Diffusion of original and counterfeit products in a developing country

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Econometric Institute Report 2010-08

Abstract

We study the diffusion of original and counterfeit products in three distinct categories in a developing country. The focus is on when their diffusion processes peak, how sales of original and counterfeit products are related and how marketing efforts can influence this process. Using a unique data set for Suriname (South America) on televisions, mobile phones and DVDs, we can support various predictions from theory and give recommendations for marketing management.

Key words: Diffusion; Counterfeits; Developing countries
JEL code: F10; O34

This version: February 9 2010
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1. Introduction

With an increase in global trade, currently involving almost all countries in the world (expect for a few autarkic ones), there is also a growing interest in studying various aspects of trade in counterfeit products. A recent survey in Staake et al. (2009) shows that counterfeit trade is sizeable, that it concerns all countries and that it is growing over time. One aspect that seems to have reached much attention recently concerns the motivations for consumers to purchase counterfeit products, in particular when they are aware that the products are indeed counterfeits, see Bian and Moutinho (2009), Tom et al. (1998) and Wilcox, Kim and Sen (2009). Interestingly, these studies all concern consumers in western countries (most notably the USA), and as such these studies address only one part of the story. Also, these studies often concern survey data and not factual purchases of counterfeit products.

Whereas consumers in western countries oftentimes can choose to purchase original or counterfeit products, in many developing countries consumers do not have much of a choice. Due to lack of budget, many consumers in those countries are forced to purchase counterfeit products even though they know that these products can be of lower quality (like televisions of DVDs) or even of harmful quality (pharmaceutical products). Hence, there is much literature on consumers buying counterfeit products, on the production of counterfeit products in certain countries and on the legal issues around counterfeiting. This literature seems to be confined uniquely to western countries and does not concern developing countries. A key reason for this might be that data for developing countries are not available and also that relevant legal measures may be absent in those countries.

In this paper we provide a first attempt to fill in this gap, and we study the diffusion of products in three categories for a developing country, in our case the South American country of Suriname. This country is a little over 163K squared kilometers and it has less than 500K inhabitants. Most of the country is heavily forested, and most citizens live in the coastal region, predominantly in Paramaribo, the country's capital city. Paramaribo has a large harbor, and most import and export goes via this harbor. Despite

an abundance of natural resources, income inequality in Suriname is very large. It is estimated that over 60% of its inhabitants are below the poverty line. On the other hand, there is a sizeable group of citizens that is rather wealthy. This means that there should be citizens who can afford to purchase original products if there are any, and also that there are many citizens who can only afford counterfeit products (as their prices are typically much lower).

In this paper we will collect and analyze annual imports data for products in three categories. These imports data are then classified as original or counterfeit products, according to a rule that gives the percentage of counterfeit products from various countries. Details will be given in the empirical section.

To guide our empirical analysis, we first put forward a few theoretical considerations on how the diffusion of original and counterfeit products may look like in a developing country, where financial resources of many consumers are scarce. The theory builds on the Norton and Bass (1987) model for the diffusion of sequences of products. We derive a few testable hypotheses from the theoretical considerations. An alternative approach that also builds on diffusion models is presented in Givon et al. (1995). These authors assume a Bass type diffusion model for the total diffusion of durable products and as such they estimate the size and diffusion pattern of counterfeit products. Our approach differs to the extent that we first estimate the diffusion of original and counterfeit products and then analyze the two resulting series.

In the empirical section we examine the validity of the proposed hypotheses for a unique data set concerning Suriname. This dataset concerns estimates of sales of televisions, mobile phones and DVDs, based on raw import figures obtained from the Foundation General Bureau of Statistics Suriname. Note that these types of data are generally not easy to obtain. Using a publicly available software piracy index, we create estimates of the total sales of original products and of counterfeit products.

Our main conclusions, which summarize those for each of the three categories, are that the diffusion pattern of original and counterfeit products is about the same, with the key difference that counterfeits are launched later and thereby also peak later. Hence, it is not the case that counterfeit products eventually take over and fully wipe out original products. A next striking result is that total sales of originals and of counterfeits are about

equal. Hence, it is again not the case that first a few originals are launched, and then counterfeits take over fully thereby shrinking originals sales towards zero.

Although our findings hold for only three categories for a single developing country, we believe that we can present a few implications for marketing management concerning optimizing sales level of original products in developing countries, and we do so in the last section of this paper.

2. Theory

In this section we derive a few testable hypotheses on how diffusion of original and counterfeit products could look like in a developing country. The basis for these hypotheses is the Norton and Bass (1987) model for generations of products, and in our case, a category of products. It is not the case that this model must also be fitted to actual data, but the theoretical model is used to shape our thoughts and to put forward some hypotheses.

2.1 Descriptions of diffusion

We start with a familiar S-shaped pattern for the diffusion of new durable products. The basic Bass (1969) model characterizes this S shape by the following functional form, that is

$$F(t) = \frac{1 - \exp(-(p+q)t)}{1 + \frac{q}{p}\exp(-(p+q)t)} \qquad (1)$$

where $t = 0,1,2,...,T$ with T the total amount of available observations, p is the so-called innovation parameter and q is the so-called imitation parameter. An example graph of the functional expression in (1) is given in Figure 1. The S-shape corresponds with total

(cumulative) sales, and the graph of the sales defined by $F(t) - F(t-1)$ is given in Figure 2.

Insert Figures 1 and 2 about here

The graph in Figure 1 shows that cumulative sales (diffusion) level off to 1 here, which would mean that in the end market potential has been reached (or: everybody has purchased the products in a category). Market potential is usually labeled as *m*, the size of the total diffusion at maturity level (like the total number of purchases of a mobile phone). The graph in Figure 2 shows that sales follow a hump-shaped pattern and that there is a moment of peak sales. The timing of the peak depends on the parameters p and q. In fact, for the Bass model it can be computed as

$$T_{peak} = \frac{1}{p+q} \log \frac{q}{p} \qquad (2)$$

This Bass model is frequently used in marketing to describe the diffusion of a single durable product. In case there is not a single product but a sequence of versions of the same product (think of new models of cars, new versions of a textbook, and cameras with newer technology) then one can use the Norton and Bass (1987) model. Later on, we will view originals and counterfeits also as two generations of products. If we call the first generation 1 and the second generation 2, then the two equations of the Norton and Bass model are

$$S_1(t) = m_1 F_1(t)[1 - F_2(t-\tau)] \qquad (3)$$

and

$$S_2(t) = F_2(t-\tau)[m_2 + m_1 F_1(t)] \qquad (4)$$

where

$S_i(t)$ is the sales of the products of generation i = 1, 2

m_i is the maturity level of generation i

$F_i(t)$ is the S-shaped function like (1) for generation i

(with parameters p_i and q_i)

τ is the launch date of the second generation

Figure 3 gives example graphs of the S-shaped functions for two successive generations, where τ is set at 30. Figure 4 gives the according sales graphs, where the data are created using (3) and (4).

Insert Figures 3 and 4 about here

In words, the Norton and Bass model says that from the time of launch of the second generation (at time τ), that then part of the sales that could have gone to generation 1 goes to generation 2. That is, so-called late(r) adopters of products in a category of generation 1 switch to generation 2 when this new generation comes to the market. By varying the parameters p_i, q_i and m_i, one can create a wide variety of patterns. In terms of original and counterfeit products, later adopters would then likely switch to the counterfeits.

In this paper we use the Norton and Bass (1987) model to hypothesize on the diffusion of original products and of counterfeit products, and their possible interaction. Indeed, we adopt the notion that generation 1 concerns the original products, while generation 2 concerns the counterfeits. We will formulate hypotheses on the properties of their diffusion processes based on this model. As these properties are defined by the parameters p_i, q_i, m_i, and τ, we arrange these hypotheses according to these parameters.

