower than that for the boom period (-163). The resulting Z statistic for the appended time series is -0.795 and not significant. That is, there is no significant evidence for less growth in the number of new full-length titles published each year during the recession period.

### *6.3. Intervention analysis of differenced time series*

Transforming the data by calculating the appropriate  $x^{\text{th}}$ -order difference (integration) provides an alternative to the discussion of regression models and their residuals. The main advantage of differencing is that it avoids much of the judgment involved in the identification and selection of regression models. One disadvantage is that data is lost in the process of differencing. Another drawback of differencing is that it tends to generate transformed time series with a relatively great variance, which may reduce the statistical power of the intervention analysis.

Figures 5 plot the observations for the ‘new titles’ time series and its first difference  $\Delta^1y$ . Table 5 exhibits the results of the intervention analysis for the differenced time series. The result implies no significant change. The boom period mean is 501. The Z value is -1.406



and not significant, so that the first difference of the time series is suitable for the analysis. The mean for the recession period is 647. The Z value for the entire time series is not significant ( $Z=-2.077$ ).

This result is consistent with those of the residual analysis of the same time series. There is no significant evidence for less growth in the number of new titles published during the recession period in comparison to the preceding boom period.

[ADD IN FIGURES 5a AND b AND TABLE 5]

## **7. Discussion of findings**

The analysis above finds no significant impact of digital copying and a severe recession between 1999 and 2006 on the number of new titles supplied in the German market for sound recordings. Eight years into the recession, the number of new titles supplied continues to expand. What is more, there is no evidence that the rate of growth of the number of new titles released to the market would have declined in the presence of digital copying.

This is a surprising result regarding the widespread concern that digital copying would disrupt supply, as well as the severity and duration of a recession period that coincides with the diffusion of digital copying technology. A recession that lasts for eight consecutive years and that reduces industry revenues in the primary market by 41% constitutes a strong impulse. It should be associated with a significant diminution of supply unless there are strong countervailing factors.

What is more, there are reasons to believe that the data underestimates the variety of works supplied during later recession years. The data addresses titles supplied on physical

sound carriers – CDs for recent years – so that any publications marketed only as downloads via the Internet or mobile telephony networks are not captured. This might create a downward bias for recent years, which would have made it more likely for the analysis to indicate less variety of supply during the recession period.

Many challenges to this investigation relate to data limitations.<sup>xvi</sup> First of all, the analysis is based on a modest number of annual data points. That restricts the choice of applicable statistical methods and the statistical power of the tests employed. At the same time, the annual nature of the data means that a long time period is covered. Any interpretation of statistical results has to remain sensitive to multiple ‘effects of history’. It is also imaginable that the full impact of the current recession has not yet transpired. It was not possible to include data after 2006, since the BV Phono ceased to report figures for ‘new titles’ and ‘overall supply’ with that year.<sup>xvii</sup>

Second, as a natural experiment, the investigation is compromised by the absence of a control group or second baseline. Since digital copying is a pervasive and ongoing phenomenon, no suitable data for these types of control functions are available.

Third, credible data on the supply of sound recordings is hard to come by and for this study it was not available from other territories or from markets for other types of copyright works that are subject to digital copying. Further research on the effect of unauthorized copying on the supply of copyright works is desirable.<sup>xviii</sup>

Last but not least, the time series analysis includes no systematic attempt to control for intervening factors. The findings do not necessarily invalidate the notion that there would be a positive link between suppliers’ revenues and the variety of supply. They are also consistent with the presence of strong, intervening factors that promote the supply of sound recordings during the recession, overlapping with any adverse effects of falling revenues to suppliers in the primary market. In theory, broader technological change in the course of ‘digitization’

could be associated with a diminution of fixed costs per product variant or additional income to rights holders from related markets.<sup>xix</sup> It has also been argued that aspects of the copyright system prior to the diffusion of digital copying technology restricted the variety of supply, for example because it was associated with barriers to entry or because it inhibited user innovation (Boldrin and Levine 2002). Furthermore, creativity may be intrinsically motivated (Frey 1997; Caves 2000) so that any adverse effect of unauthorized copying on rights holder revenues might have little impact on creative supply.

