Applying Hedonics in Practice: Analysis of US and UK methods for Flat Panel Televisions

Peter Moran, Office for National Statistics

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1. Introduction

1.1 Outline

A research project on implementing Flat Panel Televisions into the UK CPI using hedonically adjusted indices began in January 2005. The outcome of the investigation was that there was not a significant enough difference between the hedonic index and the standard imputed base price index to warrant the use of hedonics. This paper analyses the effect of using BLS methodology and variable selection on the UK datasets.

When comparing the UK and US procedures it was clear that the choice of methodology can have an impact on whether items should be priced with hedonic adjustment. Had we been using the US methodology in our CPI Flat Panel Index for 2005 it is highly likely that the recommendation would have been to introduce with quality adjustment due to the differences between the Imputed Base Price (IBP) and Hedonic indices. Whether we would have been right to do so is another question. Because the US method uses fewer attributes it produces a more volatile index which may require longer research periods.

1.2 The use of hedonically adjusted indices in the UK CPI

The UK CPI has used hedonically adjusted indices since 2003. The focus of hedonic adjustment is on hi-tech goods. The CPI currently employs the methodology on PCs, Laptops, Digital Cameras and Mobile Phone Handsets.

Hedonically adjusted indices are used where it has been proved that there is sufficient difference between a standard imputed base price index and a hedonic index due to the high turnover of goods. This problem is particularly prevalent in hi-tech goods where it is difficult to price one item through a 12-month period, but hedonic methods have also been successfully applied to clothing, where there is a large seasonal turnover.

A particular item is priced in the base period and for the subsequent months that it is available. If an item is no longer available, a new item is selected and an estimated base period price is calculated for this, based on the regression model. The hedonic function estimates the importance of characteristics in the model and adjusts the base period prices according to the characteristics a model contains.

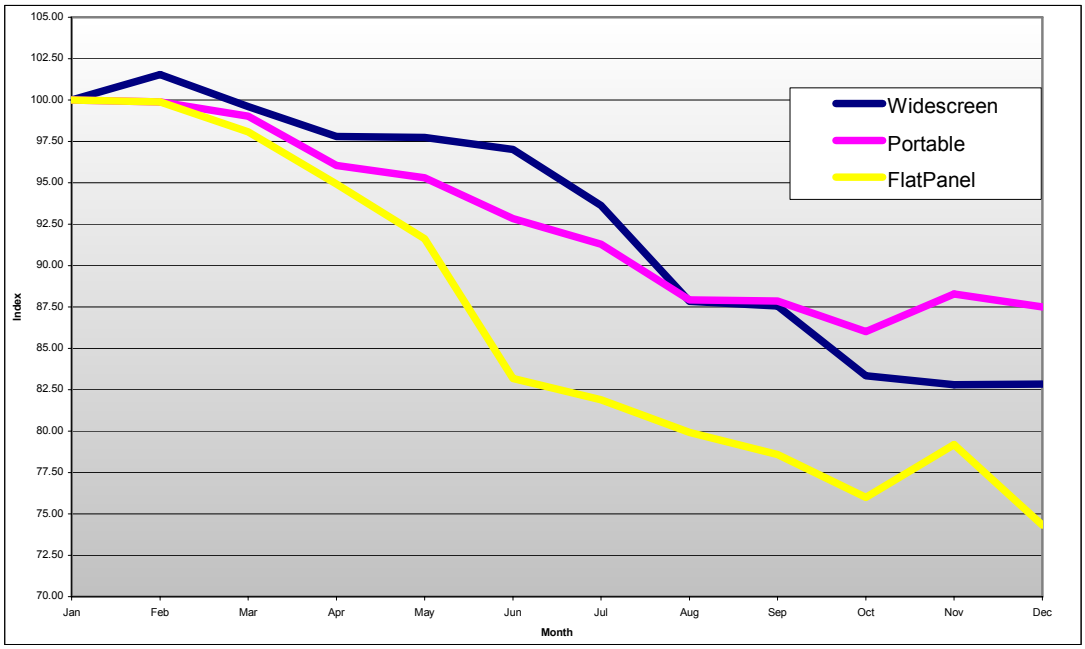
A model is updated when the difference between the actual price and expected price falls outside a pre-determined confidence interval. When this occurs, a complete product list is taken from each outlet in the sample and is used to create a dataset.
It is important to keep the model up to date as, particularly in hi-tech goods, the market changes so quickly that an attribute deemed significant at the beginning of the year can become the norm within a 12 month period.