2.2 Originals and counterfeits as two generations

We start with looking at the launch date of the counterfeits. When the Norton and Bass (1987) model is used to describe successive generations of durable products, for example where each time the technology gets improved, it has been derived (Wilson and Norton, 1990) that the best strategy for a firm is either to launch generation 2 at the same time as generation 1 or to launch generation 2 when generation 1 is sold out. This result is strongly based on the assumption that the producer is a monopolist who is the only firm making and selling that product.

In terms of original and counterfeit products, things may be different. First of all, it is unlikely that counterfeit products are developed right at the very same moment as that original products are made. It is quite likely that there is a time delay, also because the counterfeiters need time to make their counterfeit products. Second, it seems pointless to sell counterfeit products in case people would not be interested in purchasing the related original products in the first place. Hence, consumers should first be aware of the original products, and these must be available, before an interest is aroused for counterfeit products. This leads us to propose

Hypothesis 1: Counterfeits enter the market later than originals do.

The next issue concerns the sales of the original products when counterfeits come to the market. It might be conceivable that the sales of originals immediately drop and that only counterfeits will be purchased. A visual impression of such a situation is given in Figure 5. In practice this may perhaps be unlikely, as (1) counterfeits may differ in quality from the originals and (2) there will also be people who can afford to buy the originals. Hence, to us, a picture like Figure 5 seems unlikely. What is perhaps more likely is that generation 2 (the counterfeits) take over faster, that is, the imitation coefficient q of the counterfeit diffusion is larger than that of the originals' diffusion. One then would get a picture like Figure 6.

Insert Figures 5 and 6 about here

Additionally, it can also occur that the counterfeit products find their way to one type of consumers, while the original products address the other type of consumers. So, at first sight there is no other proposal to do than to assume that the two diffusion patterns are broadly similar, see also Givon et al. (1995). These considerations thus lead us to propose

Hypothesis 2: The shapes of the diffusion process of originals and counterfeits are broadly similar.

This hypothesis means that the p_i and q_i parameters can of course differ (slightly) across the originals and counterfeits, but in a general sense the pattern of sales and cumulative sales is the same. Combining Hypothesis 2 with Hypothesis 1 suggests that the diffusion of counterfeits must peak later than the diffusion of originals.

Finally, would there be any reason for the maturity levels m_1 and m_2 to differ? This would depend on the timing of the launch of the counterfeits and on the total size of the adopters of each of the types of products. And, the earlier counterfeits are introduced to the market, the larger will be m_2 relative to m_1. When the shapes of the diffusion patterns are about the same, and counterfeits are introduced a little later than the originals, we would be tempted to propose that counterfeits will have a larger maturity level than that of originals, see also the suggestion in Givon et al. (1995, p29). So,

Hypothesis 3: In the end, more counterfeit products are sold than original products.

To summarize, we conjecture that

(1) counterfeits are launched a little later than the originals and thus may peak later,
(2) diffusion patterns of originals and counterfeits are broadly similar, and,
(3) total sales of counterfeits outnumber the sales of originals

These three conjectures also suggest that there is not much interaction between the diffusion patterns of the original and counterfeit products. Hence, we propose that it is

quite likely that deviations from the diffusion paths of originals and counterfeits are not much correlated.

3. The data

We have collected data for the South American country of Suriname. It is a small and open economy, with a single large (maritime) harbor in the capital city of Paramaribo. The country has many natural resources. It once was a colony of the Netherlands, and it became independent in 1975. Economic growth slowed down since the beginning of the 1980ies, but since 2000 there is a steady growth in GDP and an increase in welfare. The country is sparsely populated, with most of the citizens living in the coastal area. Although average welfare is on the rise, the income inequalities in Suriname are quite large. The country boasts a non-negligible group of multi-millionaires, but on the other hand it is estimated that more than 60% of the population is below international poverty levels.

Sales records for products like televisions, DVDs and mobile phones, which are the categories of interest, do not exist. Hence, we have to estimate the diffusion patterns of these products using alternative methods. We consulted the Foundation General Bureau of Statistics Suriname and we were able to collect annual data on the imports of products in these three categories for the period 1996 to and including 2008. These imports are measured in kilograms and in total value (in US dollars). We decided to take the weights in kilograms as the measurement unit. Additionally, and this is crucial for our purposes, we have information on the countries of origin of the shipments.

To assign products to the classes of original products and counterfeit products, we use the software piracy index, which can be obtained from www.nationmaster.com. This website presents a list of countries and gives an estimate of the fraction of products (here: computer software) that are most likely to be counterfeit. In the Data Appendix we provide a list of relevant countries for our product categories and the corresponding percentages. Like this list, we shall take it as likely that 23% of the DVDs, mobile phones and television sets that are imported from Japan amount to counterfeit products, and that

it is as much as 82% of these products originating from China that are counterfeits. Of course, we shall never be certain whether these percentages also hold for our product categories, nor if this figure changes over time or amounts to a biased estimate, and hence we warn the reader that the subsequent data should not be considered as exact amounts but merely as estimates. For our purposes, however, the absolute numbers do not matter, but their time series properties do. We shall see below that the estimates are instrumental for finding support (or not) for the hypotheses in the previous section. In order to allow the reader to verify the computations about which we report in the next section, we present our data in the Data Appendix. Graphical details and other aspects of these series will be discussed in the next section.

4. The results

In this section we analyze the diffusion patterns for the three categories. We start with mobile phones, then we analyze television sets and we conclude with DVDs. First we focus on the diffusion pattern of the originals and counterfeits separately, and after that we consider potential correlations.

To examine the properties of the diffusion pattern we estimate the parameters in the Bass model when it is written in the format

$$Y_t = mp + (q - p)CY_{t-1} - \tfrac{q}{m}CY_{t-1}^2 + \varepsilon_t \qquad (5)$$

Here, Y_t denotes actual sales (shipments) and CY_t denotes cumulative shipments. When it is found that this Bass model does not fit the data well, for example because the estimate for p is not significant (which makes (1) difficult to interpret), then we rely on the logistic function

$$CY_t = \frac{m}{1 + \exp[-\alpha(t - \beta)]}. \qquad (6)$$

Here, t runs from 1 to T. Note that the parameter β now measures the moment of peak sales (shipments), and α implies the shape of the curve.

To examine short-run and contemporaneous correlations, we estimate a vector auto-regression of order 1, given by

$$\begin{aligned} Originals_t &= \mu_1 + \rho_1 Originals_{t-1} + \lambda_1 Counterfeits_{t-1} + \varepsilon_{1,t} \\ Counterfeits_t &= \mu_2 + \lambda_2 Originals_{t-1} + \rho_2 Counterfeits_{t-1} + \varepsilon_{2,t} \end{aligned} \qquad (7)$$

The parameters in this vector auto-regression can be estimated using ordinary least squares when applied to each of the equations. Estimated parameters in such a model are usually difficult to interpret, so in practice one typically relies on the so-called impulse response functions, see Franses (1998) and various other textbooks.

4.1 Mobile phones

The first category that we study concerns shipments of telephones. The graphical impression that one gets from Figures 7 to 9 is that diffusion patterns show similar patterns indeed.

Insert Figures 7, 8 and 9 about here

When we fit a Bass model to the data in Figure 7 we obtain insignificant estimates of p for both series, so we turn to estimating (6) for the data in Figure 9. The results on the diffusion peak appear in Table 1.

Insert Table 1 about here

From the first row of this table we learn that the diffusion peak of originals occurred in 2003, while that of counterfeits is still to come in 2010. The estimated values

of α in (6) are 0.272 and 0.250, respectively, and this shows that the diffusion patterns are indeed similar.

Insert Table 2 about here

In Table 2 we present the estimates of the maturity levels for each of the two types of products. We see that these estimates are very close, with counterfeits' total sales being slightly larger.