## **8. Conclusions**

In spite of extensive unauthorized copying and a severe recession in the German market for sound recordings after 1998, there is no evidence that the supply of copyrighted sound recordings would have grown less rapidly than before.

This finding may be counterintuitive. It is also consistent with a limited number of earlier studies on (other types of) changes in copyright strength and their effect on the supply of creative works. None of these studies established a significant effect of copyright on the supply of creative works or on the number of suppliers (for example Landes and Posner 2003; Khan 2004; Png and Wang 2009).

Digitization very probably requires a review of copyright arrangements. However, it may be misleading to base copyright policy on the assumption that there is a strong, positive relationship between excludability and the variety of supply under current market conditions.<sup>xx</sup> Further empirical research on this matter is needed. Studies on the impact of unauthorized copying on creative supply should complement the debate on any effects on rights holder revenues.

Furthermore, product variety has expanded rapidly in the German market for sound recordings throughout the last decades. In order to isolate the effects of unauthorized copying under such circumstances, it seems necessary to take account of broader technological change that coincides with the diffusion of digital copying technology.

**Figures**

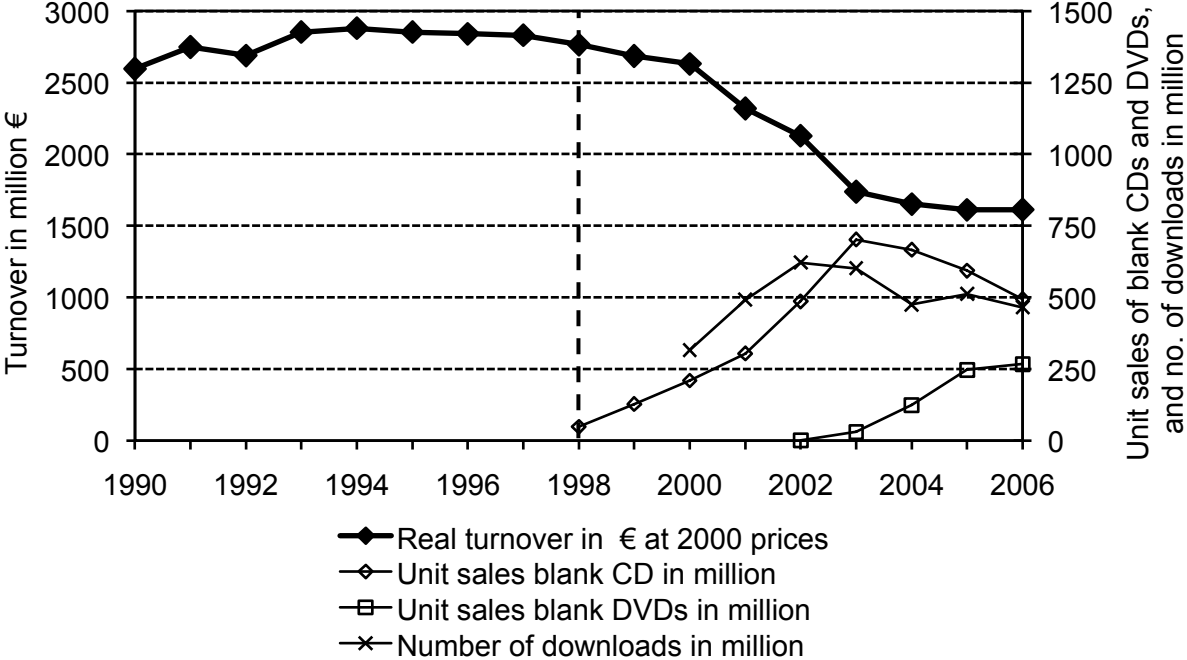


FIGURE 1.– Real turnover in the German market for sound recordings and the diffusion of digital copying technology  
Sources.– BV Phono, 1995; 2005; 2006; 2007; GfK, 2002; 2004; 2006; 2007; DESTATIS.