2. Hedonic Methods for Flat Panel Televisions

2.1 Differences between the US and UK methodologies for TV's

The UK CPI calculates separate indices for Portable TV's, Widescreen TV's and Flat Panel TV's. Analysis on the movement of CPI indices over the course of 2005 indicates that although prices are falling on all types of TV, there is significant difference between the three, as shown in chart 1.

Chart 1 – An analysis of indices in the UK CPI 2005



All three varieties have sufficient expenditure to warrant inclusion as a separate item. It is felt that there are enough significant differences between each of the three types to justify a separate index for each. The most important difference would be in screen size, where although LCD's cover all sizes, portable, widescreen and plasma have a limited number of screen sizes.

Furthermore, the characteristics for each type can vary. For example, Portable TV's are more likely to have built in extras and tend not to have a widescreen option. The depth of a TV screen has increased importance with the introduction of the flat panel.

In the UK model, brands are listed individually so each brand has its own unique coefficient whilst the BLS group their brands together. The BLS method allows the collector greater choices in selecting a replacement item without making too much impact on the predicted price, assuming other characteristics are similar.

There is no use of outlet coefficients in the BLS model. They were used in the UK version as Internet retailers hold a significant share of the market and their pricing strategies differ to those on the high street.

3. Analysis

3.1 Analysis of 2005 Flat Panel market using CPI procedures

An exhaustive list of variables was chosen in January 2005 but was reduced as websites and magazines used to collect attribute data were not consistent with the level of detail. The variables that were selected could be matched across all models.