Insert Figure 10 about here

In Figure 10 we give the impulse response functions for an estimated vector auto-regression of order 1 as in (7). The key graphs are the off-diagonal ones. The right-upper graph indicates that original sales do not respond to an impulse from counterfeits. The left-lower graph suggests that counterfeits do respond (significant at 5%) to originals, but only for one period. In sum, correlations between original and counterfeit diffusions are barely relevant.

4.2 Televisions

The second category that we study concerns shipments of televisions. The graphical impression to be obtained from Figures 11 to 13 is that actual diffusion seems rather different, but that total diffusion seems to have about the same trend.

Insert Figures 11, 12 and 13 about here

Visually it is difficult to spot the moment of peak diffusion, and hence we rely on the Bass model in (5). For originals we find that the peak year is estimated as 2003, while for counterfeits it is estimated as 2004. Table 2 shows that the estimated maturity level for counterfeits is slightly larger than that of originals. The estimated p and q parameters

for originals are 0.040 and 0.180, and those of counterfeits are 0.036 and 0.139, so again we see a strong similarity across the two diffusion patterns.

Insert Figure 14 about here

The impulse response functions in Figure 14 clearly show that there is no dynamic correlation between originals and counterfeits.

4.3 DVDs

The third and last category that we study concerns shipments of DVDs. The graphical impression to be obtained from Figures 15 to 17 is that actual diffusion is rather similar and also that total diffusion seems to have about the same trend.

Insert Figures 15, 16 and 17 about here

The estimation results in Table 2, again for the logistic function in (6) as the Bass model in (5) gives insignificant estimates for p (making estimation of the peak moment impossible), show that originals peak in 2004 while counterfeits peak in 2005. The estimates for β in (6) are 0.409 and 0.568, respectively, and their estimated standard errors are 0.055 and 0.044, and hence we can conclude that also these parameters are approximately equal.

Insert Figure 18 about here

The impulse response functions in Figure 18 clearly show that for DVDs we get a similar pattern as for mobile phones. Counterfeit diffusion now responds with one lag and with two lags to an impulse in original diffusion (left-bottom panel), but otherwise there is no dynamic correlation between originals and counterfeits.

In sum, our detailed analysis of the diffusion patterns of original and counterfeit products learns that the diffusion patterns are broadly similar but that peak diffusion of counterfeits appears later. This support for Hypothesis 2 implies that counterfeits must enter the market later, and this in turn supports our Hypothesis 1. Next, we saw that for two of the three categories the maturity level for counterfeits is estimated as being higher than for originals. However, the difference between the two estimated maturity levels is not very large (and also not significant if we compare the associated standard errors as they are also reported in Table 2). Hence, we are tempted to suggest that eventual maturity levels are about equal, at least in this case of three categories.

5. Conclusions

The analysis in this paper concerned three categories for which we have estimated annual data on original and counterfeit shipments (in kilograms) for a single developing country, here: Suriname. Data like this have never been compiled nor analyzed, so we believe that our findings are of some value for understanding diffusion of counterfeit products.

Of course, given the limited focus and sample size, we can come up with a long list of limitations to our study, which would address the data, the country, the products, and of course whether our findings lead to any generalizing statements.

On the other hand, when counterfeit diffusion mimics original products' diffusion, while at the same showing limited correlation over time with originals, there are a few lessons that can be learned for marketing management. As we did not see that counterfeits wipe away originals, it thus still seems worthwhile to introduce new original products in a developing country. If new versions of these original products are launched quickly one after another, then counterfeiters may need to make choices about which originals to copy and this may delay market entry and also may reduce counterfeit versions. To attain high maturity levels, one may want to have the diffusion to peak rapidly, and this can be achieved by marketing campaigns.

Even though the majority of customers is less likely to purchase the original product and thus to purchase more expensive products, they do show an interest in the

original product. One way to further arouse the interest of original products is to increase the quality of the originals. Additionally, management may decide to follow alternative pricing strategies in developing countries. One can think of starting with relatively low prices and perhaps later on increase those prices for newer versions of the originals. Also, increasing brand awareness can help to gain interest of potential customers.

Data appendix

Country	Percentage of counterfeit
Venezuela	87%
Indonesia	84%
China	82%
Dominica	79%
Thailand	78%
Panama	74%
Philippines	69%
India	69%
Turkey	65%
Mexico	61%
Malaysia	59%
Brazil	59%
Poland	57%
Puerto Rico	44%
South Korea	43%
UA Emirates	35%
South Africa	34%
Canada	33%
Netherlands	28%
Germany	27%
United Kingdom	26%
Switzerland	25%
Japan	23%
United States	20%

Note: Based on the Software piracy rate obtained from www.nationmaster.com consulted on October 19 2009. Countries not on this list, but with shipments recorded, get a score of 50%.

Mobile phones (in kilograms)

Year	ORIGINAL	COUNTERFEIT
1996	5198.720	1333.280
1997	5389.300	1535.700
1998	1557.910	1093.090
1999	1445.090	364.9100
2000	1818.250	483.7500
2001	3957.520	996.4800
2002	3684.870	2632.130
2003	3816.900	1855.100
2004	587.8300	265.1700
2005	6118.480	2036.520
2006	2944.030	5293.970
2007	2254.480	4175.520
2008	798.9800	254.0200

Televisions (in kilograms)

Year	ORIGINAL	COUNTERFEIT
1996	181292.8	161484.2
1997	287799.1	237610.9
1998	219298.4	216937.6
1999	206709.7	82944.34
2000	309940.5	564297.5
2001	281040.6	194256.4
2002	203554.2	470819.8
2003	154940.4	334264.6
2004	529283.7	230013.3
2005	369442.1	300435.9
2006	324814.3	400974.7
2007	237721.0	301032.0
2008	169707.9	338280.1

DVDs (in kilograms)

Year	ORIGINAL	COUNTERFEIT
1996	47815.52	14604.48
1997	60001.68	16891.32
1998	26769.82	7221.180
1999	18767.64	6736.360
2000	33564.41	12525.59
2001	46193.74	15136.26
2002	58997.44	22003.56
2003	129254.5	59259.52
2004	220195.2	160114.8
2005	114575.9	85527.11
2006	91451.60	112959.4
2007	95172.60	88723.40
2008	75173.66	85705.34

