BEBR

FACULTY WORKING
PAPER NO. 1381

The Optimal Investment Strategy Through Universal/Variable Life Insurance

Keunchang Lee
Stephen P. D'Arcy

College of Commerce and Business Administration
Bureau of Economic and Business Research
University of Illinois, Urbana-Champaign

BEBR

FACULTY WORKING PAPER NO. 1381

College of Commerce and Business Administration

University of Illinois at Urbana-Champaign

August 1987

The Optimal Investment Strategy Through
Universal/Variable Life Insurance

Keunchang Lee, Graduate Student
Department of Finance

Stephen P. D'Arcy, Assistant Professor
Department of Finance

Digitized by the Internet Archive
in 2011 with funding from
University of Illinois Urbana-Champaign

http://www.archive.org/details/optimalinvestmen1381leek

ABSTRACT

Universal life (UL) and universal/variable life (UVL) insurance are becoming the most popular products in the life insurance industry. These policies provide various tax advantages which significantly impact the returns achieved by individual investors. Using the basic economic concepts of marginal and average rate of return, this paper provides a theoretical background for determining the optimal premium contribution to UL or UVL to maximize the rate of return and illustrates the sensitivity of the optimal premium level to changes in the parameter values.

I. INTRODUCTION

Universal life insurance (UL) and universal/variable life insurance (UVL) were introduced (1979 and 1984 respectively) as new forms of life insurance policies which provide investors with insurance protection as well as a tax advantage on the treatment of investment income. Due to favorable tax treatment, flexibility in the determination of the annual contribution and relatively inexpensive life insurance protection, they have become increasingly popular among investors, comprising over 40 percent of total amount of life insurance sold in 1985.

The cash value of UL can be invested in money market funds only,[1] whereas UVL policyholders can choose their investment medium among various alternatives, which usually include money market funds, bond funds, and stock funds. As with other types of cash value life insurance, holders of both policies assume the entire risk of investment performance although UL usually has a guaranteed minimum rate of return. Other than that, there is no guarantee by insurers on the investment results and cash value of these policies fluctuates along with changes in the capital markets.

The tax advantage of UVL[2] becomes increasingly important as the holding period lengthens. Similar to unrealized capital gains on stock investments, taxes on the investment earnings are deferred until the cash value is distributed, unlike interest earnings on bonds. Furthermore, since mortality costs

and expense loadings are offset from investment earnings, the actual tax payment is substantially smaller than other non-tax advantaged alternatives. Since typical UVL policies include either flat or proportional expense loadings and the tax benefit increases with the holding period, it takes time for UVL to dominate other non-tax sheltered investment alternatives. Another important tax advantage of UVL is that if the cash value is distributed as part of a death benefit, investment earnings are not subject to taxation at all. This provision is similar to the stepped up basis at death of unrealized capital gains.

The amount of the contribution to UVL is not predetermined. Investors can decide how much premium to put into these policies depending upon their financial situation or relative tax exposure at the time of contribution. However, they need to keep the accumulated cash value of the policy in excess of the mortality costs. Since most of these advantages come from taxation, IRS limits the maximum contribution to UVL by setting two guidelines to prevent investors from contributing excess amounts to these policies. Therefore, in order to qualify as a life insurance policy, investors should meet either 1) cash value accumulation test or 2) test of both guideline premium and cash value corridor test.

The cash value accumulation test requires that the cash value not exceed the net single premium required to fund future contract benefits. The net single premium is calculated at an interest rate of the greater of 4% or the guaranteed minimum

rate. The guideline premium test requires that cumulative premiums paid do not exceed the greater of the a) "guideline single premium" using as the interest rate the greater of 6% or the guaranteed minimum rate or b) sum of "guideline level premium" computed at the interest rate of the greater of 4% or the guaranteed rate. The cash value corridor test is met if death benefits exceed 250% of the cash value for an insured of attained age up to 40, grading down to 100% at age 95.

