ONDERZOEKSRAPPORT NR 9514

The Efficiency of Accounting Signals : A Comparison Between the Inventory and the Depreciation Accounting Method

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D/1995/2376/15

THE EFFICIENCY OF ACCOUNTING SIGNALS : A COMPARISON BETWEEN THE INVENTORY AND THE DEPRECIATION ACCOUNTING METHOD

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Abstract

One of the main comments on the signalling inventory model (Hughes & Schwartz, 1988) was the absence of a comparison between FIFO and other possible signalling devices. In this paper the model of Hughes & Schwartz (1988) is extended by adding a second accounting signal: the depreciation accounting method.

If the manager-owner can choose between FIFO and linear depreciation to solve asymmetries in information about the success of the project, he will always choose the signal, which results in the smallest increase in taxes paid. Therefore, the characteristics of the investment and the purchasing policy are very important. In capital intensive industries, where investments in fixed assets are large, FIFO is expected to be the cheapest signal. As the volatility of prices and the inventory level go up, FIFO becomes more expensive as a signalling device.

Differences in the cost from using a certain signalling strategy can explain why differences in reporting strategies between industries occur.

Keywords: choice of accounting methods, efficiency of signals, depreciation and inventory accounting method

1. Introduction

In literature it is shown that accounting choices can solve asymmetries in information between the investors and the firm about the expected market value. The auditor's choice (Titman & Trueman, 1988; Feltham, Hughes & Simunic, 1990; Datar, Feltham & Hughes, 1991), the auditor's replacement (Dye, 1991), the inventory accounting method (Hughes and Schwartz, 1988) or the expected cash flow levels (Hughes, 1986) can fulfil a signalling function about the value of the project. In all these models, firms with a high expected market value choose an unexpected accounting method or financial policy: FIFO, a high quality auditor or a high level of debt in order to reveal their private information.

The problem with most signalling models is that the signalling device is given in advance: it is the dividend level, the manager's ownership, the inventory method. In reality, the manager can choose between all these possible information suppliers. In the literature, the efficiency of accounting signals is not extensively discussed. Datar, Feltham and Hughes (1991) investigated the choice of the auditor and the retained ownership together. Part of the asymmetries in information is solved by the auditor's choice and the rest by the management's ownership. The introduction of two signals results in a lower signalling cost and a larger utility for the manager. While they made a comparison between a financial and an accounting signal, two accounting signals are compared in this paper. Because one of the main comments on the Hughes and Schwartz model (1988) was the lack of comparison of FIFO with other signals, in this paper the inventory method and the depreciation method are chosen as possible accounting signals.

I build a model, where asymmetries in information about the level of fixed costs exist, high or low fixed costs. Both types of firms sell a homogeneous product and they play Cournot competition in the first stage of the game. Given the value maximising output, the successful firm with low costs determines the signalling device to reveal the firm type: linear depreciation or FIFO. The main conclusion of the paper is that economic determinants influence the choice between FIFO and linear deprecation as a signalling device. The level of investment and inventory, the depreciation rate and the volatility of prices play a part. Large investments in fixed assets and a high rate of accelerated depreciation create a large difference between the linear and accelerated depreciation amounts and a large increase in the taxes paid from using linear depreciation. Therefore, firms with high investment rates often prefer FIFO to reveal the firm type. Moreover, FIFO becomes more attractive as a signalling device when the volatility of prices and the inventory level are low.

The paper is organised as follows. The assumptions of the model and the sequence of the game are clarified in section 2. The choice between FIFO and linear depreciation is dealt with in section 3. Finally, some concluding remarks are made in section 4.

2. The model : assumptions and sequence of the game

I assume a duopoly: two firms compete with each other in the product as well as in the competitive market of equity. The two firms sell a homogeneous product [1] and they only differ in the amount of fixed costs: FC_H or FC_L. The successful firm faces smaller fixed costs (FC_H) than the unsuccessful firms (FC_L) ($FC_H < FC_L$). Therefore, the successful firm (H) realises higher cash flows than the unsuccessful firm (L). The success of the firm is private information only known by the manager of the firm, the type of the firm t is an element of T = {H, L}.

Both types buy the good they sell in the product market at a price P, this price has a uniform distribution between P_{min} and P_{max}. At the start of the project the manager-owner buys x products at an initial price P_I. The price of the goods sold P_o is determined by the quantity sold by the firm itself and the competitor. I assume that the price of the goods sold equals:

$P_o = a - b(q_{Lj} + q_{Hj})$
P: the price of the goods sold;
b: a fixed parameter, that expresses the degree of price elasticity;
q_{tj}: the quantity sold by a t-type firm in period j.