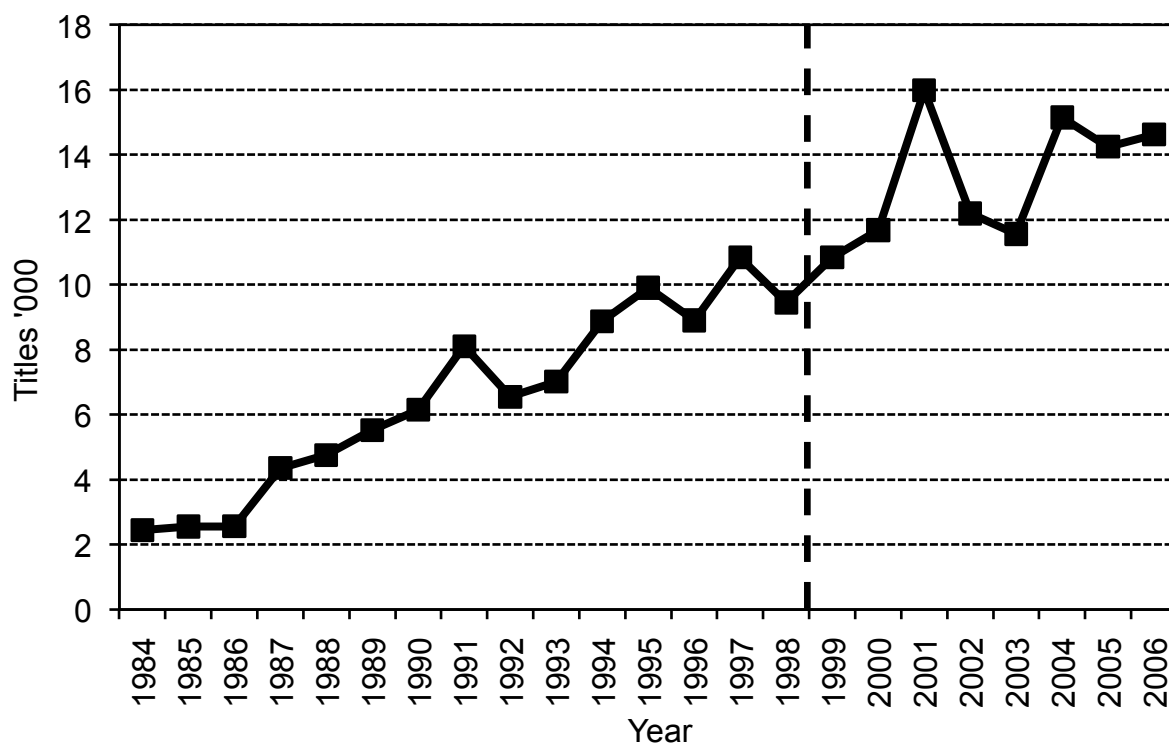


FIGURE 2.– Time-plot of the number of ‘new titles’ released annually  
 Source.– BV Phono, various issues.