Table 1 - Analysis of UK Regression models 2005

		January		April		June	
	Variable	**Coeff Est.**	**Std. Error**	**Coeff Est.**	**Std. Error**	**Coeff Est.**	**Std. Error**
Basics	Intercept	4.24438	0.12449	2.97798	0.18404	3.42042	0.1583
	Screen Size	0.07319	0.00228	0.07255	0.00193	0.06558	0.00174
	LCD	0.35721	0.04236	0.5084	0.04727	0.2393	0.03391
	WS	0.18467	0.02805	******	******	******	******
	Brightness	-0.0001231	0.0000594	0.00022519	0.00007615	******	******
	Contrast	0.00005101	0.0000163	0.00005155	0.00001696	******	******
	Viewing Angle	******	******	0.00451	0.00097457	0.00424	0.00091315
	Vertical_Res	0.00055176	0.00007695	0.00049873	0.0000762	0.00056451	0.00005791
Shops	Argos	******	******	0.15355	0.04152	0.17874	0.0392
	Bennetts	******	******	******	******	0.07734	0.03521
	Powerhouse	******	******	0.16604	0.06297	0.1085	0.05386
	ElectricShop	******	******	0.10861	0.02417	0.05316	0.02603
	RicherSounds	-0.30509	0.09393	******	******	******	******
	EmpireDirect	-0.11572	0.0221	******	******	-0.10811	0.02287
	Index	******	******	0.27077	0.06484	0.18325	0.03959
	MillerBrothers	0.14464	0.02185	0.20594	0.02519	0.19384	0.04083
	JohnLewis	0.16334	0.02392	0.21822	0.02684	0.12795	0.03006
Brands	Beko	-0.23186	0.07522	******	******	-0.30682	0.07887
	DMTech	-0.32769	0.09793	******	******	******	******
	Fujitsu	******	******	0.21769	0.08419	0.27536	0.10398
	Goodmans	-0.37863	0.08127	-0.29637	0.10076	-0.28705	0.08454
	Hitachi	-0.16073	0.05795	******	******	******	******
	JVC	******	******	0.17852	0.03548	******	******
	LG	-0.10874	0.03737	******	******	******	******
	Loewe	0.33127	0.08788	0.53928	0.09598	0.30243	0.08852
	Panasonic	******	******	0.20347	0.03684	0.10699	0.0323
	Philips	******	******	0.29632	0.03861	0.2635	0.02616
	Pioneer	******	******	0.18804	0.07006	0.4036	0.06507
	Samsung	-0.07723	0.03452	-0.08351	0.04109	******	******
	Sharp	******	******	0.14802	0.05086	******	******
	Sony	0.1864	0.03749	0.33576	0.03579	0.18729	0.02926
	Thomson	******	******	******	******	0.51111	0.16515
	Toshiba	******	******	******	******	-0.12808	0.04279
Sound	Total Watts	-0.00399	0.0017	******	******	******	******
	Dolby	0.12544	0.02317	0.07116	0.03236	******	******
	BBE	-0.06948	0.02932	******	******	******	******
	Trubass	0.22638	0.051	0.16141	0.04788	******	******
	A2	0.16231	0.02965	0.20293	0.03386	0.11104	0.03196
	WOW	******	******	0.20452	0.0589	******	******
Sockets	Scarts	0.04794	0.01496	0.04452	0.01559	0.06618	0.01508
	Headphone Socket	-0.09117	0.03364	******	******	******	******
	S-Video	******	******	-0.19445	0.0511	-0.09244	0.03382
	PC Input	-0.13749	0.02371	******	******	******	******
Extras	Digital Freeview	0.14715	0.02157	0.20584	0.0256	0.1991	0.02558
	SECAM	-0.077	0.02118	******	******	-0.06874	0.02248
	NTSC	0.16261	0.02704	0.1281	0.02421	0.10566	0.02322
	Depth	-0.00064941	0.00014608	******	******	0.00055068	0.00015404
	PIP	******	******	******	******	0.09166	0.0191
	Comb Filter	0.09588	0.02445	******	******	******	******
	Sleep Timer	-0.10652	0.03682	-0.08931	0.03248	-0.11808	0.0314

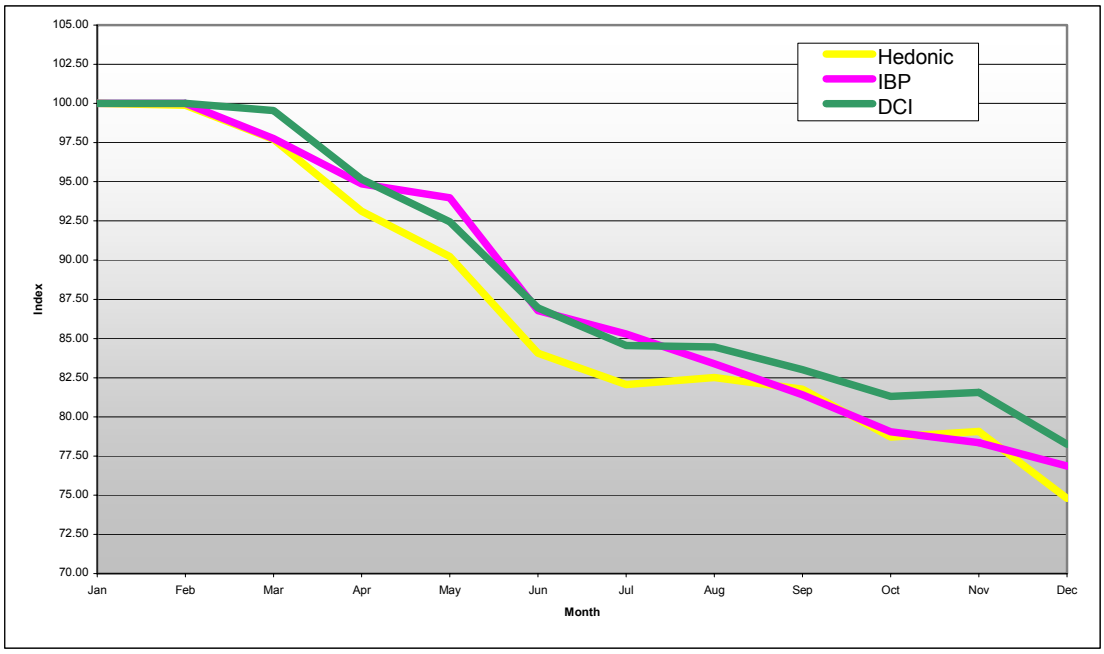
	N	Adjusted R^2
January Model	421	0.9533
April Model	440	0.9464
June Model	484	0.9465

