INFINITE PLANNING HORIZON, LAND OPPORTUNITY COST AND FAUSTMANN METHODOLOGY

José Luiz Pereira de Rezende[1], Antônio Donizette de Oliveira[1],
Luiz Moreira Coelho Júnior[2]

(received: december 20, 2004; accepted: may 10, 2005)

ABSTRACT: The paper studied and discussed The Faustmann Method (Land Expected Value - LEV) comparing it with The Net Discounted Value project evaluation criterion, in an infinite horizon (NDV_∞). The method was applied for determining land value, envisaging eucalyptus plantation in savannah area (cerrado) in Brazil, for the purpose of charcoal production. For the same situation the Net Discounted Value was applied and compared. The costs considered were establishment, maintenance and harvesting and that the forest was managed with the substitution being done after cutting the original establishment at seven years of age, that is, there is no coppicing transport. The substitution cost was considered equal to that of establishment. The only income considered was the sale of the wood produced for energy (250 st/ha) at the price of US$ 7.10/st in the cutting age. The main conclusions were: For any discount rate, LEV is always a larger value than NDV_∞ because NDV_∞ considers land in the relationship of costs; the assumption that land only has value for wood production, implied by Faustmann methodology, doesn't have theoretical nor practical support; if there is no alternative for land use, then its opportunity cost is zero and there would be no reason to determine its value; land productive value is not the only value that enters in the formation of its price. The Faustmann methodology doesn't capture the other factors that affect land price, for instance, the speculative effects, cultural values, land protective value, protection against inflation and of status attribution, etc..; LEV indicates how much can be spent in any cost item left out of the calculations.

Key words: Faustmann method, land expectation value, economic analysis, project evaluation.

HORIZONTE DE PLANEJAMENTO INFINITO, CUSTO DE OPORTUNIDADE DA TERRA E O MÉTODO DE FAUSTMANN

RESUMO: *Estudou-se e discutiu-se o Método de Faustmann - Valor Esperado da Terra (VET) - e comparou-se os resultados obtidos com aqueles fornecidos pelo método do Valor Presente Líquido, em um horizonte infinito de planejamento (VPL_∞). O método foi aplicado na determinação do valor da terra objetivando o plantio de Eucalyttus sp., em área de cerrado no Estado de Minas Gerais, para a produção de carvão vegetal. Para a mesma situação, o método de Valor Presente Líquido será aplicado e os resultados serão comparados. Os custos considerados foram implantação, manutenção e colheita. O povoamento foi manejado em ciclo de produção de um único corte, isto é, após o corte do sistema de alto fuste, aos sete anos de idade, realiza-se nova implantação. O custo de reforma foi considerado igual ao custo de implantação. A única renda considerada foi a venda da madeira produzida para energia (250 st/ha) ao preço de US$ 7.10/st na idade de corte. As conclusões principais foram: para qualquer taxa de desconto, o VET é sempre maior que o VPL_∞, porque o VPL_∞ considera a terra na relação de custos; a suposição que terra só tem valor para a produção de madeira, implícita na metodologia de Faustmann, não tem consistência teórica nem prática; se não há alternativa para o uso da terra, seu custo de oportunidade é zero e não há razão para determinar seu valor; o valor produtivo da terra não é o único valor que entra na formação de seu preço. A metodologia de Faustmann não captura os outros fatores que afetam o preço da terra, por exemplo, os efeitos especulativos, terra como valor de proteção, proteção contra inflação e de conferência de estatus, etc.; o VET indica quanto pode ser gasto em qualquer fator de custo deixado fora do cálculo do VPL.*

Palavras-chave: Método de Faustmann, valor esperado da terra, análise econômica, avaliação de projeto.