Figures

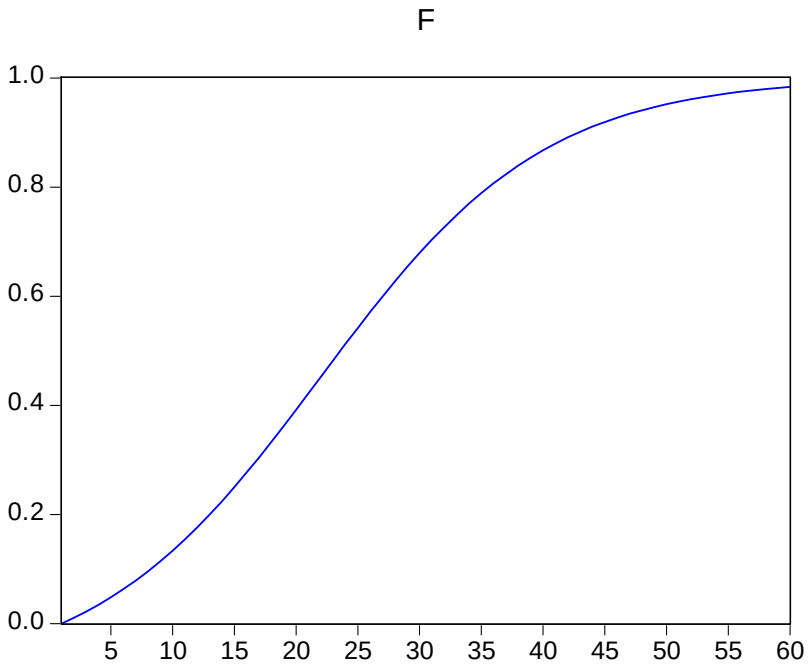

Figure 1: the function in (1) with $p = 0.01$ and $q = 0.1$

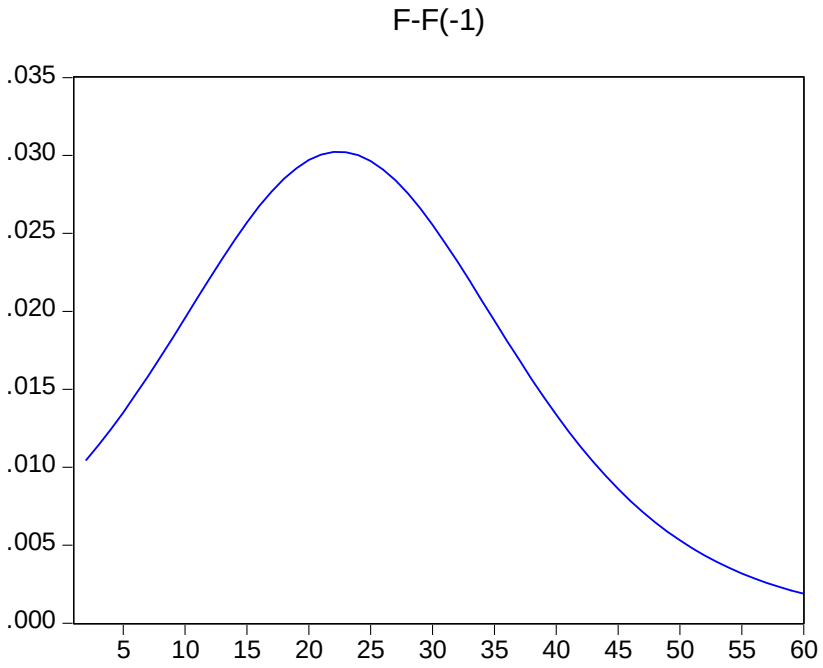

Figure 2: Sales corresponding to the function in (1).