All models produced a good adjusted R^2 value.

Based on the regressions models calculated above, an index was calculated throughout 2005. The regression model was updated when the difference between actual and estimated prices breeched their confidence limits.

IBP is an index based on our standard method of imputing a base price.
DCI is a direct comparison index, which compares only price and uses no imputation procedure.

Chart 2 – A Flat Panel TV index using UK variables



The chart proves that there is very little difference between all three indices. Applying hedonics uses a lot more resources than standard methodology and as there is no significant difference between the IBP index and the hedonics index, it was deemed unnecessary to price Flat Panel TV's using hedonic quality adjustment.

3.2 Analysis of 2005 Flat Panel market using BLS procedures

To convert the UK dataset into one suitable for analysis by the BLS model, we took the three datasets from January, April and June 2005 and adapted the variables to fit the BLS system.

Brands are grouped into 4 variables with the top brands being assigned to group 4, working down to the budget brands in group 1. Sony is given a group of its own.

There are a number of distinct brands operating in the US and UK markets so it was impossible to draw a direct match between the two.
To split the UK brands into groups, an initial regression was carried out for each of the three datasets using brands only. They were then grouped by analysing their coefficients throughout the year.

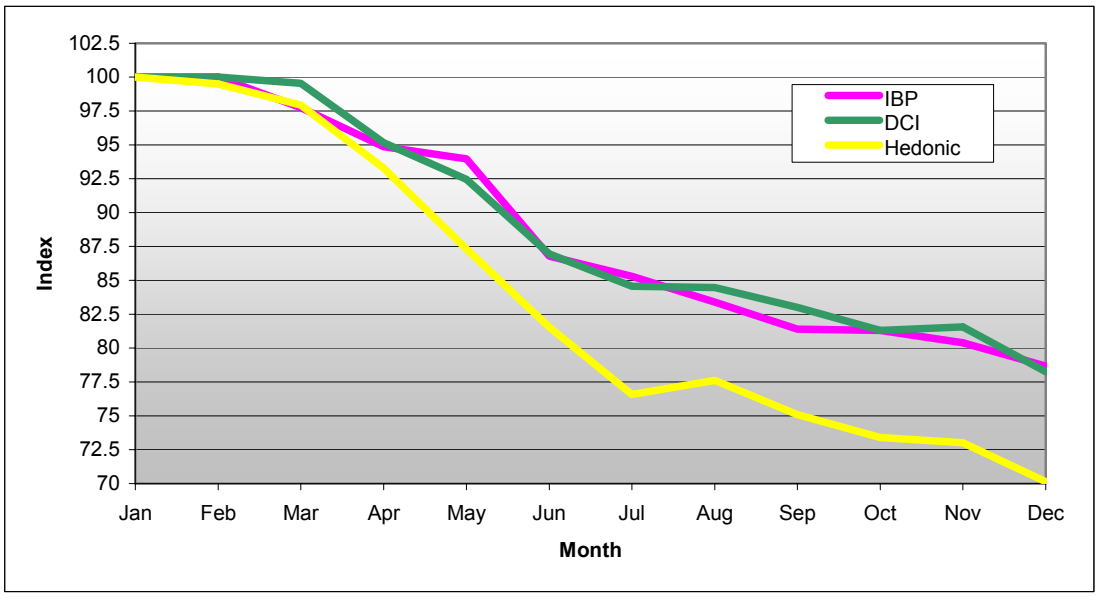
Group 1	Group 2	Group 3	Group 4
DMTech	Humax	Philips	Loewe
Goodmans	LG	Pioneer	Panasonic
Hitachi	Sanyo	Sharp	JVC
Samsung	Toshiba	Thomson	
Beko		Fujitsu	