1 INTRODUCTION

During the XVIII century and the first half of the XIX century, the foundations of the modern forest science began to be delineated by a small group of "foresters" in Germany and in Austria. The mensuration of the economical returns of investments in forest activity began to constitute the main concern of forest management. König (1813), cited by Fernow (1913), developed the first work on land revenue (land rent). The concept of land rent continued to be developed by their contemporaries, among who stood out Martin Faustmann, whose formula, commonly called land expectation value (LEV), or soil expectation value (SEV) has been exhaustively mentioned in forest literature, mainly in Europe (GANE, 1968).

[1] Professores do Departamento de Ciências Florestais da UFLA – Cx.P. 3037 – 37.200-000 – Lavras, MG –Brazil – jlprezen@ufla.br; donizete@ufla.br

[2] Economista, Mestre em Engenharia Florestal – Professor do Instituto de Educação Afonso Cláudio – Rua Presidente Lima, 178 – Centro – 29.100-330 – Vila Velha, ES – lmcjunior@hotmail.com

At that time, significant areas were being relocated from wood production to agriculture; therefore, to determine the compensation for the forest landowners constituted a real problem. Thus, the reality of Europe at the half of the XIX century was completely different from today's reality in Brazil, mainly in some parts of South and Southeast, where the forest activity is more attractive economically than that agriculture. In Europe at that time, the problem was to substitute forest area (productive and managed) for agricultural area. In Brazil nowadays, in a certain way, the opposite is happening.

Faustmann was also motivated by a Gheren (1849) previous work of which results he disagreed. He begins examining, under the economical point of view, a unit of bare land, in which a forest species is planted, that, in a rotation, it yields thinnings and a final cut, after which the cycle (rotation) repeats infinitely. The work calculated land value for reforestation and the value of immature stands, i.e., those stands that had not reached the cutting age. Faustmann worried only about LEV, taking all the other variables as deterministic and correct.

Faustmann (1849) and Gheren (1849) worked with cash flow, considering infinite horizon, arriving to bare land value that was the objective. Faustmann recognized that Gheren, in this matter, was correct. His formula, however, only generated solid results when it began with bare land, because in this case the value of the forest coincided with the value of the land. Most of the work of Faustmann was dedicated to demonstrate three different ways to determine the value of immature forest (without considering land value). Paradoxically, Faustmann didn't become known for this part of the work, but for the part that Gheren had already correctly developed and published.

An explanation given by Gane (1968) why the merits were given to Faustmann and not to Gheren is the fact that Faustmann expressed the results through a concise formula, deducing in a more academic and pedagogic way.

Faustmann (1849) and Gheren (1849) separated their works in two parts: the first they called "Solution for the intermittent management" and the second, "Solution to sustained management". Possibly, this was the first time that the expression sustained production (sustained yield) appeared in forestry literature.

The second solution was for today's called even-aged regulated forest (planted), i.e. , the total area of the forest was divided in stands, whose number coincided with the rotation in years. In the case of an area "A" and rotation of "t" years, A/t stands were with one year of age; A/t with two years, and so forth, until , finally, A/t stands were at the cutting age.

Two situations were examined. In the first one, "it was planted" every year, A/t ha until the whole area was fully planted. However, that caused losses, because the majority of the area was not producing anything for a long period of time. At that time, the authors ignored any alternative for land use. In the second one, "it was planted" at once the whole area of "A" ha and along time the forest was regulated. The procedure at that time was, starting from t/2 years, to begin to cut the forest until reaching the objective. Faustmann proposed a different solution, but it didn't take into account land opportunity cost. On this particular, he was criticized by Oderwald & Duerr (1980).

Faustmann and Gheren understood that the forest was composed of two basic values: the value of the stock in growth and the value of the land. To arrive to land value, he determined the value of the forest and deduced the value of the growth stock. It was exactly the determination of the value of the forest that generated the controversy.

Gheren (1849) concluded that LEV for agricultural purpose varied from 6 Rthlr/acre, earth for pasture, to 48 Rthlr/acre, the best land use alternative. He didn't make any reference to the opportunity cost of capital. Seemingly, he ignored the principle, because he didn't comment on, for instance, that land cost should be taken as the largest found value.