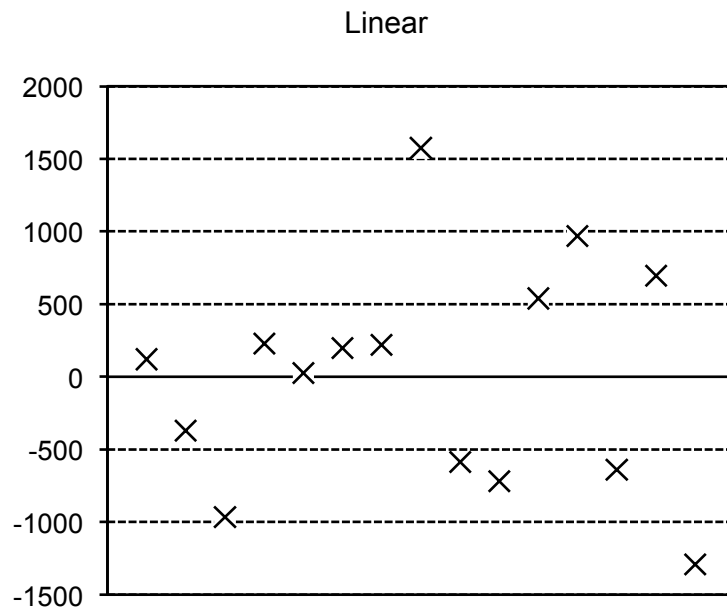


FIGURE 3.– Residual plot for the linear regression model of ‘new titles’ during boom period

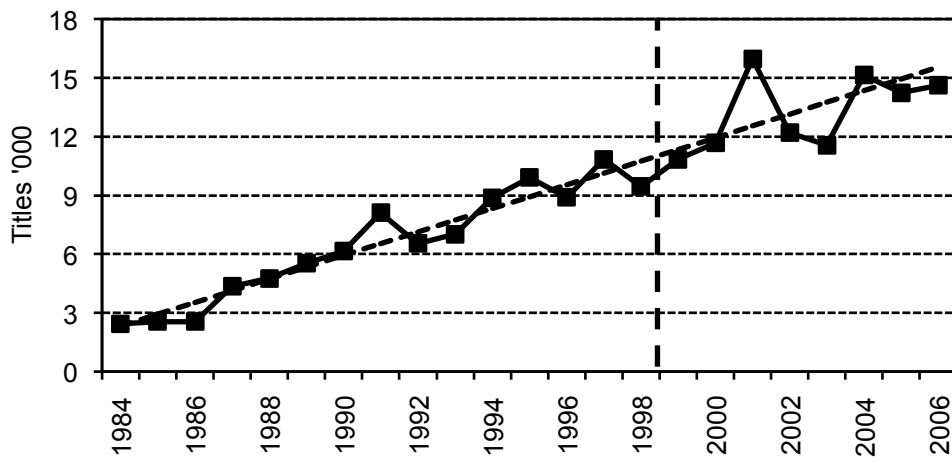


FIGURE 4a.– Documentation of the linear model for ‘new titles’ / Observations and linear model predictions



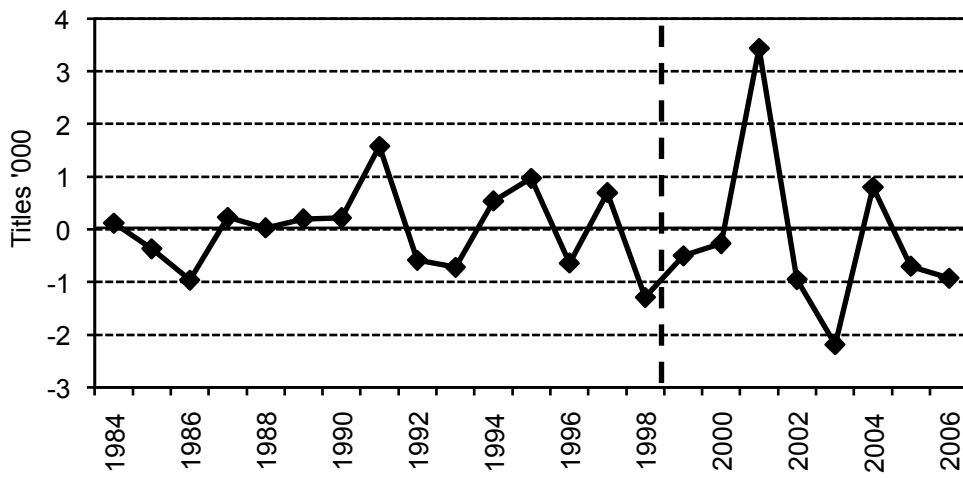


FIGURE 4b.— Documentation of the linear model for ‘new titles’ / Residuals for the linear model enlarged