I assume a two period model, where in the first period the number of products bought equals the number of goods sold, while in the second period the number of goods sold minus the initial level of inventory x are bought and the inventory at the end of the project equals zero [2].

Both types of firms have to invest K$ in fixed assets because the manager-owner wants to start a company. The manager-owner sells a part of the totally owned company to raise K$; a_1 is the part of the shares sold [3].

Given these assumptions in *the first stage of the game* both firms play a Cournot game. Without considering the reporting strategies and the related tax consequences, each type determines the value maximising output in the first as well as in the second period [4].

$$\max_{q_{t1},\, q_{t2}} E(V_0(t)) = -P_I x - K + E(q_{t1}(a - b(q_{L1} + q_{H1})) - Pq_{t1} - Fk_t)/(1+i) + E(q_{t2}(a - b(q_{L2} + q_{H2})) - P(q_{t2} - x) - Fk_t)/(1+i)^2$$

$E(V_0(t))$:	the expected value of a t-type firm at time zero;
P :	the price of the goods bought;
q_{tj}:	the quantity sold by a t-type in period j;
P_I:	the initial price of the purchases;
x:	the initial amount of goods bought;
K:	the amount of investment;

Because both types face the same marginal costs, the value maximising output is the same for both types in both periods and it equals (a-P)/3b. As the input price P increases, the marginal cost of selling one unit goes up and the value maximising output decreases. As the elasticity of the output prices goes up, the marginal revenue of selling one unit and the value maximising output decrease.

Given this value maximising output (a-P)/3b, in *the second stage of the game* both types determine an inventory and a depreciation method for tax and reporting purposes. The same method must be used for reporting and tax purposes. The depreciation method is d and d is an element of D = {α, s}, which is restricted to either linear depreciation (s = 1/2 in both periods) or accelerated depreciation ($\alpha > 1/2$ and α is the depreciation rate in the first period and $(1 - \alpha)$ is the depreciation rate in the second period).

The manager of the firm also determines an inventory policy choice v and v is an element of V = {FIFO, LIFO}. If LIFO is chosen, the expected cost of the goods sold equals E((P(a-P)/3b) in the first period and E(P((a-P)/3b - x))+ P_I x in the second period. If FIFO is used the cost of the goods sold equals E(P((a-P)/3b - x))+ P_I x in the first period and (P(a-P)/3b) in the second period.

In a complete information environment the manager will choose the reporting strategies, which minimise the taxes paid. I assume a concave and increasing tax rate environment, where $tax(x_{tdvj}) = M - e^{-c(x_{qdvj})}$.

where	M:	the maximal tax rate M;
	c:	the slope of the tax rate;
	x_{qdvj}:	profits of a q-type firm in period j using the depreciation method d and the inventory method v;
	e:	the exponential function e.

In this environment four reporting strategies are possible: {s, FIFO}, {s, LIFO}, {α, FIFO} or {α, LIFO}. The manager will certainly choose these reporting strategies, which maximise his income over the total life of the project:

$$\text{Max} \quad a_1V_o(t, d, v)-K + (1-a_1)V_2(t, d, v)/(1+i)^2$$

The manager receives an income at the start of the project by selling a_1 of the shares. The price is determined by the beliefs of the investors. At the end of the project he receives his part of the cash flows realised. The cash flows realised at the end of the first period are invested in a risk free asset, the interest rate received after taxes is i and the income from investments in risk free assets is taxed separately at a fixed tax rate t.

Given these assumptions the sequence of the game is designed in Figure 1.

Insert Here Figure 1

Figure 1: The sequence of the game when the manager determines the quantity sold, the inventory and the depreciation method

1. Nature determines the level of fixed costs;
2. The manager observes the type of the firm and he determines the value maximising output q_H or q_L;
3. Given this value maximising output, the manager determines the reporting strategy {α,LIFO}, {α,FIFO}, {s,LIFO}, {s, FIFO};
4. Investors observe the inventory and the depreciation method and given their beliefs they offer a price for the shares sold : $a_1V_o(q, d, v)$. This price is determined by the reporting strategies because they determine the taxes paid;
5. The manager chooses the highest price offer and his income over the total life of the project equals: . $a_1V_o(q, d, v) - K + (1- a_1)V_2(q, d, v)/(1+i)^2$