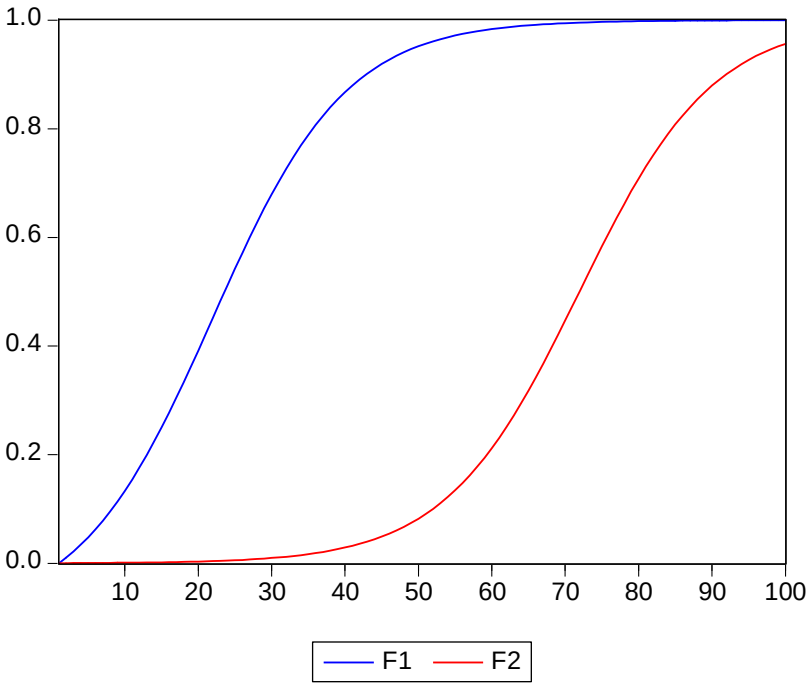

Figure 3: Two functions like in (1) with $p = 0.01$ and $q = 0.1$

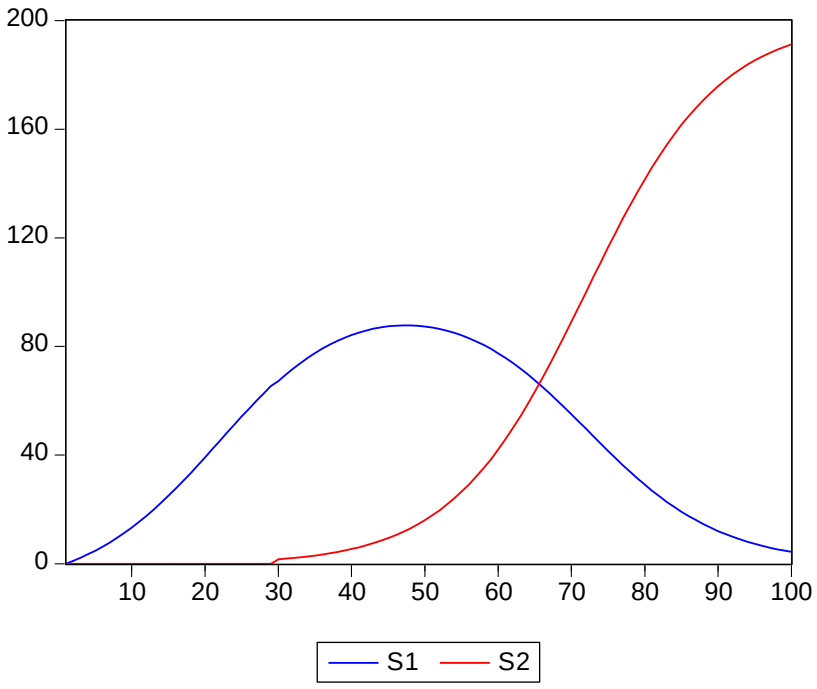

Figure 4: Sales of generations 1 and 2 where $m_1 = m_2 = 100$

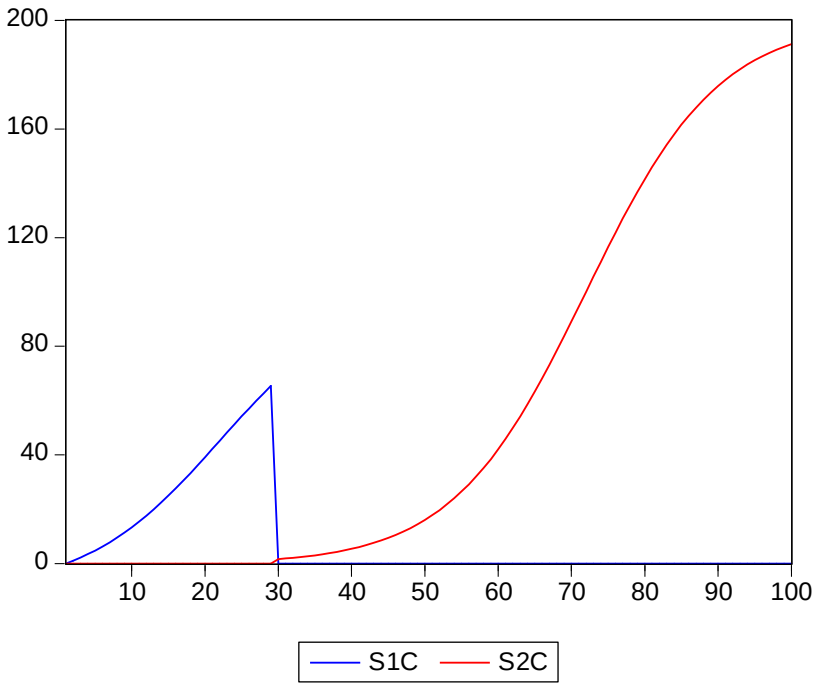

Figure 5: Original sales drop to zero when counterfeits are introduced

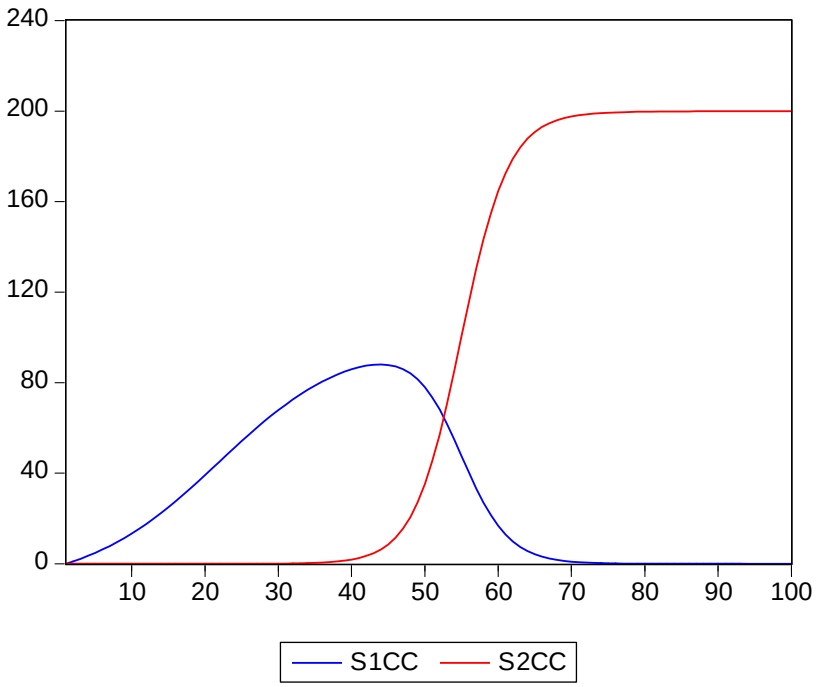

Figure 6: Counterfeits quickly take over the market.

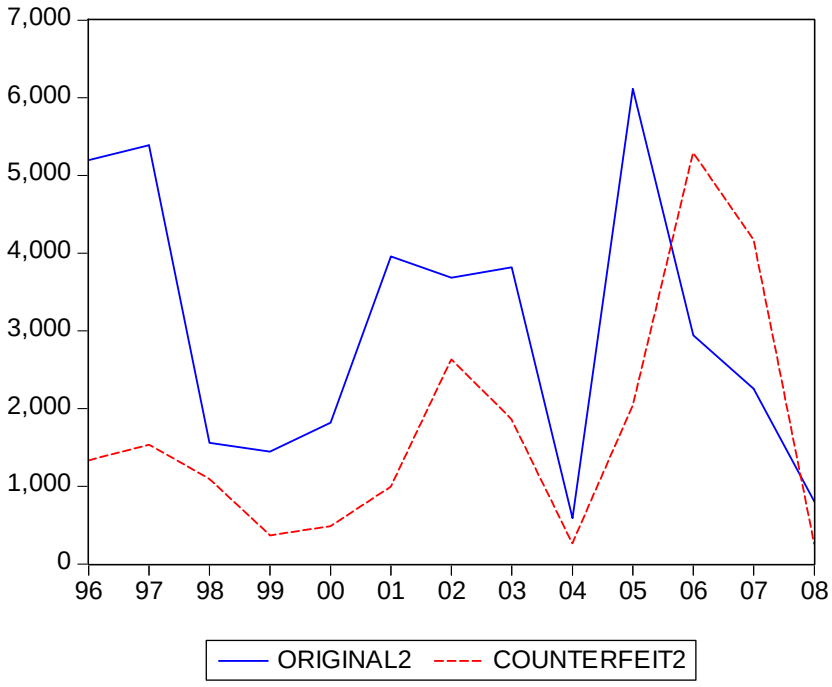

Figure 7: Originals and counterfeits: the case of mobile phones

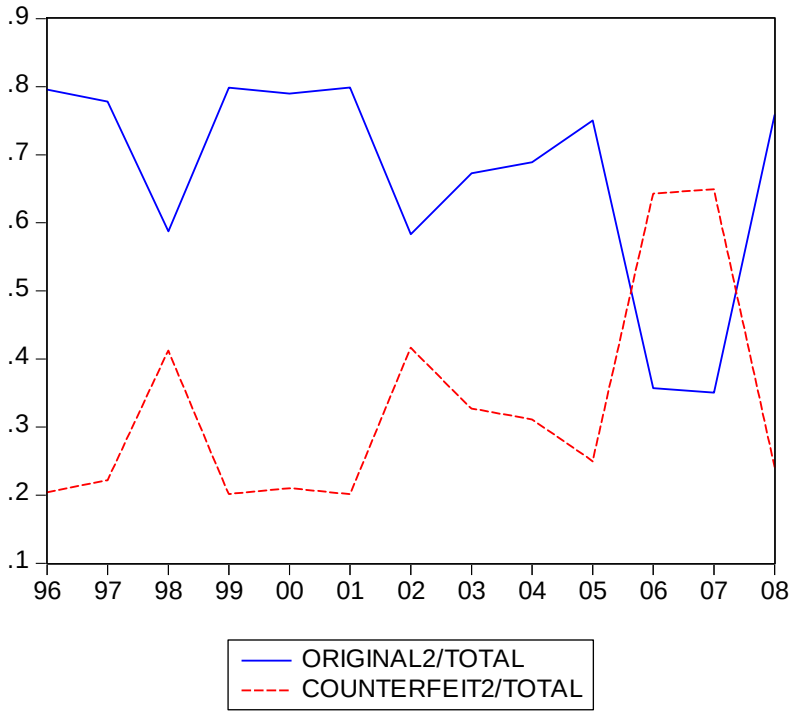

Figure 8: Fraction of total, Originals and counterfeits: the case of mobile phones

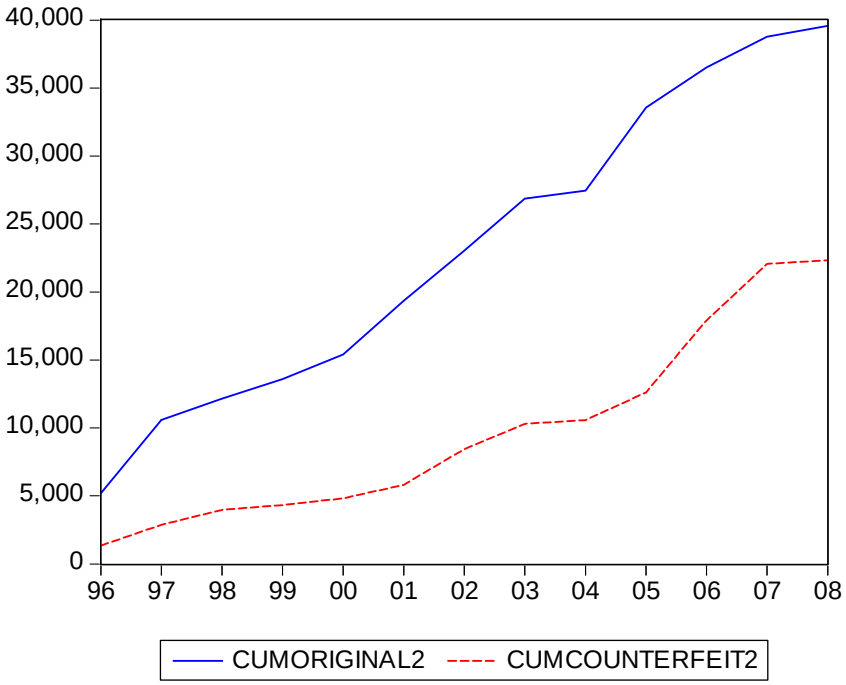

Figure 9: Total diffusion of originals and counterfeits: the case of mobile phones