Table 2 – Analysis of BLS variables for 2005

	January		April		June	
Variable	**Coeff Est.**	**Std. Error**	**Coeff Est.**	**Std. Error**	**Coeff Est.**	**Std. Error**
Intercept	**0.34349**	0.17859	**0.46727**	0.16816	**0.67682**	0.20136
Log_Screen_Size	**1.9098**	0.04804	**1.88689**	0.04599	**1.7922**	0.05163
Log_LCD_Size	**0.04112**	0.01119	**0.04794**	0.01076	*****	*****
Widescreen	*****	*****	**0.09953**	0.03341	**0.12415**	0.03488
LCD	*****	*****	*****	*****	**0.08218**	0.03607
Stereo	*****	*****	**0.11893**	0.03614	*****	*****
Console	*****	*****	*****	*****	**0.11049**	0.04788
PIP	*****	*****	*****	*****	**0.04456**	0.02208
S_Video	**-0.35309**	0.16726	**-0.22965**	0.06511	*****	*****
Video_Inputs	**0.41971**	0.17708	*****	*****	**-0.18611**	0.0833
Component	*****	*****	*****	*****	**0.12246**	0.02546
Brand_Group3	**0.13415**	0.02955	**0.21408**	0.02937	**0.12935**	0.0287
Brand_Group4	**0.29627**	0.03274	**0.26781**	0.03158	**0.12531**	0.0298
Sony	**0.30939**	0.03516	**0.45689**	0.03709	**0.29816**	0.03465
CombFilter	**0.13036**	0.03162	*****	*****	**0.08949**	0.0293
HDTV_Ready	**0.15959**	0.03551	*****	*****	*****	*****

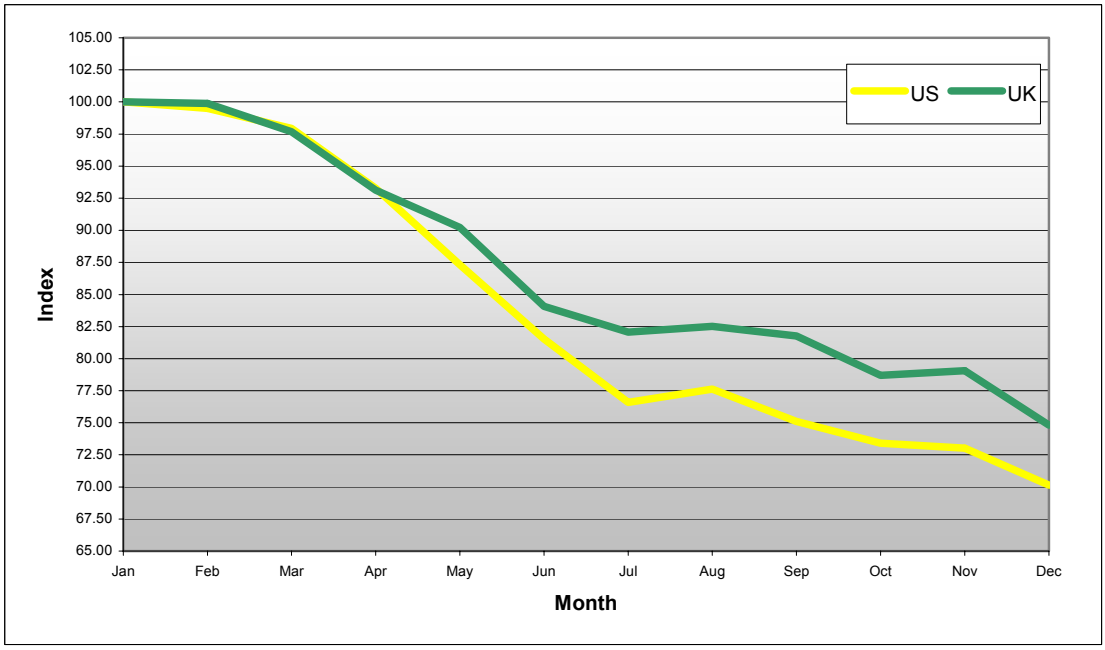
The hedonic models calculated above produced the following index, updated at the same times as the UK version.