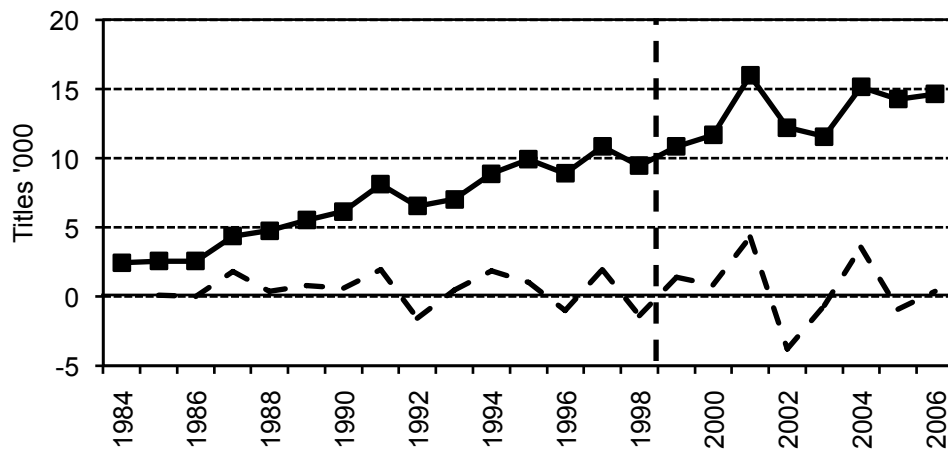


FIGURE 5a.— Documentation of first difference scores for ‘new titles’ / Observations and their first difference scores ( $\Delta^1y$ )

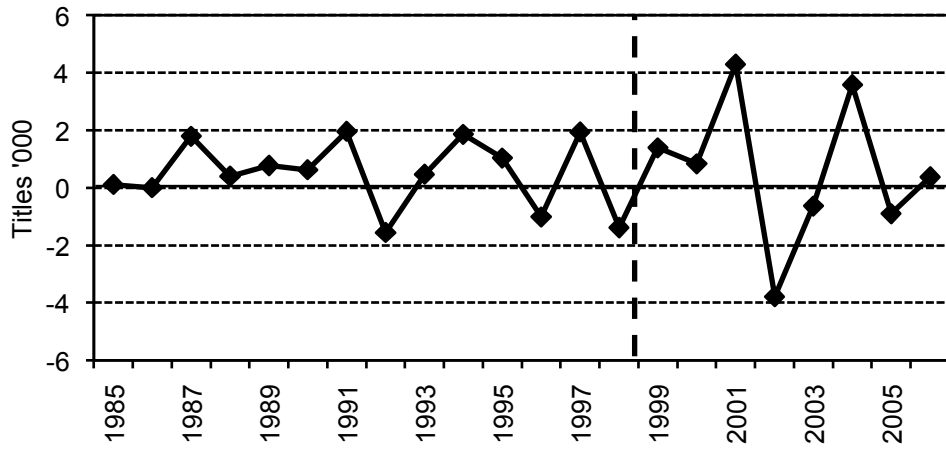


FIGURE 5b.– Documentation of first difference scores for ‘new titles’ / First difference scores enlarged

**TABLE 1****REAL TURNOVER IN THE GERMAN MARKET FOR SOUND RECORDINGS AND  
THE DIFFUSION OF DIGITAL COPYING TECHNOLOGY**

Year	Real turnover (million € at 2000 prices)	Unit sales blank CDs in million	Unit sales blank DVDs in million	Number of Downloads in million
1990	2,596	--	--	--
1991	2,748	--	--	--
1992	2,689	--	--	--
1993	2,852	--	--	--
1994	2,879	--	--	--
1995	2,853	--	--	--
1996	2,841	--	--	--
1997	2,830	--	--	--
1998	2,764	49	--	--
1999	2,686	128	--	--
2000	2,630	210	--	316
2001	2,319	304	--	492
2002	2,129	486	1	622
2003	1,738	702	30	602
2004	1,651	666	124	475
2005	1,612	594	247	512
2006	1,614	494	267	465