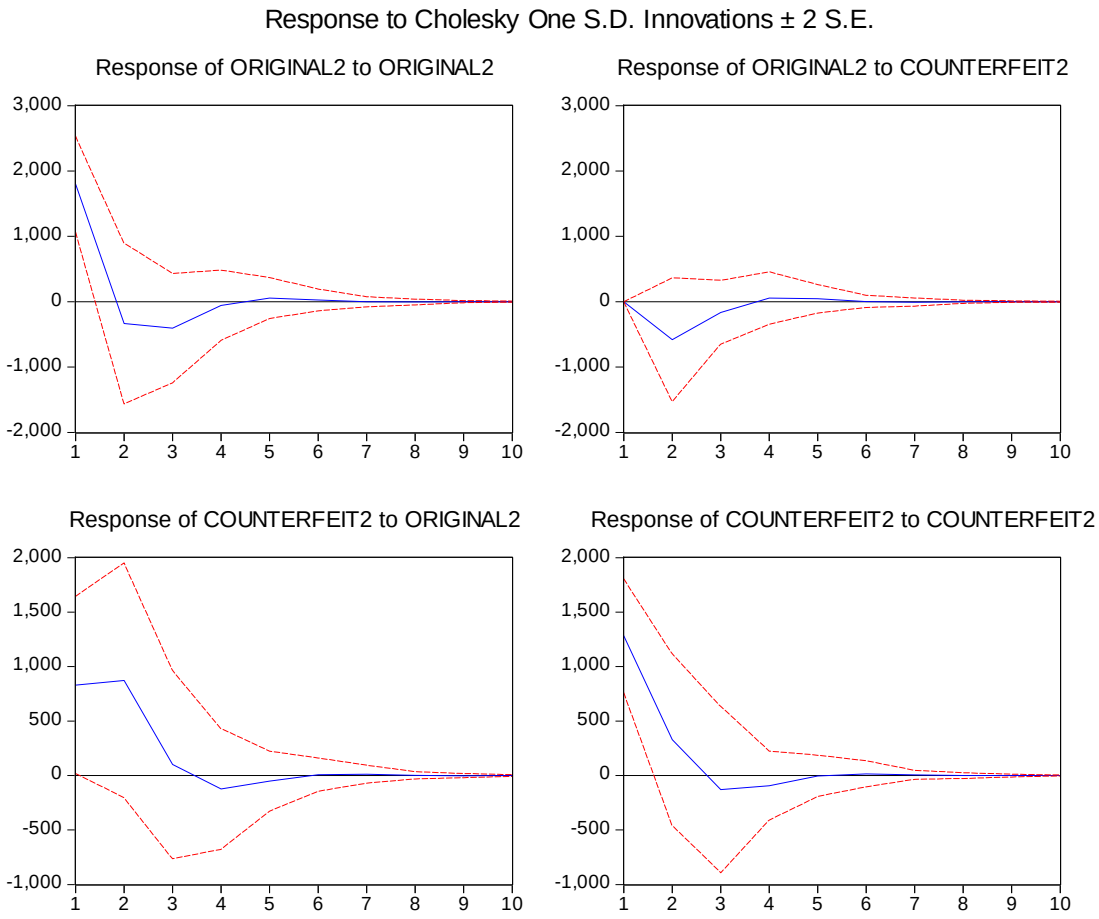

Figure 10: Impulse response functions for a vector auto-regression for the bivariate variable containing Originals and Counterfeits: the Case of Mobile phones

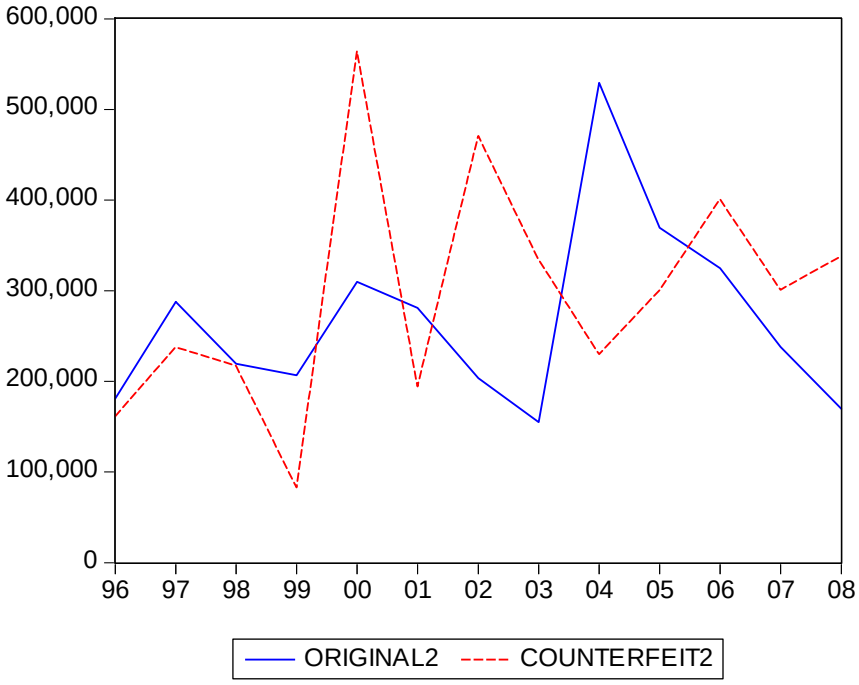

Figure 11: Originals and counterfeits: the case of televisions

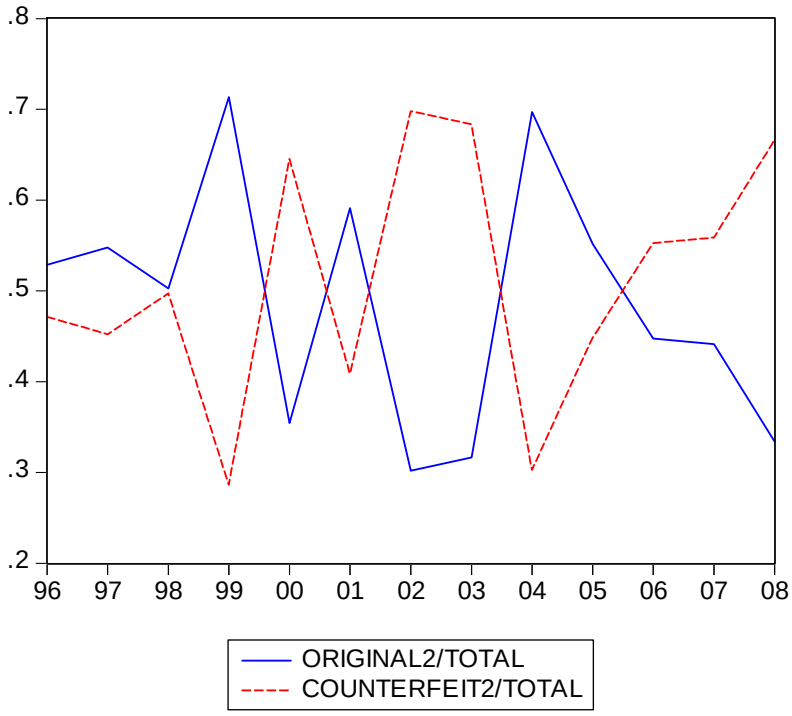

Figure 12: Fraction of total, Originals and counterfeits: the case of televisions