Chart 3 – A Flat Panel TV index using US variables



The BLS method illustrates a substantial difference between the hedonic function index and the imputed base price index.

Chart 4 – Comparing the US and UK hedonic indices for 2005



The most striking difference between the two indices is the 5 point difference in the hedonic index by the end of the year which leads me to question of which, if any, of the functional forms provided the most "steady" index.

3.3 The effect of using different functional forms

For the purposes of this investigation, I reverted back to using the UK variables and data.

The BLS method uses a Double Log method, which calculates the log of the dependent variable (price) and also the log of all continuous variables (in this case, screen size and LCD size) as shown below:

Double-Log $lnP = a_0 + a_1 ln(screen\ size) + a_2 ln(lcd\ size) + a_3(widescreen) + \ldots\ldots$

The method used in calculating the UK Flat Panel regression models is a semi-log regression, which only calculates the log of the dependent variable, price.

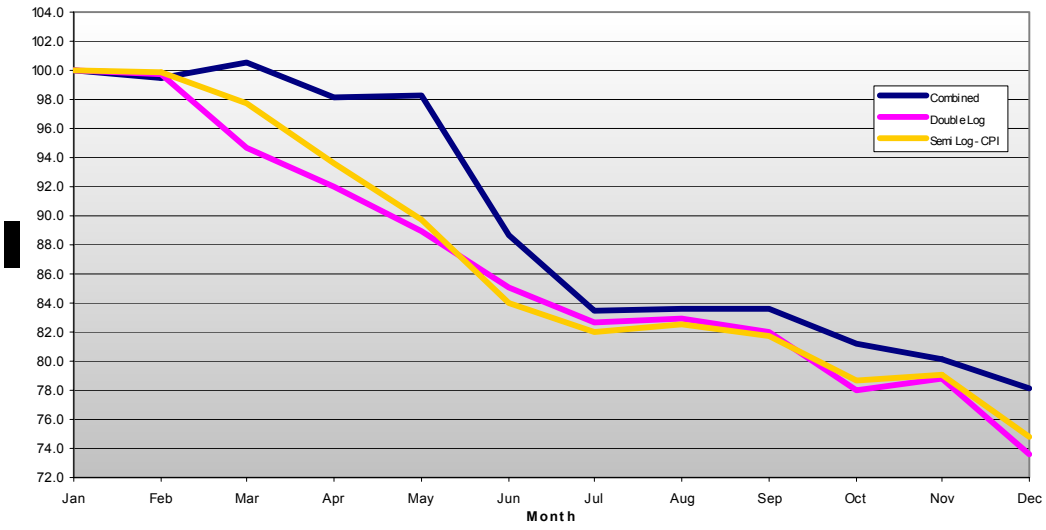
Semi-Log $lnP = a_0 + a_1(screen\ size) + a_2(widescreen) + \ldots\ldots\ldots$

Another possible model uses a combined method, which is used to reduce collinearity between variables. If two variables are intrinsically linked, for example, Horizontal and Vertical Resolution, they can be combined to create one variable.

Combined Method $= a_0 + a_1(screen/weight) + a_2(hor\text{-}res * ver\text{-}res) + \ldots\ldots$

The linear model was not deemed suitable as variable coefficient were excessively large. I applied the three functional forms described above to the UK datasets for January, April and May and they gave me the following results.