Faustmann (1849) found 5 Rthlr/acre as land value. To justify that the found value was below the smallest "market value" encountered by Gheren (1849), he affirmed: "we don't want to investigate if the low land value found is caused by the low productivity and, or, for the low prices of the wood considered, we are just interested in principles."

Therefore, even at that time, LEV found by Gheren-Faustmann criteria didn't coincide with land market value (LMV), being inferior. This occurred because the criterion didn't take into account that

there are other variables influencing land value and did not consider that forest activity could not be the best alternative use. Not being tecnified and having full and cheap labor, the main item of the production cost of wood, at that time, was land, explaining the great concern with the economical treatment of this input.

Today, the participation of land in the total wood production costs is not so significant. Thus, under the economical point of view, it is not justified that the objective of the forest activity be to maximize the returns land. To maximize the returns of the capital, employed, in their several forms, seems more economically sound.

In the case of the intermittent management, when the evaluation time coincides with the beginning or with the end of the rotation, LEV coincides with the value of the land, because there is no growth stock. However, if this doesn't happen, in other words, stock there is been in growth (forest still didn't reach the rotation), the solution of the problem becomes more difficult.

The contribution of Faustmann exceeded the restricted world of the forest economy, because, when analyzing the problem of land value determination, he also pointed out the solution of the problem of determining the optimal time of substitution of the capital goods, for instance, equipments. It consisted of the first practical use of what today is known as "cash flow" (GANE, 1968).

Speidel (1966) attributed to Faustmann the first proposition of the discounted present value (DPV). However, König (1813), cited by Gane (1968), had already proposed and examined deeply the matter. One cannot affirm, however, that he was the pioneer.

The knowledge of LEV or of the discounted cash flow it was a long time without use, reappearing in the literature only in Böhm-Bawerk (1890), cited by Gane (1968), and in Fisher (1907), when again entered in forgetfulness, only reappearing in the fifties, this time, seemingly, to stay forever.

Faustmann (1849) not even implicitly talks about how to manage the forest or how to determine rotation age. The problem of the discount rate is not mentioned. He manifests, however, a sharp perception of the economical nuances, when he determines LEV (land rent) in the optimal cutting age, because it at this age that he determined land opportunity cost for agriculture or the cost of removing land from forest production.

All those that adopted the forest management aiming at to maximize the financial return favored the use of the König-Faustmann method, or, at least, they stimulated its use. The foresters of the United States and of England learned with the German School that the great rotation is that that produces the maxim "land expected income."

In Brazil, the Germans Moosmayer (1969) and Speidel (1966), first Forest Economy teachers of the Country, popularized LEV. Now, many students, teachers and researchers have been using Faustmann's formula, seemingly, in an erroneous and different way than originally imagined. His formula, however, became classic and its knowledge is almost obligatory in forestry economics. LEV, however, is only used in forestry, pure economy does not make any reference to it.

Faustmann's model assumes implicitly the following that:

- the costs of all factors involved in wood production process are included in the calculation, except land cost (DAVIS & JOHNSON, 1987). Leuschner (1984) expressed this assumption establishing land cost as zero;
- the used discount rate reflects opportunity cost of investor's capital;
- land will be used for the "chosen purpose" for such a long time that can be considered infinite;
- land doesn't possess any good of value constructed or established on it (LEUSCHNER, 1984).

Besides those, two other presuppositions or important restrictions are not mentioned in the literature; they are:

- the cash flow will be the same in perpetuity, what means that it will always be cultivated the same species, for the same purpose, and that the relative prices will remain constant along time;
- land only has value for wood production.

Thus, the objectives of this research were to study and discus Faustmann Method (Land Expected Value – LEV) and compare it with the Net Discounted Value project evaluation criterion, in an infinite horizon (NDV_{∞}).