Studies on tax advantaged life insurance policies have been performed by several authors. Adelman and Dorfman (1982) compared tax advantaged insurance policies with other investment alternatives and measured the effect of tax rate changes on the investment results. Broverman (1986) studied the internal rate of return on life insurance and annuities by examining contingent death benefits over premiums paid and illustrated that the holding period is a critical factor in determining investment performances.

Warshawsky (1985) conducted research on the effect of 1982 TEFRA and 1984 TRA and found that the higher the interest rate, the better the life insurance performance over other competing investment alternatives. Belth (1982) studied the effect of front-end loads of universal life insurance policies on the realized rate of return and concluded that for universal life insurance, the rate of return on the surrender value is significantly affected by expense loadings and it depends on whether expense loadings are treated as a protection element or

savings component.

Chung and Skipper (1987) studied the effect of the interest rate on surrender value of UL policies and found out that current interest rates are not a particularly reliable indicator of policy value. They pointed out, instead, that less noticeable expense loadings, mortality costs, and surrender charges are of great importance in determining policy value.

More recently, D'Arcy and Lee (1987) compared, by computer simulation, the performance of UVL with a number of investment alternatives assuming investors would purchase an equivalent amount of term life insurance coverage. Using industry average data for each parameter values of UVL, they formulated how the after tax surrender values of each investment alternative are determined and showed how to choose the optimal investment vehicle depending on investors' expected holding period.

This paper shows how to determine the optimal contribution to UVL under the framework of marginal rate of return (MRR) and average (or internal) rate of return (IRR) for a given holding period, assuming investors need a certain amount of life insurance coverage. So, for a given annual available fund level, investors can choose the optimal investment medium and decide how much to invest through each investment alternative to maximize their expected return.

This differs from Broverman's study in that this shows how the percentage return of the cash surrender value, not of the

death benefit, is calculated and suggests the optimal contribution amount to UVL to maximize IRR. This study further develops D'Arcy and Lee's findings since this points out not only the optimal investment media but the exact amount to invest through UVL and other alternatives to get highest return.

In section II, the calculation of MRR and IRR are presented. In section III and IV, the optimal investment strategy under no-load and load UVL policies is studied. In section V, the effect of changing parameter values such as tax rate, interest rate and holding period, on the optimal investment strategy is discussed. Section VI summarizes the paper and draws conclusions from this research.

II. DETERMINATION OF RATE OF RETURN

Analysis of the performance of UVL and other investment alternatives shows differences in accumulated values resulting from the different tax treatment of investment earnings. Since individuals are assumed to maximize the after tax return on their investments and comparison of investment alternatives in this study is done within the same investment risk classes, investors' only concern is the terminal value of their investments after taxes.

Setting the main focus on the relative advantage of UVL compared with other alternatives, all investors are assumed to purchase a certain amount of life insurance coverage, either

through UVL or term life insurance of equivalent face value and put the remaining amount into investment vehicles. Since the main advantage of UVL over other alternatives is related to taxation, this advantage becomes larger the longer the investment horizon. However, if only the target annual contribution amount is allowed to vary and all other parameters are fixed, then the optimal contribution to UVL giving investors the highest return on their investment can be found. For this purpose, the investment is the total contribution to the UVL policy less mortality costs.

The after tax surrender value of UVL can be formulated as one of the following two expressions depending on whether the cumulative cash value exceeds the total premiums paid.

$$UVL = \begin{cases} \Sigma\{(1-E_i)P - FC_i\}(1+r)^{n-i+1} & \text{for } P<=P^* \\ \Sigma(1-t)\{(1-E_i)P-FC_i\}(1+r)^{n-i+1} + tnP & \text{for } P>P^* \end{cases}$$

where UVL : after tax surrender value of UVL

n : holding period as number of years

E_i : front end expense loadings at year i as a percentage of premium

P : annual available capital

F : face value of the policy

C_i : cost of term insurance at year i

r : pre-tax annual rate of return on UVL investments

t : marginal tax rate of insured

The shift point P^*, where the cash value equals the sum

of premiums paid, can be found by setting UVL equal to total premiums paid (nP) and solving for P.

$$P^* = \frac{\Sigma FC_i(1+r)^{n-i+1}}{\Sigma(1-E_i)(1+r)^{n-i+1} - n}$$

Only for premiums greater than P^* is UVL subject to taxation because the cash value exceeds the total premiums paid. In other words, only when investment income is greater than the cumulative sum of mortality costs and expense loadings, are taxes payable for this excess value at the time of withdrawal. For premiums less than P^* the cash value of UVL is not subject to taxation after a holding period of n years even though there are some investment gains, because investment earnings are not enough to cover the sum of mortality charges and the expense loadings. In the UVL policy, the sum of mortality costs and expense loadings are virtually tax deductible from investment earnings.