Chart 5 – Functional Form Analysis carried out on UK CPI Flat TV's



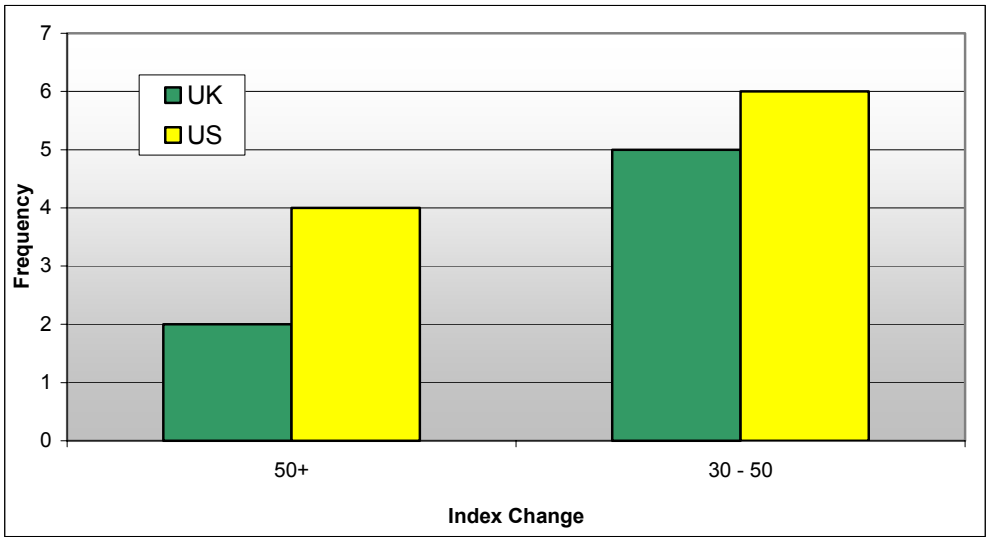
The results of the investigation showed that the functional form that one uses does not make a significant difference to the index.

However, the double log method does give the lowest index which would provide support to the fact that the US method of calculating an index would produce a lower index than

the UK method. This only accounts for a small fraction of the difference and another consideration could be the number of variables used. As can be seen from tables 2 and 4, there are fewer variables used in the US calculations. Only 16 variables are deemed significant over the course of the year compared with over 50 in the UK. This is largely down to grouping brands and not using outlet coefficients.

It can be inferred that by using fewer variables you are going to develop a more volatile index as, if you have more variables there are more likely to counteract any sharp changes in others. This is not the case when variables are grouped together. For instance, brands being grouped together ought to provide a smoother index as it allows for substitution between brands. An analysis into the variability of the indices shows that the US model is more volatile than the UK version. The index has risen or fallen by more than 30 points on 7 occasions the UK model, whereas the US model has 10 such occurrences.

Chart 6 – Large Index changes in the US and UK model indices



The largest fall for a US model occurred when the index fell by more than 50% between July and August. There was a partial brand effect, through switching from Philips to Sony but there was also a significant fall because there was no component input on the new model. The effect was reduced in the UK model as there were a number of other attribute changes that were making a contribution, thus reducing the importance attached to one particular variable.

The two largest changes on the UK index both occurred due to a change in brand, when switching from Philips to Samsung, and back again.

There were a number of examples of brand change in the US model where the coefficients remained the same, ensuring a smoother transition between brands:

Samsung – LG
Loewe – JVC
Panasonic – JVC
Sanyo – Hitachi
Hitachi – LG

These changes would all have created an effect in the UK model.

4. Conclusions

The analysis of functional forms showed that there was little difference between applying double log, semi log and a combined method to the UK dataset. Using the double-log method on both the UK and US datasets produced a 4point difference in the index by December. Having used the same hedonic method and the same functional form, this infers that the US index is falling at a quicker rate due to the number of variables it uses in its regression models. These variables produced a more volatile index as proven by chart 6, despite allowing for greater substitution between brands.

There are a number of areas in which further investigation could prove beneficial for the UK index, particularly the brands effect. The volatility in the UK index was mainly as a result of a switch between brands, which would suggest that adopting the method of grouping brands could help provide a smoother index. Some indices that use Probability Proportional to Size sampling (PPS) in the UK CPI group brands together into high, medium and low. This could easily be transferred to the hedonic models by running an initial regression based on only brand and price before grouping brands based on their coefficients.