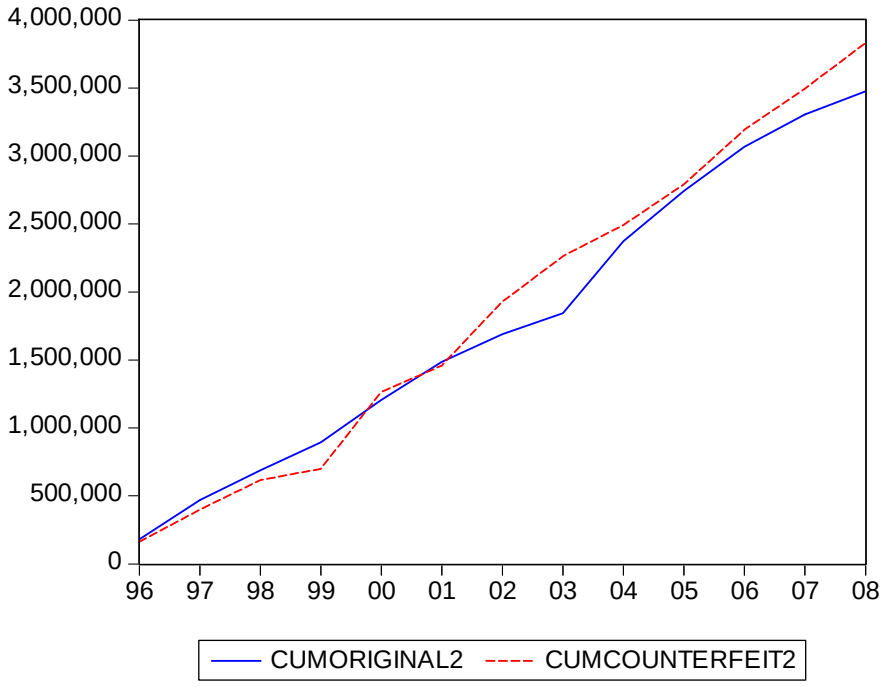

Figure 13: Total diffusion of originals and counterfeits: the case of televisions

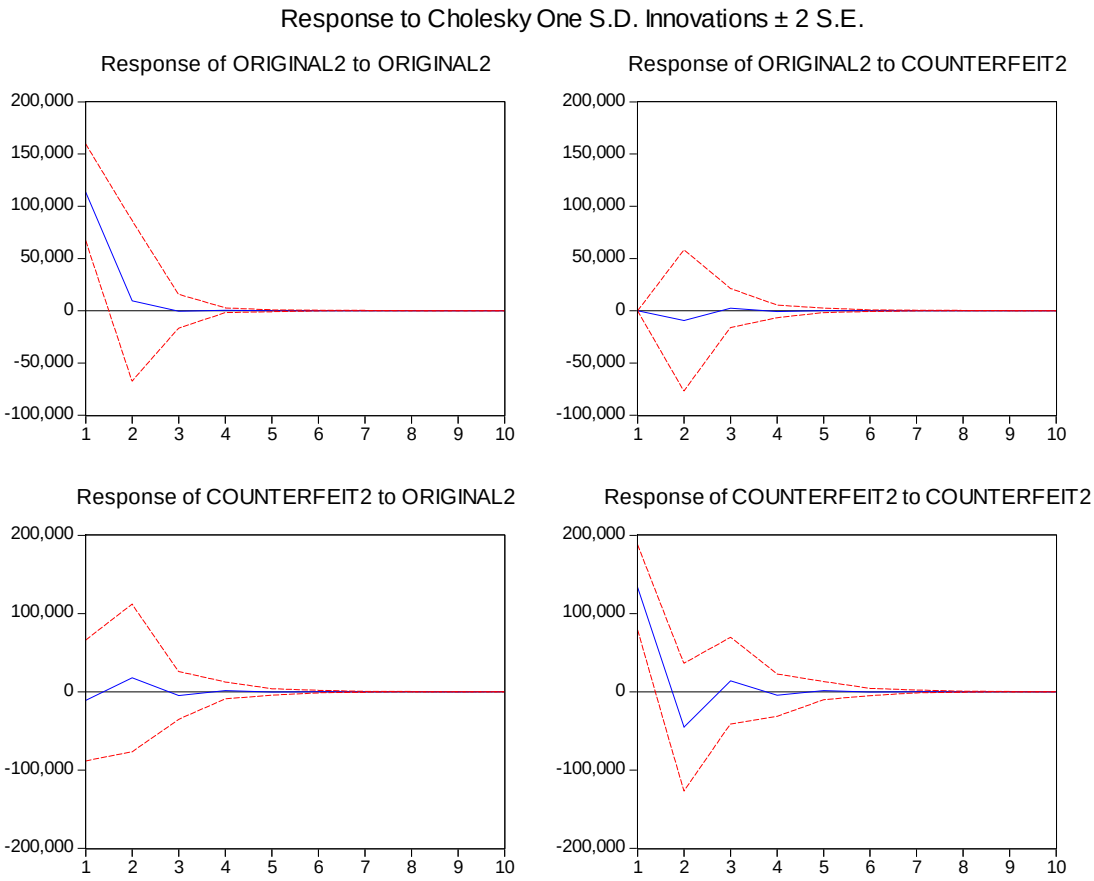

Figure 14: Impulse response functions for a vector auto-regression for the bivariate variable containing Originals and Counterfeits: the Case of Televisions