2 MATERIALS AND METHODS

Faustmann's method was applied in the determination of land value envisaging eucalyptus plantation in savannah area (cerrado) in Brazil, for producing charcoal. For the same situation the Net Discounted Value (NDV_∞) will be applied and compared.

The costs considered are: establishment, maintenance and harvesting. Table 1 shows the values of costs and their distribution along time.

To simplify, it is considered that the forest will be managed with a new plantation being done every seven years, that is, there is no coppicing management. Besides, it is considered that the substitution cost will be the same of the establishment cost.

The only considered income is that originating from the sale of the wood produced for energy (250 st/ha) at the price of US$ 7.10/st.

Table 1 – Activities involved in the eucalyptus wood production for energy, their respective costs and occurrence times.

Tabela 1 – *Atividades envolvidas na produção de madeira de eucalipto para energia com os respectivos custos e épocas de ocorrência.*

Activities	Year of occurrence	Cost (US$/ha)
- Establishment		
Seedling production	0	82.50
Area preparation	0	138.50
Manuring	0	43.70
Planting and replanting	0	22.30
Weed control	0	35.80
Miscelaneous	0	48.60
Subtotal		*37.40*
- Maintenance		
Weeding	1	52.70
Manuring	1	27.40
Cleaning	2	21.30
Pest control	1 to 7	5.90
Fire control	1 to 7	2.20
Forest inventory	1 to 7	1.60
Miscelaneous	1 to 7	19.50
Before harvesting cleaning	7	8.50
- Harvesting (US$ 2,00/st)	7	500.00

The formulas for calculating the current value (CV) of costs and incomes considered, at the given annual discount rate (i), are:

- Establishment cost (EC), that happens in year zero and it will occur every "n" years (rotation) in an infinite sequence, as established by Faustmann's criterion. The activities or operations that compose this cost are: area preparation, pest control, maruring, production of seedlings, planting, replanting and miscelaneous. The current value (CV_{IC}) of any activity can be calculated by the formula:

$$CV_{EC} = \frac{EC(1+i)^n}{(1+i)^n - 1} \quad (1)$$

- Maintenance cost: Its occurrence time varies in function of the operation type, as shown below.

Weeding (WE) and manuring (MA): they happen one year after the establishment. Its current value ($CV_{WE, MA}$) will be:

$$CV_{WE,MA} = \frac{\frac{(WE+MA)(1+i)^n}{(1+i)^n - 1}}{(1+i)} \quad (2)$$

Clearing (CL): it happens two years after the establishment and it will be appealing to each n years until the infinite. Its current value (CV_{CL}) will be:

$$CV_{CL} = \frac{\frac{CL(1+i)^n}{(1+i)^n - 1}}{(1+i)^2} \quad (3)$$

Before cutting clearing (BP): it happens in the cutting year, repeating every "n" years infinitely. Its current value (CV_{BP}) will be:

$$CV_{BP} = \frac{BP}{(1+i)^n - 1} \quad (4)$$

Pest control (CC), fires control (FF), forest inventory (FI) and miscelaneous (SE): happen annually in an infinite. Its current value ($CV_{CC,FF,FI,SE}$) will be:

$$CV_{CC,FF,FI,SE} = \frac{CC + FF + FI + SE}{i} \quad (5)$$

- Harvesting (CR): it happens in the year of the final cut and keep happening every "n" years (rotation) until the infinite. The harvesting cost is obtained multiplying the wood volume, in st/ha (V), by the harvesting cost of each st (C), i.e., CR = V.C. The current harvesting cost (CV_{CR}) will be:

$$CV_{CR} = \frac{CR}{(1+i)^n - 1} \quad (6)$$

- Gross revenue (GR): it happens in the year of the final cutting and it will keep occurring every "n" years (rotation) in an infinite sequence. Its value in the harvesting year is obtained multiplying wood volume (V), in st/ha, by its price (P), in US$/st, i.e., GR = PxV. The current value of the income (CV_{GR}) it will be:

$$CV_{GR} = \frac{GR}{(1+i)^n - 1} \quad (7)$$

Therefore, land expected value (LEV) is given by the equation bellow:

$$LEV = \frac{GR}{(1+i)^n - 1} - \frac{EC(1+i)^n}{(1+i)^n - 1} - \frac{\frac{(MA+WE)(1+i)^n}{(1+i)^n - 1}}{(1+i)} - \frac{\frac{CL(1+i)^n}{(1+i)^n - 1}}{(1+i)^2} - \frac{BP}{(1+i)^n - 1} -$$

$$- \frac{CR}{(1+i)^n - 1} - \frac{CC + FF + FI + SE}{i} \quad (8)$$

Faustmann understood that this LEV was the value that one could pay for land, i.e., he didn't consider the current value of land cost (CV_{LC}) in equation 8. However, CV_{LC} is given by:

$$CV_{LC} = \frac{LC}{i}$$

Equaling this value to LEV,

$$CV_{LC} = \frac{LC}{i} = LEV$$

So, the value of bare land is given by the discounted value of the annual parcel LC (annual land cost), that occurs in perpetuity.

3 RESULTS AND DISCUSSION

Using the data of costs and incomes mentioned and considering a discount rate of 8% p.a., the equation 8 indicates that:

$$LEV = \frac{1,775.00}{(1+0.08)^7 - 1} - \frac{371.40(1+0.08)^7}{(1+0.08)^7 - 1} - \frac{\frac{(52.70+27.40)(1+0.08)^7}{(1+0.08)^7 - 1}}{(1+0.08)} - \frac{\frac{21.30(1+0.08)^7}{(1+0.08)^7 - 1}}{(1+0.08)^2} -$$

$$- \frac{8.50}{(1+0.08)^7 - 1} - \frac{500}{(1+0.08)^7 - 1} - \frac{5.90+2.20+1.60+19.50}{0.08} = US\$295.65$$

Table 2 shows LEV equals to US$ 295.65, a value much lower than land price per ha in cerrado area of Brazil. According to Leuschner (1984) the methodology can be used to determine how much a investor can pay (to invest) in any factor. For calculating each one of them, for instance the expected value (EV) of seedling production, one must exclude this cost and take into consideration the costs of all other inputs. The same principle was followed for calculating the maximum value that could be paid to any other input, considering land value as US$ 350.00 per ha.

The EV of each activity is directly proportional to its participation in the total cost; consequently, EV of an activity whose current market cost value is smaller than the difference between the market land value and LEV will be negative.

For a discount rate of 8% p.a., LEV is US$295.95, a larger value than NDV_∞ US$-54.35. This will be always the case, because NDV_∞ considers land in the relationship of costs (See the section "Differences between LEV and NDV_∞"). LEV, in the case, underestimates land market value.

If one investor pays by land the calculated LEV, then NDV, in any planning horizon considered, will be "zero"; consequently, The Internal Rate of Return (IRR) of the investment will be the adopted discount rate.

Table 3 shows the contribution of the activities considered. The participation of land cost 13.76% indicates that, individually, it is only inferior to the harvesting cost. Grouping the costs, it can be concluded that land cost is only inferior to establishment cost (35.10%), maintenance cost (23.57%) and harvesting cost (27.57%).

The problem of the planning horizon can be better understood analyzing the Table 4. It can be observed, for instance, that it is not necessary that the horizon be really infinite. For a discount rate of 6% p.a., about 99% of LEV and of NDV_∞ are obtained in, approximately, 70 year horizon. Logically, for larger discount rates such as 10% and 14% p.a., the same porcentual of NDV and of LEV are obtained in smaller horizons, between 42 and 56 years and between 28 and 42 years, respectively. The idea of Chakravarty (1962) to determine the planning horizon was exactly that.