3. Results

In a complete information environment, if profit levels are sufficiently high and the initial price of the goods bought P_I is small, both types prefer {α, LIFO} to reduce the taxes paid. If {α, LIFO} is the best choice in a complete information environment, the choice {α, LIFO} must result in a larger income than the other possible paths {s, LIFO}, {s, FIFO} and {α, FIFO}.

or

$a_1 V_0(t, \alpha, LIFO) - K + (1-a_1) V_2 (t, \alpha, LIFO)/(1+i)^2 > a_1 V_0(t, \alpha, FIFO) - K + (1-a_1) V_2 (t, \alpha, FIFO)/(1+i)^2$ (1)

$a1 V_0(t, \alpha, LIFO) - K + (1-a_1) V_2 (t, \alpha, LIFO)/(1+i)^2 > a_1 V_0(t, s, FIFO) - K + (1-a_1) V_2 (t, s, FIFO)/(1+i)^2$ (2)

$a_1 V_0(t, \alpha, LIFO) - K + (1-a_1) V_2 (t, \alpha, LIFO)/(1+i)^2 > a_1 V_0(t, s, LIFO) - K + (1-a_1) V_2 (t, s, LIFO)/(1+i)^2$ (3)

Whether {α, LIFO} is the value maximising choice depends on the level of cash flows, the amount of investment and the initial price of the goods bought (Proof see appendix proposition 1). If the price of the initial purchases and the amount of investment are large, {s, FIFO} can be the value maximising choice. In this case, these two reporting methods can never fulfil a signalling role.

In an incomplete information environment investors do not know the type of the firm. If no information is supplied, all types are valued at the same price, which is disadvantageous for the successful project H. The manager of the firm with low costs can reveal its private information by the choice of a reporting strategy. If the accounting choice {α, LIFO} is the value maximising choice, the manager can reveal its type by one of the following strategies: {α, FIFO}, {s, FIFO} or {s, LIFO}. Because a duopoly situation exists with two types of firms and two accounting methods, the manager can choose between different signalling strategies and the efficiency of signals can be considered [5]. First, I discuss which strategy can be a signal of a successful project H, that means low fixed costs. Afterwards, I compare these strategies and I investigate under which circumstances a certain strategy will be preferred.

Because {α, LIFO} is the value maximising choice for both types, the manager of the successful project can not separate from the unsuccessful firm by choosing this strategy. If he chooses this strategy, the manager of the unsuccessful firm will always imitate the successful firm because he does not have to pay additional taxes by choosing a non-value maximising method {α, FIFO} or {s, LIFO}. Moreover, a larger price for the shares sold at the start of the project would be received because the firm is identified as a successful firm.

If the manager chooses a signalling device not only {α, LIFO} but also {s, FIFO} will not be used to reveal the firm type. This choice is not efficient because only two different types occur and the manager only possesses private information about one unknown parameter: the level of fixed costs. If the manager chooses {α, FIFO} or {s, LIFO}, it is an unexpected behaviour and investors will identify the firms using one of those strategies as a successful firm. The asymmetries in information are solved but the manager must face an increase in taxes paid. If the manager chooses {s, FIFO}, no new information is supplied but more taxes must be paid and the manager's income decreases. Therefore, a manager who maximises his utility, will never choose {s, FIFO} to reveal the firm type when asymmetries in information about one unknown parameter and two different types of firms exist. He prefers either {α, FIFO} or {s, LIFO} to solve asymmetries in information.

Proposition : If the difference is larger between the accelerated and the linear depreciation amounts than between the expected costs of the goods sold using LIFO and FIFO, the manager of the successful firm will prefer {α, FIFO} above {s, LIFO} to reveal the positive inside information, low fixed costs.

Before comparing {α, FIFO} and {s, LIFO} the reliability of each signalling strategy must be investigated.

If the inventory method is chosen as a signalling device, only {α, FIFO} can be a signal of high cash flows but this strategy can only occur as an equilibrium strategy when the manager of the successful project can realise an increase in income compared to {α, LIFO}. Moreover, the manager of the unsuccessful project may not have an incentive to imitate. In other words, he must realise the largest income by choosing {α, LIFO}. Revealing the firm's type is advantageous for the successful firm when :

$a_1 V_0(H, \alpha, FIFO) - K + (1-a_1) V_2 (H, \alpha, FIFO)/(1+i)^2$

$> a_1 V_0(L, \alpha, LIFO) - K + (1-a_1) V_2 (H, \alpha, FIFO)/(1+i)^2$ (4)

The manager of the unsuccessful firm realises the largest income by choosing {α, LIFO} when:

$(1-a_1) V_0 (L, \alpha, LIFO) - K + a_1 V_2 (L, \alpha, LIFO)/(1+i)^2$

$> (1-a_1) V_0 (H, \alpha, FIFO) - K + a_1 V_2 (L, \alpha, FIFO)/(1+i)^2$ (5)

If these two conditions are fulfilled, {α, FIFO} is a reliable signal of a successful project, low fixed costs.