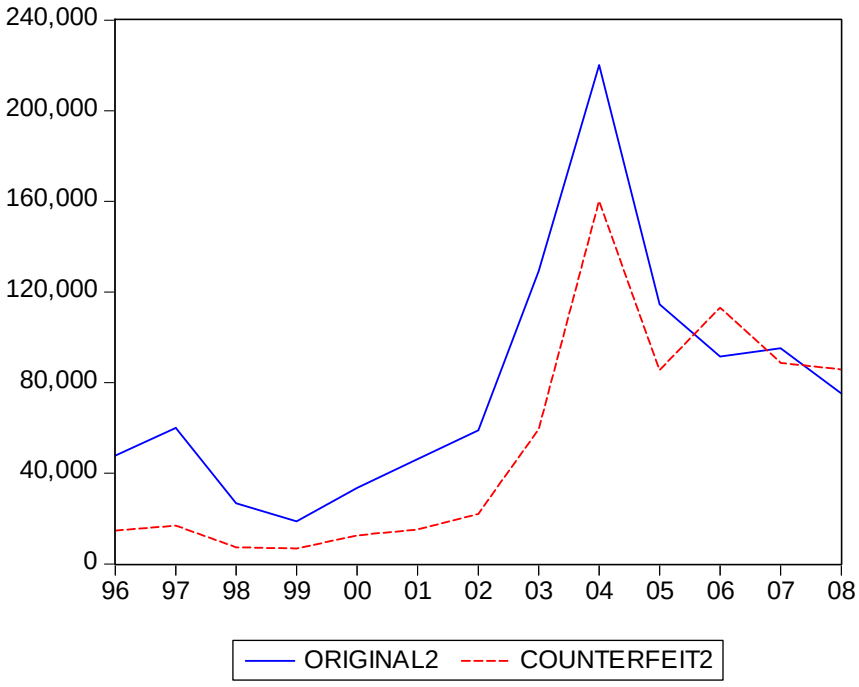

Figure 15: Originals and counterfeits: the case of DVDs

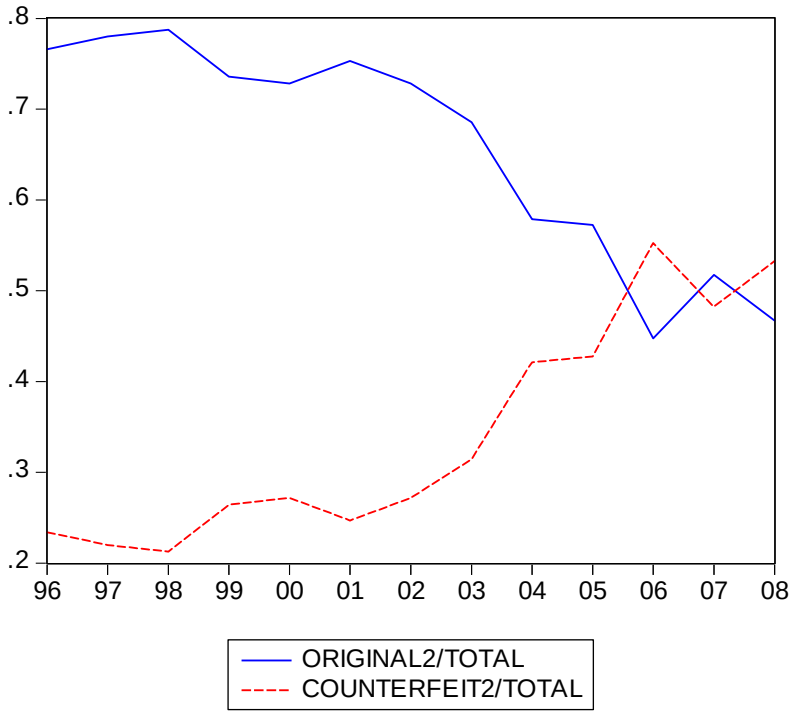

Figure 16: Fraction of total, Originals and counterfeits: the case of DVDs

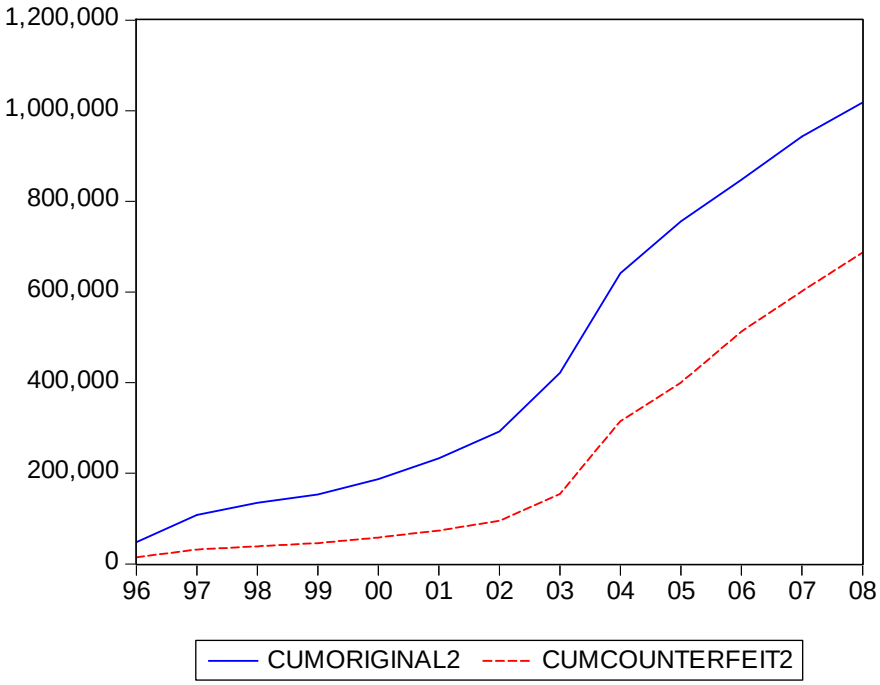

Figure 17: Total diffusion of originals and counterfeits: the case of DVDs

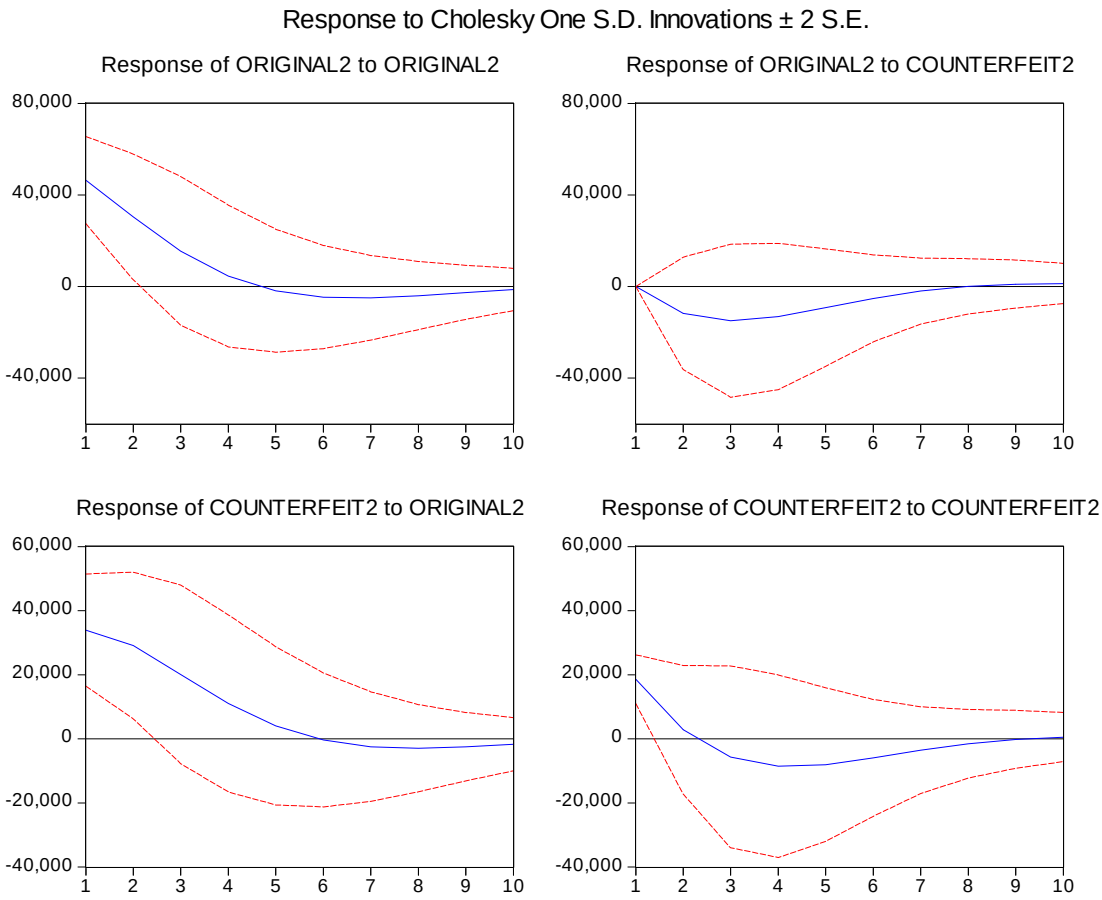

Figure 18: Impulse response functions for a vector auto-regression for the bivariate variable containing Originals and Counterfeits: the Case of DVDs

Tables

Table 1: Estimates of the time of the peak of diffusion

Category	Originals			Counterfeits		
	Parameter	(Std. error)	Year	Parameter	(Std. error)	Year
Mobile phones*	6.605	(0.717)	2003	13.634	(4.178)	2010
Televisions**	6.842	(NA)	2003	7.720	(NA)	2004
DVDs	8.314	(0.565)	2004	9.113	(0.346)	2005

* Parameter estimates are based on a logistic function
** Parameter estimates are based on a Bass growth curve

Table 2: Estimates of the level of maturity

Category	Originals Parameter (Std. error)		Counterfeits Parameter (Std. error)	
Mobile phones*	49767	(4021)	58477	(34873)
Televisions**	4658066	(1293148)	6144432	(NA)[+]
DVDs*	1263922	(116217)	818647	(61776)

* Parameter estimates are based on a logistic function
** Parameter estimates are based on a Bass growth curve
[+] This estimate is obtained from first estimating a Bass model for total diffusion (is originals plus counterfeits), and from the estimated maturity level for the total (10802498) we subtract the estimated maturity level for originals (4658066)

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