SOURCES.– BV Phono, 1995; 2005; 2006; 2007; GfK, 2002; 2004; 2006; 2007; DESTATIS.

NOTE.– Scores for the year 2000 in Columns 3 to 5 capture the period between April 2000 and March 2001.

**TABLE 2****OLS REGRESSION RESULTS FOR 'NEW TITLES' DURING THE BOOM PERIOD**

Equation	Model Summary					Parameter Estimates			
	R <sup>2</sup>	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	.924	157.450	1	13	.000	1,722.371	601.279	--	--
Logarithmic	.848	72.704	1	13	.000	403.361	3,295.376	--	--
Inverse	.543	15.456	1	13	.002	8,387.707	-8,385.981	--	--
Quadratic	.933	83.261	2	12	.000	1,019.470	849.361	-15.505	--
Cubic	.937	54.410	3	11	.000	1,703.706	406.061	51.577	-2.795
Compound	.883	98.059	1	13	.000	2,485.512	1.113	--	--
Power	.913	136.293	1	13	.000	1,836.978	.624	--	--
S	.659	25.133	1	13	.000	9.050	-1.687	--	--
Growth	.883	98.059	1	13	.000	7.818	.107	--	--
Exponential	.883	98.059	1	13	.000	2,485.512	.107	--	--
Logistic	.883	98.059	1	13	.000	.000	.898	--	--

NOTE.- t=1 in 1984.

**TABLE 3**

F TEST TO COMPARE THE FIT OF THE MODELS OF 'NEW TITLES'

Equation	df	SS(X)	F ratio	P
Linear	13	8,358,148	Linear-quadratic 1.62	.21
Quadratic	12	7,366,375	Quadratic-cubic .71	.72
Cubic	11	6,918,851	Linear-cubic 1.14	.42

**TABLE 4**

INTERVENTION ANALYSIS FOR 'NEW TITLES', BASED ON LINEAR OLS REGRESSION FOR THE BOOM PERIOD

	Year	Score <i>y</i>	Model predic- tion <i>e</i> <sup>(a)</sup>	$\hat{\epsilon}$ $= y_t - e_t$		
Boom (pre- period)	1984	2,444	2,324	120	Boom period:	
	1985	2,555	2,925	-370	$D^2 = 18,714,396$	
	1986	2,561	3,526	-965		
	1987	4,356	4,127	229	$2SS_{\hat{\epsilon}} = 16,716,296$	
	1988	4,755	4,729	26	( $\bar{\epsilon}$ for the boom	
	1989	5,528	5,330	198	period is 0)	
	1990	6,151	5,931	220	Boom period and	
	1991	8,108	6,533	1,575	recession period:	
	1992	6,548	7,134	-586	$D^2 = 65,074,504$	
	1993	7,015	7,735	-720	$C = -0.1195$	
	1994	8,876	8,336	540	$Sc = 0.2409$	
	1995	9,907	8,938	969	$2SS_{\hat{\epsilon}} = 56,171,208$	
	1996	8,898	9,539	-641	( $\bar{\epsilon}$ for the recession	
1997	10,836	10,140	696	period is -163.1)		
Recession (post- period)	1998	9,451	10,742	-1,291	$C = -0.1585$	
	1999	10,840	11,343	-503	$Sc = 0.1994$	
	2000	11,678	11,944	-266		
	2001	15,980	12,545	3,435	$Z = -0.7947$	
	2002	12,194	13,147	-953	not significant	
	2003	11,561	13,748	-2,187		
	2004	15,148	14,349	799		
	2005	14,249	14,951	-702		
	2006	14,624	15,552	-928		

NOTE.— The linear OLS regression model for 'new titles' during the pre-period ( $t=1$  in 1984) is  $y=601.28t+1722.4$ . For the Z statistic, the critical value at 15 observations and the .05 level of significance is 1.6493, and for the .01 level of significance it is 2.2369. The critical value at 23 observations for the .05 level of significance is 1.6485, and for the .01 level of significance it is 2.2676 (Young, 1941).