Table 2 – Land expected value (LEV) and expected values of each activity that composes the total cost, considering a discount rate of 8% p.a.

Tabela 2 – *Valor esperado da terra (VET) e valores esperados de cada atividade ou operação que compõe o custo total, considerando uma taxa de desconto de 8% a.a.*

Activities that compose the total cost	Expected value of activities (US$/ha)
- establishment	
Seedling production	143.71
Area preparation	278.16
Manuring	50.56
Planting and replanting	- 0.82
Pest control	31.59
Miscelaneous	62.32
Subtotal 1	*565.52*
- Maintenance	
Weeding	62.79
Manuring	6.55
Clearing	- 10.52
Pest control	19.39
Fire control	- 26.86
Forest inventory	- 34.36
Miscelaneous	189.39
Before harvesting cleaning	- 42.45
Subtotal 2	*163.93*
- Harveting	646.09
- Land value	295.65

3.1. Critics to Faustmann methodology

In spite of the great deed of Faustmann and of the great admiration that he enjoys among foresters, some considerations should be made in relation to his formula. The first of them is linked to the realism of the model and of the assumptions that implicitly the model adopts. The efficiency or usefulness of any model, or technique, depends on the degree of reality that their assumptions adapt to the real problem analyzed. However, it is apt to who will make the decision, or to the analyst, to examine the situation and the pertinent facts carefully. Some considerations about the assumptions and restrictions of Faustmann model can be made:

- The problem of the planning horizon is object of long and intricate discussion in the economical literature (ABOUCHAR, 1997; MISHAN, 1971; NICHOLS, 1964). Some authors suggest the use of the course of action involving reapplication of the capital rests and differences of cash flows among projects, intermediate returns, etc.; others suggest, without specifying which, the imposition of a horizon. Feldstein (1964) suggested that the discount rate be increased until that one that makes the discounted value of both costs and revenue insignificant. Chakravarty (1962) seems to be the unique economist to plead the use of an infinite horizon, to avoid outrages. Anyway, the use of infinite horizon is very spread and significant only in forestry science, in which domain, it seems not to be preceded of deeper exam of its theoretical, or even practical, implications.

Table 3 – Current land cost and costs of the activities, establishment maintenance and harvesting of eucalyptus wood and theirs respective participations (%) in the total cost of production, considering infinite planning horizon.

Tabela 3 – *Valor atual do custo da terra e das atividades de implantação, manutenção e colheita de madeira de eucalipto e as respectivas participações (%) no custo total de produção, considerando horizonte de planejamento infinito.*

Activities	Without considering land cost		Considering land cost	
	Current value of the cost (US$/ha)	% of the total cost	Current value of the cost (US$/ha)	% of the total cost
- Establishment				
Seedling production	198.07	9.04	198.07	7.80
Area preparation	332.53	15.18	332.53	13.09
Manuring	104.92	4.79	104.92	4.13
Planting and replanting	53.54	2.44	53.54	2.11
Pest control	85.95	3.92	85.95	3.38
Miscelaneous	116.68	5.33	116.68	4.59
Subtotal 1	*891.69*	*40.70*	*891.69*	*35.10*
- Maintenance				
Weeding	117.16	5.35	117.16	4.61
Manuring	60.91	2.78	60.91	2.40
Clearing	43.84	2.00	43.84	1.73
Pest control	73.75	3.37	73.75	2.90
Fire control	27.50	1.26	27.50	1.08
Forest inventory	20.00	0.91	20.00	0.79
Miscelaneous	243.75	11.13	243.75	9.59
Before harvesting clearing	11.91	0.54	11.91	0.47
Subtotal 2	*598.82*	*27.34*	*598.82*	*23.57*
- Harvesting	700.45	31.97	700.45	27.57
- Land	-	-	350.00	13.76
Total	*2,190.96*	*100.00*	*2,540.97*	*100.00*

* Land price = US$350.00/ha.