Using the above formula for after tax surrender value, internal and marginal rate of returns can be calculated. The IRR is the average rate of return earned on all investment dollars whereas the MRR is the return on the last dollar. The IRR can be found by equating UVL with the following formula.

$$UVL = \Sigma(P-C_i)(1+IRR)^{n-i+1}$$

The difference between this and the previous formula is that this formula for IRR holds regardless of the P level. The MRR can be found by equating the marginal increase in after tax

surrender value with the return earned by unit dollar of investment at a specific interest rate, and solving for that interest rate. In other words, MRR is determined by differentiating the above two formulae with respect to P, equating them, and solving for MRR. Differentiation gives us following expressions.

$$\frac{d\,UVL}{d\,P} = \begin{cases} \Sigma\,(1-E_i)(1+r)^{n-i+1} & \text{for } P <= P^* \\ \Sigma\,(1-t)(1-E_i)(1+r)^{n-i+1} + tn & \text{for } P > P^* \end{cases}$$

and

$$\frac{d\,UVL}{d\,P} = \Sigma\,(1+MRR)^{n-i+1}$$

Both IRR and MRR can be solved through an iterative process with the help of a computer.

III. RETURN ON NO-LOAD UVL POLICY

For a no load UVL policy, one without front-end charges or surrender charges for a holding period of n years, the amount available to invest is the same as a comparable investment alternative. Examination of the mortality charges of major UVL insurers reveals that mortality costs of UVL do not differ significantly from term insurance rates and therefore, they are assumed to be the same.[3] For premiums less than P^*, MRR is simply r. However, for premiums greater than P^*, MRR is less than r but always higher than (1-t)r for a holding period greater

than one year. (See Appendix.) The reason why MRR is higher than (1-t)r is that although premiums in excess of P^* earn r each year which is subject to taxation, the tax payment is deferred until the policy is surrendered. The taxable portion of investment income each year also earns interest for the following years until the policy is withdrawn. Thus MRR is higher the longer the holding period. For holding periods less than or equal to one year, the MRR of UVL is exactly the same as that of a comparable investment, which is (1-t)r, because no tax deferral advantage comes into play. Therefore, no one would be willing to invest through UVL if the holding period does not exceed one year under a load UVL policy because this gives a lower MRR than alternatives due to expense loadings. Hereafter, without loss of generality, the investment horizon is assumed to be longer than one year.

Up to the point P^*, the IRR is the same as MRR, which is r. As P increases beyond P^*, IRR decreases and asymptotically approaches MRR. This occurs because progressively larger proportions of the investment are earning MRR instead of r, thus lowering IRR.

Figure 1 illustrates these results. In that graph, MRR equals IRR up to P^*. The curved portion beyond P^* represents IRR and the straight line segments MRR. After tax returns on other non-tax sheltered investment alternatives are shown as the straight line at the bottom of that graph. MRRs and IRRs of alternative investments are the same regardless of the premium

level. Therefore, investors would not choose to invest through these alternatives. Instead, they would choose to invest the entire amount, subject to the IRS maximum, through UVL if UVL has no expense loading and offers the same pre-tax returns as the other alternative.

However, if a UVL policy earns a lower pre-tax return than other investment alternatives, which is common for a no load policy, then investors may choose different optimal investment strategies depending upon the available capital level. When the after tax return on the alternative investment is above the MRR of UVL, the optimal investment strategy is to put P^* into UVL and the remainder into the alternative investment to achieve a higher MRR for additional amounts beyond P^*.