**TABLE 5**

INTERVENTION ANALYSIS FOR 'NEW TITLES', BASED ON FIRST DIFFERENCE

	Year	Score Y	1st difference $\Delta^1y$		
Boom (pre- period)	1984	2,444	--	Boom period:	
	1985	2,555	111		
	1986	2,561	6	$D^2 = 50,101,186$	
	1987	4,356	1,795	$2SS(\Delta^1y) = 37,144,415$	Boom period and recession period:
	1988	4,755	399		
	1989	5,528	773		
	1990	6,151	623	the boom period is	
	1991	8,108	1,957	500)	$D^2 = 185,011,984$
	1992	6,548	-1,560		
	1993	7,015	467	$C = -0.3488$	$2SS(\Delta^1y) = 130,049,138$
	1994	8,876	1,861	$Sc = 0.2481$	(mean for $\Delta^1y$ during the recession period is 584)
	1995	9,907	1,031		
	1996	8,898	-1,009	$Z = -1.4061$ not significant	$C = -0.4226$
	1997	10,836	1,938		
1998	9,451	-1,385			
Recession (post- period)	1999	10,840	1,389		$Sc = 0.2035$
	2000	11,678	838		
	2001	15,980	4,302		$Z = -2.0769$
	2002	12,194	-3,786		Not significant
	2003	11,561	-633		
	2004	15,148	3587		
	2005	14,249	-899		
	2006	14,624	375		

NOTE.— For the Z statistic, the critical value at 14 observations and the .05 level of significance is 1.6494, and for the .01 level of significance it is 2.2310. The critical value at 22 observations for the .05 level of significance is 1.6486, and for the .01 level of significance it is 2.2647 (Young, 1941).



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## Footnotes

<sup>i</sup> As reported on the website of the Music Media Entertainment Group (2010).

<sup>ii</sup> Quote translated from the original statement in German: “Jeder Urheberrechtsbruch muss klar verfolgt werden, sonst verlieren wir kulturelle Vielfalt und Märkte.” (Krempf 2009).

<sup>iii</sup> Varian (2005) provides an overview of a number of business models that may sustain rights holder profits in the presence of unauthorised copying.

<sup>iv</sup> If we ignore the possibility of divergent interests among different types of rights holders or among different types of users, an efficient level of copyright protection could thus provide a Pareto improvement.

<sup>v</sup> The long run is defined here as a period of time in which suppliers fully adapt their output of copyright works to unauthorized copying. The case for copyright policy further depends on any short-run benefits to copiers, and on the efficiency of copyright as a countermeasure to unauthorized copying (Bhattacharjee et al. 2006).

<sup>vi</sup> The BV Phono merged into the ‘Bundesverband der Musikindustrie’ in 2008.

<sup>vii</sup> This data also serves as the foundation for the German contribution to the widely used statistics published by the International Federation of the Phonographic Industry (IFPI).

<sup>viii</sup> BV Phono turnover data combines data collected by the association, extrapolations from representative consumer studies and data assembled from retailers. According to BV Phono management, turnover figures collected by the association itself are based on voluntary reports of about thirty of the largest distributors (wholesalers) of phonograms. Until recently, the BV Phono published reports according to which their data covered between 80 and 95% of the market in terms of turnover for any given year. As distributors tend to cooperate with a number of record companies, BV Phono figures probably incorporate a number of titles published by record companies that are not BV Phono / IFPI Germany members. To assess the size of the market not covered by distributors’ reports, the BV Phono falls back on extrapolations from representative consumer studies by the market research firms GfK and Media Control. In this paper, the aggregate figure that estimates the overall size of the market is used.