An efficiency problem only occurs when the manager can also choose another signalling device to reveal the private information: {s, LIFO}. As for {α, FIFO} the manager of the successful project is only prepared to use {s, LIFO} when the higher price received for the shares sold is larger than the decrease in income at the end of the project because additional taxes must be paid by using linear depreciation or:

$a_1 V_0 (H, s, LIFO) - K + (1-a_1) V_2 (H, s, LIFO)/(1+i)^2$

$> a_1 V_0 (L, \alpha, LIFO) - K + (1-a_1) V_2 (H, \alpha, LIFO)/(1+i)^2$ (6)

The manager of the unsuccessful project must realise the largest income by choosing {α, LIFO} or:

$a_1 V_0 (H, s, LIFO) - K + (1-a_1) V_2 (L, s, LIFO)/(1+i)^2$

$< a_1 V_0 (L, \alpha, LIFO) - K + (1-a_1) V_2 (L, \alpha, LIFO)/(1+i)^2$ (7)

If the signalling conditions (4) up to (7) are fulfilled, an efficiency problem occurs: the manager can choose between {s, LIFO} and {α, FIFO} to solve asymmetries in information. An efficient signal is a signal, which results in the largest increase in income from identification as a successful project with low fixed costs. As shown, both strategies result in an increase in the price received for the shares at the start of the project but more taxes must be paid at the end of the project. To know which strategy {s, LIFO} or {α, FIFO} will be chosen, the net revenue of both strategies must be determined and compared. The difference between the signalling revenue, the higher price received for the shares at the start of the project, and the signalling cost, the lower income at the end of the project, is the net revenue from using a certain strategy.

The increase in income for the manager of a H-firm from using {α, FIFO} can be determined from condition (4) and it equals:

$$a_1 (V_0 (H, \alpha, FIFO) - V_0 (L, \alpha, LIFO)) - (1-a_1)(V_2 (H, \alpha, LIFO) - V_2 (H, \alpha, FIFO))/(1+i)^2 \quad (8)$$

If the manager of the H-firm uses {s, LIFO}, the increase in income can be determined from condition (6) and it equals:

$$a_1 (V_0 (H, s, LIFO) - V_0 (L, \alpha, LIFO)) - (1-a_1)(V_2 (H, \alpha, LIFO) - V_2 (H, s, LIFO))/(1+i)^2 \quad (9)$$

The manager of the successful project will use the signalling device, which results in the largest increase in income over the total life of the project. The manager prefers the strategy {α, FIFO} above {s, LIFO} when (9) is smaller than (8), the additional taxes paid are smaller using the first strategy or :

$$(V_2(H, \alpha, LIFO) - V_2 (H, s, LIFO))/(1+i)^2 > (V_2 (H, \alpha, LIFO) - V_2 (H, \alpha, FIFO))/(1+i)^2 \quad (10)$$

I show in Figure 2 under which circumstances this condition can met.

Insert Here Figure 2
Figure 2: The effect of the chosen accounting methods on the change of the tax rate in the first and second period

If the manager uses the value maximising strategy {α, LIFO}, $x_{H_\alpha LIFO1}$ is the level of profits and the taxes paid are minimised in the first period. Whatever strategy is used as a signalling device, {s, LIFO} as well as {α, FIFO} result in an increase in profits in the first period ($x_{H_\alpha LIFO1} < x_{H_\alpha FIFO1} < x_{HsLIFO1}$). In Figure 2, the increase in profits is larger using {s, LIFO} than {α, FIFO} ($x_{HsLIFO1} > x_{H_\alpha FIFO1}$) because the difference between the depreciation amounts is larger than between the costs of the goods sold ($\alpha K - K/2 > E(P - P_I)x$). In this case, in the first period the increase in the tax rate