The revised IRR schedule (IRR^*) for this optimal strategy is shown as dotted line in figure 2. Up to point P^*, IRR on this strategy is same as r. Beyond P^*, IRR decreases but at a slower rate than when putting entire amount on UVL, and again it asymptotically approaches the after tax return on the alternative investments as P increases. Changes in the tax rate do not change the overall picture unless the tax rate is zero.

IV. RETURN ON LOAD UVL POLICY

With front end expense loadings, the calculation of the return on UVL investment is a little more complicated. Under a proportional load UVL policy, a certain proportion of the annual

contribution is deducted by the insurer before it is invested. This effectively lowers the base amount and investment income. However, to compare with other alternatives properly, the base amount of UVL should include expense loadings in calculating IRR. In this case, each year's base amount is simply the annual contribution amount less mortality charges.

Due to the effect of loadings, MRR of UVL starts at 0. This is actually meaningless, but we need to mention this fact for the purpose of comparing with non-tax advantaged alternatives because the latter always earns a return of (1-t)r. The average rate of return or IRR starts at 0 when MRR is 0 for very low P. As P increases, IRR increases rapidly as the proportion of non-zero MRR increases and reaches a peak when P is P^*.[4] Beyond P^*, it decreases and again asymptotically approaches MRR for the same reason as described earlier.

Therefore, for premiums less than or equal to P^*, IRR is less than or equal to MRR. For premiums greater than P^*, IRR is higher than MRR. Figure 3 illustrates these results. As P increases, the IRR curve moves up and crosses the IRR schedule of the comparable non-tax sheltered alternative at P' and reaches a peak at P^*. As P increases beyond P^*, IRR declines and crosses the IRR curve of the alternative investments, and approaches the MRR of UVL.

The optimal investment policy depends on the annual available capital level. If an investor's annual available fund is less than P', then optimal choice would be to buy a term life

insurance policy and invest the entire difference through the non-tax sheltered alternative. If the annual fund is between P' and P^*, then investor should invest the entire amount through UVL. For fund levels greater than P*, the optimal investment strategy is to put P^* into UVL and invest the remainder through the non-tax advantaged alternative.

The IRR schedule for this strategy is shown in figure 4. Up to P^*, the revised IRR curve (IRR^*) is the same as that of UVL. But beyond P^*, it is located at a higher level than the previous IRR curve of UVL and it approaches the MRR schedule of the alternative investment. By choosing this strategy, investors can achieve a higher than (or at least the same average rate of return as) that of UVL policy.

In other words, for premiums in excess of mortality costs but not enough to cover loadings, both MRR and IRR is 0. In fact, investors cannot hold the UVL policy unless their funds are enough to cover both mortality costs and loadings charged by UVL insurers. For premiums in excess of both mortality costs and loadings, MRR jumps to some point and stays at that level until investment earnings are subject to taxation.

Although initial investment earnings are not taxed if they do not exceed mortality costs and loadings, MRR is still lower than r. The reason for this is that although expense loadings are deducted from each dollar of contribution and therefore, less money is invested to build up cash value, the base amount for the return calculation includes that loadings for

proper comparison purposes. Expense loadings act as a buffer in the sense that they virtually moderate the tax advantage inherent in UVL policy. For premiums greater than P^*, MRR drops down to and stays at some level below (1-t)r due to the effect of both expense loadings and taxation.

V. THE EFFECTS OF CHANGES IN PARAMETER VALUES

Changes in parameter values of UVL have a significant impact on the optimal investment strategy. Reduction in the tax rate increases the MRR of UVL for premiums greater than P^* and vice versa. But it has no impact on either MRR or IRR for premiums less than or equal to P^* because investment income is not subject to taxation for that interval. For premiums greater than P^*, the IRR curve lies at higher level than before due to higher MRRs for that region.

However, tax rate changes have no impact on the critical amount P^* unless taxes are either 0 or 100 percent. In those cases, P^* would be either the maximum contribution allowed by IRS regulations or a minimal amount just enough to cover mortality costs respectively. Figure 5 shows these results.