Table 4 – Effect of Planning Horizon and of Interest Rate on the proportion of NDV (US$) in relation to NDV_{∞} (US$).

Tabela 4 – *Proporção do VPL (US$) em relação ao VPL_{∞} (US$) em função do Horizonte de Planejamento e da Taxa de Juros.*

Horizon (years)	6%			10%			14%		
	NDV	NDV_{∞}	%	NDV	NDV_{∞}	%	NDV	NDV_{∞}	%
7	96.14	287.02	33.49	-124.46	-255.65	48.68	-287.26	-478.47	60.04
14	160.07		55.77	-188.33		73.67	-402.06		84.03
28	230.87		80.40	-237.92		93.07	-466.27		97.45
42	262.19		91,35	-250.98		98.17	-476.52		99.59
56	276.04		96.17	-254.42		99.52	-478.16		99.93
70	282.16		98.31	-255.32		99.87	-478.42		99.99
84	284.87		99.21	-255.56		99.97	-478.47		100.00
98	286.07		99.67	-255.62		99.99			
112	286.60		99.85	-255.5		100.00			
126	286.84		99.84						
140	286.94		99.47						
154	286.99		99.99						
168	287.02		100.00						

Faustmann adopts infinite horizon, what makes most of the forest economists to affirm that is an advantage. However, the pure economists see this with certain restriction and disadvantage, affirming that even in developed and stable economies the relative prices change. They affirm, categorically, that in horizons above 20 years one cannot admit that the relative prices assumption will hold true (ABOUCHAR, 1997). The reasons pointed out by forestry economists seem vague and with little theoretical sustentation, comparatively to those pointed out by pure economists, that seem theoretically more sound.

The adoption of infinite horizon can be used to balance horizons of projects with different durations.

- The assumption that land only has value for wood production doesn't have theoretical nor practical support, because if there is no alternative for land use, then its opportunity cost is zero. So there would be no reason to determine its value.

- The Faustmann's criterion is only used in forestry area, being practically ignored in other economic areas.

- The contribution of land cost in wood production cost is low, below 20% (REZENDE et al., 1994).

- LEV is function of the rotation age that in turn is function of land cost; therefore, to determine rotation without considering land cost, is not correct (HALEY, 1966; McKILLOP, 1971; PEARSE, 1967; REZENDE et al., 1994).

- The land opportunity cost, in practice, always exists (LEUSCHNER, 1984; McKILLOP, 1971; REZENDE et al., 1994). The influence of land cost on forest rotation in many situations is significant (HALEY, 1966; REZENDE et al., 1994).

- Land is typically a private good, therefore the performance of the market, for determining its price, cannot be ignored.

- The forest activity doesn't have active participation or significance in land price formation (EGLER, 1985; REZENDE, G., 1982).

- LEV is not considered a project evaluation criterion. Besides, when it was proposed, the other criteria used today thoroughly spread in the economy were not known.

- Land productive value is not the only value that enters in the formation of its price. The method of Faustmann doesn't capture, for instance, the speculative effects or value of land, land protective value protection against inflation and of status conference, among other (EGLER, 1985; SAYAD, 1982).

- LEV indicates that IRR of the investment, if the investor pays for land the price indicated by LEV, will be, exactly, equal to the used discount rate.

- Traditional companies can maintain the land always covered by forests, but no necessarily with the same species and always seeking the same purpose, what confers certain degree of unreality to LEV and the infinite horizon.

- A company that already has a planted area and want to determine the wood production cost cannot use the criterion of Faustmann, because it, certainly, is not wondering how much one can pay for the land, but what the opportunity costs of all factors are, including land. To determine, objectively, the profitability or economical viability of the enterprise, these costs, referring to land, are the interests on the invested value.

The assumption that certain factors are free (cost zero), as land, is totally incompatible with the concepts of the opportunity cost, that it is basic for the whole economical theory (PEARSE, 1967). Nowadays, land is seen as a factor of production as any other one, not deserving special treatment. Its cost for wood production is what could be gained in another activity. This is denominated opportunity cost and it will be discussed bellow.