($\Delta_{1linear} > \Delta_{1FIFO}$) and in the taxes paid is larger using {s, LIFO} than {α, FIFO}. Figure 2 shows not only the effect in the first but also in the second period. Compared to {α,LIFO}, {α, FIFO} as well as {s, LIFO} result in smaller profits ($x_{HsLIFO2} < x_{H_\alpha FIFO2} < x_{H_\alpha LIFO2}$) and a smaller amount of taxes paid. Because the total amount of write-offs is the same over the total life of the project and more costs are expensed in the first period using {α, FIFO} than {s, LIFO}, the costs expensed in the second period are smaller using the first strategy and the profits realised are larger. Because the profit level is smaller using {s, LIFO} than {α, FIFO}, the decrease in tax rate is larger using {s, LIFO} than {α, FIFO} ($\Delta_{2linear} > \Delta_{2FIFO}$). The concave and increasing tax rate function and the time value of money are the reasons why the advantage of {s, LIFO} in the second period can never be larger than the advantage in the first period ($\Delta_{2linear} - \Delta_{2FIFO} < \Delta_{1linear} - \Delta_{1FIFO}$). If the difference is larger between the depreciation amounts than between the cost amounts of the goods sold, the increase in the tax rate and the taxes paid is larger using {s, LIFO} than {α, FIFO}. In Appendix proposition 2 this statement is proven.

In conclusion, the choice of a signalling device depends on the relationship between the level of profits. If the difference is larger between the depreciation amounts than between the cost amounts of the goods sold, {s, LIFO} results in a larger increase in taxes paid and the manager -owner benefits from the largest increase in income by choosing {α, FIFO} as a signalling strategy.

Whether this situation occurs certainly depends on the characteristics of the investment and purchasing policy. As the investment amount goes up, the difference between the accelerated and linear depreciation amount increases and the additional taxes paid from using {s, LIFO} grow. Therefore, I expect that in capital intensive industries, where investments are large, {α, FIFO} is a less expensive signalling device (The proof is made in Appendix proposition 3).

The legal environment also influences the choice of a signalling device. As the accelerated depreciation rate increases, the firm can realise larger tax savings from using accelerated depreciation and linear depreciation becomes a more expensive signalling device. Therefore, in countries, where the accelerated depreciation rate is high, the choice of {s, LIFO} is less likely to be chosen as a signalling device (The proof can be found in Appendix proposition 4). In conclusion, as the investment amount and the accelerated depreciation rate increase, {s, FIFO} becomes a more expensive signalling device.

However, the characteristics of the purchasing policy may not be ignored in choosing {s, LIFO} or {α, FIFO}. As the initial price drops, an increase in the price becomes more likely, and the expected cost difference between {α, FIFO} and {α, LIFO} as well as the increase in the taxes paid from using {α, FIFO} go up. Therefore, as P_I decreases, {α, FIFO} becomes a more expensive signalling device. In industries where the current price of the purchases is low and the volatility of prices is high, the chance is larger that {s, LIFO} is chosen as a signalling device. Moreover, as the firm invests more in an initial level of inventory, this effect is strengthened (The proof is made in Appendix proposition 4 and 5).

4. Conclusion

In this paper a comparison is made between two accounting signals: the inventory and the depreciation accounting method. The model of Hughes and Schwartz (1988) is enriched by adding Cournot competition and by introducing a second signal the depreciation accounting method. The main conclusion is that FIFO will not always be hold as a signalling strategy to reveal the positive inside information.

I investigate the signalling problem in an environment, where two firms, one with high and one with low fixed costs, compete in the product as well as in the financial market. In the product market both types sell a homogeneous product and they play Cournot competition. Because the product is homogenous and the marginal cost of the goods sold is the same for both types, neither the quantity sold nor the price can be used as a signalling device. By adding Cournot competition in the signalling model, the quantity as well as the price of the good sold as the cash flows realised are endogenised, what does not occur in the model of Hughes and Schwartz (1988).

Given the value maximising quantities, the manager-owner determines the signalling device: FIFO or linear depreciation. The manager-owner of the firm with low costs has an incentive to reveal its success because he sells a part of his shares and he can receive a higher price for the shares sold if the asymmetries in information are solved.

I assume an environment where the manager-owner can choose between two depreciation accounting methods, linear or accelerated depreciation, and two inventory methods, FIFO and LIFO. In a complete information environment an income maximising manager-owner will always choose accelerated depreciation and LIFO to minimise the taxes paid. In an incomplete information environment and a duopoly situation the other three strategies can be used to solve asymmetries in information. However, linear depreciation and FIFO are certainly not an efficient choice because asymmetries in information about only one parameter, the expected cash flows and a duopoly situation with two types of firms exist. The addition of a second unexpected accounting signal does not offer any new information while the manager must pay additional taxes. Therefore, in a duopoly situation the manager chooses either (linear depreciation, LIFO) or (accelerated depreciation, FIFO) in order to reveal the firm type.