Reduction in the tax rate also increases the return on non-tax advantaged alternative. Due to the result of both reduced tax advantage and the increased proportion of expense loadings of UVL as compared with the tax savings, both MRR and IRR of investment through a typical load UVL policy never reach

those of comparable investments under a very low marginal tax rate. In other words, investors with a zero or very low tax bracket may always be better off by not investing through a typical load UVL policy. Figure 6 is an illustration of this situation. However, most investors are in a high enough tax bracket to find P^* of reasonable value.

Changes in the parameter values other than the tax rates affect P^*, the optimal premium level of UVL. The impact of an increase in the interest rate on P^* is represented in figure 7. At higher rates of return, cash values increase faster than at lower rates of return. Therefore, even at a smaller premium, investment earnings exceed the sum of mortality costs and expense loadings and are subject to taxation, resulting in smaller values of P^* than that at low interest rates.

When interest rates are low, investors can safely increase the annual contribution to UVL up to a certain amount without concern about the taxation on the invested fund because the growth rate of investment earnings is too slow to match the mortality costs and expense loadings charged by UVL insurer. So, if the investment horizon is fixed, then the optimal premium amount to UVL becomes larger the lower the rate of return.

The effect of expense loadings is rather straightforward. Higher loadings cause UVL to become less favorable and increase P^*. Like that of UVL at a very low tax rate, IRR of UVL under heavy expense loadings may not reach that of the alternative investment. In that case, an investor's optimal

strategy is to invest through an alternative, not through UVL.

As many authors pointed out, the holding period of UVL is by far the most important factor in determining the relative merits of UVL. However, when considering the optimal premium level, a different result occurs. The longer the holding period, the lower the optimal premium level. Since accumulated investment income on UVL becomes larger for longer holding periods, it exceeds the sum of mortality charges and expense loadings more quickly and is subject to taxation at a lower premium level. Therefore, for a given face value on a load UVL policy, the advantage of UVL becomes larger and the cash value accumulates faster the longer the holding period. As illustrated in Figure 8, the IRRs are higher and P^* is smaller for longer holding periods.

VI. SUMMARY AND CONCLUSION

Taking full advantage of the tax benefits inherent in universal/variable life insurance policies, investors can decide the optimal investment amount for UVL and other investment alternatives by which they can maximize their total return on investments. Since most taxpayers have at least a 15 percent marginal tax bracket under current tax laws, investors can choose an optimal premium and coverage of UVL in most cases. The optimal contribution to a UVL policy under the typical UVL parameter values can b summarized as follows:

Annual Fund Level	No Load UVL Policy	Load UVL Policy
$AF < P'$	AF	0
$P' <= AF < P^*$	AF	AF
$P^* <= AF <= P^{max}$	AF	P^*
$P^{max} < AF$	P^{max}	P^*

where AF : annual available investment fund
P' : premium level where IRR of UVL equals that of comparable investment
P^* : critical premium where cash value of UVL equals the total premiums paid
P^{max} : maximum allowed by IRS regulations

Individuals may have different optimal strategies if their tax rates are too low, expense loadings are too high, or the interest rate earned by the insurer is below comparable investments. However, this table may be a good guide for investment through a UVL policy for most cases. Practically, it is not easy to for individual investors to find out all parameter values of UVL accurately. Among them, correct forecasting of future interest rate is the most difficult. However, with the best estimates of future interest rates and parameter values collected from insurers, investors can decide the optimal amount to put into UVL for their own investment horizon.

REFERENCES

Adelman, Samuel W., and Dorfman, Mark S., "A Comparison of TDA and Non-TDA Investment Returns," The Journal of Risk and Insurance, Vol. 49, No. 1 (March, 1982), pp. 73-90.

American Council of Life Insurance, Life Insurance Fact Book, Update, 1986, (American Council on Life Insurance: Washington, 1986), pp. 12.

Best, A. M. Company, Best's Flitcraft Compend (Oldwich, NJ: A.M. Best Company, 1986), pp. 644-46.