Opportunity cost - the economy defines it as the value of other alternatives (opportunities) that are left aside, in order to obtain a certain product or service (BANNOCK et al., 1985). This concept differs from the understanding of the accountants to whom the cost of producing something is the total necessary money to obtain it (REZENDE, J., 1982).

Zivnuska (1949) recognized that "the basic problem for any forest investor is the same with which the entrepreneurs are confronted in any field": to compare anticipated costs with foreseen incomes; thus, the conception of the forest economical theory should be the same of that of the general and orthodox economy". Therefore, not to consider the cost of any used factor is not correct. The market value seems to be the best indicator of land cost opportunity, and the interests on its value the best indicator of land real cost during the time of land occupation.

3.2 Differences between LEV and NPV_∞

NPV shows, in today's values, what still remains after remunerating all production factors, including land. The capital is remunerated by the discount rate considered; the other items and inputs, by their market values; and, finally, the administration, by the opportunity cost. This surplus, in the economical jargon, is called "pure profit", what remains after remunerating all the factors by the discount rate.

LEV indicates how much can be spent in any cost item left out of the calculations, usually land, at a given discount rate. Thus, it can be said that the technique of LEV is not used only to determine how much the investor can pay for land, but also to any other cost item (LEUSCHNER, 1984).

That is not little, but it is not everything, as some authors think. LEV does not informs, for instance, the economic feasibility of the enterprise or of the economic returns of the capital invested in the activity.

Land value cannot be excluded. It has an opportunity cost that is always present. A land owner has always the possibility of selling the land and to apply the value obtained, for instance, in bank deposits, government's titles, shares etc. Therefore, the argument that already the earth is possessed is a sound one.

Although it is true that the inclusion of land cost will reduce NPV, IRR or any other indicator, not to proceed this way is not correct. No matter how high is the investment in land, it is just the reality of the facts.

Samuelson (1976) determined that the economic rotation is that maximizes the present discounted value of the cash flow, in an infinite chain. This is what the economic literature call discounted or present liquid value of the cash flow, considering infinite horizon (NPV_∞). However, this is not LEV of König, Faustmann and Gheren that doesn't include land cost, trying to maximize the return to this factor. NPV includes in the calculation the cost of opportunity of land use, calculated by the interest on its value.

In Faustmann (1849) and Gheren (1849) works, the market value of land is not mentioned. Faustmann said explicitly that what matters was the economical principle and no the practical reality.

Faustmann (1849) was aware of the existence of land opportunity cost, when pointed out that "obviously the land owner cannot demand more for

his stand than the value high enough to compensate him for the income not gained." His understanding of the idea of the opportunity cost is patent, stating that "the owner could have lent the value corresponding to the land market price instead of having used it for wood production."

4 CONCLUSIONS

For any discount rate, LEV will be always a larger value than NPV_∞ because NPV_∞ considers land in the relationship of costs.

The assumption that land only has value for wood production, implied by Fausmann methodology, doesn't have theoretical nor practical support, because if there is no alternative for land use, then its opportunity cost is zero and there would be no reason to determine its value.

The contribution of land cost to the wood production cost is not high enough to justify especial treatment.

The forest activity doesn't have active participation or significance in land price formation, so land price is not determined by forestry activity.

Land productive value is not the only value that enters in the formation of its price. The Faustmann methodology doesn't capture the other factors that affect land price, for instance, the speculative effects or value of land, land protective value, protection against inflation and of status conference, etc...

A company that already has a planted area and want to determine the wood production cost cannot use Faustmann criterion, because it, certainly, is not wondering how much one can pay for the land, but what the opportunity costs of all factors are, including land.

LEV indicates how much can be spent in any cost item left out of the calculations, usually land, at a given discount rate.

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