I show that industry characteristics play a major part in choosing one of these strategies. The manager-owner of the firm will always choose the signal, which results in the smallest increase in taxes paid and the largest increase in income. In industries where the volatility of prices is high, the chance of an increase in price and in taxes paid from using FIFO is large. Therefore, in industries with a high volatility of the input prices, I expect that FIFO is not preferred as a signalling device.

However, the characteristics of the investment policy may not be ignored. As the investment amount goes up, the increase in profits from using linear depreciation as well as the increase in taxes paid grow. Therefore, I expect that in capital intensive industries, accelerated depreciation and FIFO are used as reporting methods because the cost from using linear depreciation is too high.

The analysis of the difference in costs between these strategies also shows that legislation has a major influence. As the allowed accelerated depreciation rate drops, the difference between the depreciation amounts as well as the additional taxes from using linear depreciation decrease and linear depreciation becomes more attractive as a signalling device. However, legislation also limits signalling by the choice of accounting methods. The choice of FIFO and linear depreciation is only a reliable signal when the same method must be used for tax and reporting purposes. If the depreciation rate could be determined freely, the firm with low costs could probably reveal its type by the value maximising depreciation rate. Because signalling by the depreciation rate is free, it would certainly preferred as a signalling device. The characteristics of the legal environment also explain why the inventory and the depreciation accounting method together are unable to reduce the signalling cost. Contrary to the study of Datar, Feltham and Hughes (1991) either the depreciation method or the inventory method is used as a signalling device.

This signalling model illustrates why differences across industries in reporting strategies could occur (Watts & Zimmerman, 1990). However, signalling by an income increasing reporting strategy remains an expensive signalling device, it always results in an increase in the taxes paid because legislation only offers the discrete choice between two alternatives. The main challange for the future is to compare these two accounting methods as a signalling device and to introduce more industry related characteristics in empirical studies.

APPENDIX

Proposition 1: If cash flows are sufficiently large and P_I is small, {α, LIFO} is the value maximising choice in a complete information environment.

The expected taxes if the depreciation method d and the inventory method v is used, equal:

$$+\left(\frac{(x_{tdv1}(M- e^{-c(x_{tdv1})})}{(1+i)} + \frac{(x_{tdv2}(M- e^{-c(x_{tdv2})})}{(1+i)^2}\right)$$

If x_{tdv1} is larger than 1/c the taxes paid are an increasing function of the profits realised. Therefore, the taxes paid are certainly larger using {s, LIFO} than {α, LIFO}. Moreover, if P_I is smaller than E(P), the expected profits and the taxes paid are larger using {α, FIFO} than {α, LIFO}. Finally, if P_I is smaller than E(P), the expected profits and the taxes paid are certainly larger using {s, FIFO} than {α, LIFO}.

Proposition 2: If the difference is larger between the linear and accelerated depreciation amounts than between the LIFO and FIFO cost of the goods sold, {α, FIFO} is a less expensive signalling device than {s, LIFO}.

When the characteristics of the tax rate environment, the investment and purchasing policy are filled in condition (10), the increase in taxes paid is larger using {s, LIFO} than {α, FIFO} when :

$$M(\alpha K - K/2)\left(\frac{1}{(1+i)} - \frac{1}{(1+i)^2}\right) - \left(\frac{1}{(1+i)} - \frac{1}{(1+i)^2}\right)M((P_{max} + P_{min})/2 - P_I)x$$

$$+\left(\frac{(x_{H\alpha FIFO1} + 1/c)\, e^{-c(x_{H\alpha FIFO\,1})}}{(P_{max} - P_{min})\, c(2(a-P)/9b - x)(1+i)} - \frac{(x_{HsLIFO1} + 1/c)\, e^{-c(x_{HsLIFO\,1})}}{(P_{max} - P_{min})\, c(2(a-P)/9b)(1+i)}\right.$$

$$\left. + \frac{(x_{H\alpha FIFO2} + 1/c)\, e^{-c(x_{H\alpha FIFO\,2})}}{(P_{max}-P_{min})c(2(a-P)/9b)(1+i)} - \frac{(x_{HsLIFO2} + 1/c)\, e^{-c(x_{HsLIFO\,2})}}{(P_{max}-P_{min})c(2(a-P)/9b -x))(1+i)^2}\right)\Bigg|_{P_{min}}^{P_{max}} > 0 \quad [6]$$