<sup>ix</sup> There is a slight reservation regarding this 2% threshold. In the yearbook 2006, real falls in 2000 are given at 1.8%. In previous yearbooks (BV Phono 2004; 2005), the figure was 2.2%. Such discrepancies are likely to be the result of revaluations according to changes in the member firms.

<sup>x</sup> All following tests were also run with 1998 re-classified as a recession year. This reclassification did not alter the general result for any test. These calculations can also be regarded as a (limited) robustness test.

<sup>xi</sup> Handke (2006) illustrates a great number of market entries by small record companies that occurred in Germany after 1998.

<sup>xii</sup> The share of compilations fell from 29.4% in the year 2000 to 19.3% in 2007. If this illustrates a consistent trend, this would bias the number of releases in earlier years upward and the growth in the measure of titles during the recession downwards.

<sup>xiii</sup> Since the BV Phono adapts its figures to changes in its membership with each issue, there are (mild) inconsistencies between figures for the same year in various issues. In counting titles, this study uses the figure for long-play titles on the dominant sound carrier format for the years 1984-1992 as reported in BV Phono (1994) and for the years 1993 to 1999 as reported in BV Phono (2000). For later years, the figure for 'albums' as reported in BV Phono (2007; 2008) is used. Concerning new titles in the genre of classical music, the greatest number of titles appeared on vinyl LPs until 1986. In 1987, the CD became predominant in the sense that most new releases were marketed on this format. For popular music, the music cassette (MC) preceded the CD as the predominant format. The number of new releases on CDs eclipsed that for MCs in 1988 for 'pop national' and in 1987 for 'pop international'.

<sup>xiv</sup> Young (1941) provides a list of significance levels for the Z statistic.

<sup>xv</sup> In the following, 'stationary' refers to a state in which there is no significant deviation from random variance according to the C statistic.

<sup>xvi</sup> The gradual nature of the intervention and a potential lag in its effect on the dependent variable has been discussed above.

<sup>xvii</sup> In addition, it could be a problem that the start and end of the time series are determined by data availability rather than theoretical considerations. However, it makes no difference for the basic direction of results if any number of earlier years of the pre-period are omitted. Note that it makes no sense to omit more than 7 pre-period years, since otherwise there are less data points than required for the statistical method at hand. No post-period data can be omitted, since the number of observations is equal to the minimum number of observations necessary.

<sup>xviii</sup> In addition to further intervention studies on time series that capture developments in other markets, panel studies that combine data from several markets would be a way to establish the generalizability of results. However, panel studies are unlikely to resolve the problem with estimating the long-term effect of unauthorized, digital copying. That is because the diffusion of digital copying technology (especially file-sharing) occurred roughly simultaneously in all major markets.

<sup>xix</sup> For discussions of digitization and product variety, see Brynjolfsson and Smith (2000) and Anderson (2004). Additional income due to technological change would be roughly consistent with advanced contributions to the economics of copyright that deal with indirect appropriability (Liebowitz 1985), various business models (Varian 2005) and network effects (Takeyama 1994).

<sup>xx</sup> To be sure, the diversity of supply and its welfare consequences are complex issues. A diverse supply of cultural products is usually considered to be highly desirable. Variety as the sheer number of product variants may be a crude measure of diversity, however (e.g. Weitzman 1992; Stirling 1998; van der Wurff and van Cuilenberg 2001; Benhamou and Peltier 2007). What is more, standard economic analysis implies that greater product variety is not always desirable, and under monopolistic competition, markets cannot be relied upon to always approximate efficient levels of product differentiation (e.g. Mankiw and Whinston 1986; Lancaster 1990).