The first two terms show the difference in expected taxes paid between {α, FIFO} and {s, LIFO} when the maximal tax rate M is applied. If the difference between the accelerated and linear depreciation amount $((\alpha - 1/2)K)$ is larger than the expected cost difference between LIFO and FIFO $((P_{max} + P_{min})/2 - P_I x)$, the increase in profits and additional taxes paid is larger using {s, LIFO} than {α, FIFO}. However, the tax rate is smaller than the maximal tax rate M. The difference in additional cash flows realised between {s, LIFO} and {α, FIFO} because the tax rate is smaller than M, occurs in the third term for the first period and in the fourth term for the second period. If the difference between the depreciation amounts is larger than between the costs of the goods sold, the increase in profits is larger using {s, LIFO} than using {α, FIFO}, $x_{H_\alpha FIFO1}$ is smaller than $x_{HsLIFO1}$.In this case, the advantage of a tax rate different from M is larger using (α, FIFO) than using (s, LIFO) because $(x_{tdvj} + 1/c)\ e^{-cx_{tdvj}}$ is a convex decreasing function of the profits for all values of x_{tdvj} [7]. The profits in the second period are larger using {α, FIFO} than using {s, LIFO} $(x_{H_\alpha FIFO2} > x_{HsLIFO2})$. Therefore, the additional cash flows because the tax rate is smaller than M are larger using {s, LIFO} than {α, FIFO}, and {s, LIFO} creates an advantage in the second period. However, this advantage is smaller than the disadvantage of {s, FIFO} is the first period because $(x_{tdvj}+1/c)e^{-cx_{tdvj}}$ is a convex decreasing function of the profits x_{tdvj}. Therefore, the sum of the exponential terms is positive. Because the difference between the first two terms is also positive, the additional taxes paid are certainly larger using {s, LIFO} than {α, FIFO}.

In conclusion, the strategy {s, LIFO} is a more expensive signalling device than {α, FIFO} when the difference between the depreciation amounts is larger than the difference between the expected cost of the goods sold using LIFO and FIFO.

Proposition 3: If K increases, {s, LIFO} becomes a more expensive signalling device

The first order derivative of the cost difference between {s, LIFO} and {α, FIFO} to K in proposition 2 equals :

$$M(\alpha - 1/2) \left(\frac{1}{(1+i)} - \frac{1}{(1+i)^2} \right)$$

$$+c\left(\frac{\alpha(x_{H\alpha FIFO1})\, e^{-c(x_{H\alpha FIFO1})}}{(P_{max} - P_{min})\, c(2(a-P)/9b - x)(1+i)} - \frac{1/2(x_{HsLIFO1})\, e^{-b(x_{HsLIFO1})}}{(P_{max} - P_{min})\, c2(a-P)/9b(1+i)} \right.$$

$$\left. + \frac{(1-\alpha)\,(x_{H\alpha FIFO2})\, e^{-c(x_{H\alpha LIFO2})}}{(P_{max} - P_{min})\, c2(a-P)9b\,(1+i)^2} - \frac{1/2\,(x_{HsLIFO2})\, e^{-c(x_{H\alpha FIFO2})}}{(P_{max} - P_{min})\, c(2(a-P)/9b - x)\,(1+I)^2} \right) \Bigg|_{P_{min}}^{P_{max}}$$

Because $x_{tdvj}\, e^{-x_{tdvj}}$ is a convex decreasing function for values of x larger than 2/c and $\alpha/(c(2(a-P)/9b-x)) > 0{,}5/(c(2(a-P)/9b-x)) > 0{,}5/(c(2(a-P)/9b)) > (1-\alpha)/(c(2(a-P)/9b))$, the difference between the exponential terms is certainly larger in the first than in the second period. If K increases, the decrease in taxes paid is larger using {α, FIFO} than {s, LIFO} and {s, LIFO} becomes less attractive as a signalling device. However, if profits are smaller than 2/c and larger than 1/c, the time value of money determines whether {s, LIFO} becomes more attractive as a signalling device. Finally, if profits are smaller than 1/c, {s, LIFO} becomes a cheaper signalling device. If a firm reports a loss, an increase in the investment amount results in a larger loss, no additional tax savings can be realised by using accelerated depreciation and accelerated depreciation becomes less attractive as a signalling device.

Proposition 4: If α increases, {s, LIFO} becomes a more expensive signalling device

The first order derivative of the cost difference in proposition 2 to α equals :

$$MK \left(\frac{1}{(1+i)} - \frac{1}{(1+i)^2} \right)$$

$$+ cK \left(\frac{(x_{H\alpha FIFO1})\, e^{-c(x_{H\alpha FIFO1})}}{(P_{max}-P_{min})\, c(2(a-P)/9b - x)(1+i)} - \frac{(x_{H\alpha FIFO2})\, e^{-c(x_{H\alpha FIFO2})}}{(P_{max}-P_{min})\, c(2(a-P)/9b - x)\,(1+i)^2} \right) \Bigg|_{P_{min}}^{P_{max}}$$

Because $x_{qdvj}\, e^{-cx_{qdvj}}$ is a concave or convex decreasing function for values larger than 1/c, $x_{H_\alpha FIFO2}$ is larger than $x_{H_\alpha FIFO1}$, {s, LIFO} becomes a more expensive signalling device. The strategy {s, LIFO} becomes more attractive as a signalling device for profits smaller than 1/c. If firms realise negative profits, no taxes must be paid and an increase in the depreciation amounts does not result in an decrease of the taxes paid.

Proposition 5: If P_I decreases, {s, LIFO} becomes more attractive as a signalling device.

The first order derivative of the cost difference between {s, LIFO} and {α, FIFO} to P_I in proposition 2 equals :

$$Mx \left(\frac{1}{(1+i)} - \frac{1}{(1+i)^2} \right)$$

$$+ \; cx \left[\frac{(x_{H\alpha FIFO1})\, e^{-c(x_{H\alpha FIFO1})}}{(P_{max}-P_{min})\, c(2(a-P)/9b - x)(1+i)} + \frac{(x_{HsLIFO2})\, e^{-c(x_{HsLIFO2})}}{(P_{max}-P_{min})\, c(2(a-P)/9b - x)\,(1+i)^2} \right]_{P_{min}}^{P_{max}}$$

Because only positive terms occur, {α, FIFO} certainly becomes less expensive as a signalling device when P_I grows. However, if the initial price drops {s, LIFO} becomes more attractive as a signalling device.

Proposition 6: If x increases, {α, FIFO} becomes less attractive as a signalling device.

The first order derivative of the cost difference between {s, LIFO} and {α, FIFO} to x in proposition 2 equals :

$$-M((P_{max} + P_{min})/2 - P_I) \left(\frac{1}{(1+i)} - \frac{1}{(1+i)^2} \right)$$

$$+ \left[\frac{-c(P-P_I)(x_{H\alpha FIFO1})\, e^{-c(x_{H\alpha FIFO1})}}{(P_{max}-P_{min})\, c(2(a-P)/9b - x)(1+i)} + \frac{c(P-P_I)(x_{HsLIFO2})\, e^{-c(x_{HsLIFO2})}}{(P_{max}-P_{min})\, c(2(a-P)/9b - x)\,(1+i)^2} \right]_{P_{min}}^{P_{max}}$$

Because $x_{H_\alpha FIFO1}$ is smaller than $x_{HsLIFO12}$ and $x_{qdvj}e^{-cx_{qdvj}}$ is a decreasing function of the profits for values larger than 1/c, the first order derivative is certainly negative. As the initial inventory x increases, the additional taxes paid by using FIFO increase and {α, FIFO} becomes a more expensive signalling device.

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NOTES

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1 Because a homogeneous product is assumed, Bertrand competition is impossible.

2 The inventory at the end of the project must equal zero to consider all tax effects.

3 The part of the shares sold is exogeneously determined, otherwise it can also fulfill a signalling function.

4 The value maximising output is determined before taxes because otherwise the chosen depreciation and inventory method would determine the quantity sold.

5 If more than two types exists, (s, FIFO) can also occur as an equilibrium strategy.

6 $x_{H_\alpha FIFO1} = (a-P)^2 /9b + (P-P_I)x - Fk_h - \alpha K$

$x_{HsLIFO1} = (a-P)^2 /9b - Fk_h - K/2$

$x_{H_\alpha FIFO2} = (a-P)^2 /9b - Fk_h - (1-\alpha) K$

$x_{H_\alpha LIFO2} = (a-P)^2 /9b + (P-P_I)x - Fk_h - K/2$

7 This effect is strenghtened by the smaller constant term, which is smaller using (α, FIFO) than using (s, LIFO)($(c\,2(a-P)/9b-x) -x) < c2(a-P)/9b$).