Belth, Joseph M., "A Note on Disclosure of Realized Rate of Return for Retirement Accumulations, Savings Accounts, and the Savings Component of Universal Life Insurance Policies," The Journal of Risk and Insurance, Vol. 49, No. 4 (December, 1982), pp 613-17.

Black, Kenneth, Jr. and Skipper, Harold, Jr., Life Insurance, (11th Edition; Eaglewood Cliffs, New Jersey: Prentice-Hall, Inc., 1987), pp. 230-231.

Broverman, Samuelson, "The Rate of Return on Life Insurance and Annuities." The Journal of Risk and Insurance, Vol. 53, No. 3 (September, 1986), pp 419-34.

Chung, Yosup and Skipper, Harold, Jr., "The Effect of Interest Rate on Surrender Values of Universal Life Policies," The Journal of Risk and Insurance, Vol. 54, No. 2 (June, 1987), pp 341-7.

D'Arcy, Stephen P and Lee, Keunchang, "A Comparison of Universal/ Variable Life Insurance with Similar Unbundled Investment Strategies," The Journal of Risk and Insurance, forthcoming.

Explanation of Tax Reform Act of 1984 (Chicago, IL: Commerce Clearing House, 1984), Chapter 9.

Power, Mark L., Hira, Labh S., and Murphy, Roger P., "Universal Life: Taxation and the Actuarial Concept of Life Insurance," Journal of Insurance Regulation, Vol. 4, No. 1 (September, 1985), pp. 68-76.

Warshawsky, Mark, "Life Insurance Savings and The After-Tax Life Insurance Rate of Return," The Journal of Risk and Insurance, Vol. 52, No. 4 (December, 1985), pp. 585-606

FOOTNOTES

1. Some insurers tie the rate of return of universal life insurance to the portfolio rate of return earned by the insurer. This strategy can benefit the policyholder if this rate is higher than money market fund rates but poses a risk to the insurer. If short term interest rates rise above the portfolio rate, policyholder may move funds to competitors. This situation is not included in this paper as the investment return of UL would differ from alternative investments.

2. Hereafter, UVL is used to represent all universal/variable life policies and universal life that actually ties investment performance to short term money market rates.

3. A comparison of the mortality charges in universal life for the ten largest writers with non-guaranteed term insurance rates both taken from Best's Review data found them to be virtually identical.

4. If IRR is less than MRR at this point, IRR would continue to increase and asymptotically approach MRR from the bottom. This is possible only under heavy expense loadings coupled with a very low tax rate. Given normal parameters for UVL policies, this behavior is not likely.

APPENDIX

To prove that the MRR of a no load UVL policy is always greater than (1-t)r for a holding period greater than one year, compare the marginal increase in after tax surrender value of UVL for $P>=P^*$ with the cash value increase of a dollar tax free investment that earns (1-t)r.

$$
\begin{aligned}
& \text{Marginal surrender value increase in UVL} \\
- & \text{Marginal cash value increase in tax free investment} \\
= & \quad \Sigma(1-t)(1+r)^{n-i+1} + tn \quad - \quad \Sigma\{1+(1-t)r\}^{n-i+1} \\
= & \quad (1-t)(1+r) + t \quad - \quad \{1+(1-t)r\} \\
+ & \quad (1-t)(1+r)^2 + t \quad - \quad \{1+(1-t)r\}^2 \\
+ & \quad (1-t)(1+r)^3 + t \quad - \quad \{1+(1-t)r\}^3 \\
+ & \quad \ldots\ldots \\
+ & \quad (1-t)(1+r)^n + t \quad - \quad \{1+(1-t)r\}^n \\
= & \; 0 + tr^2(1-t) + \{3tr^2(1-t) + tr^3(1-t)(2-t)\} + \ldots\ldots \\
> & \; 0 \qquad \text{for } 0<t<1,\ r>0,\ n>1
\end{aligned}
$$

Q.E.D.

Since the after tax surrender value of a no load UVL policy is greater than that of tax free investment earning (1-t)r, the return on UVL is greater than (1-t)r. If n=1, they are exactly the same. In other words, when the holding period is one year, the return on UVL is (1-t)r.

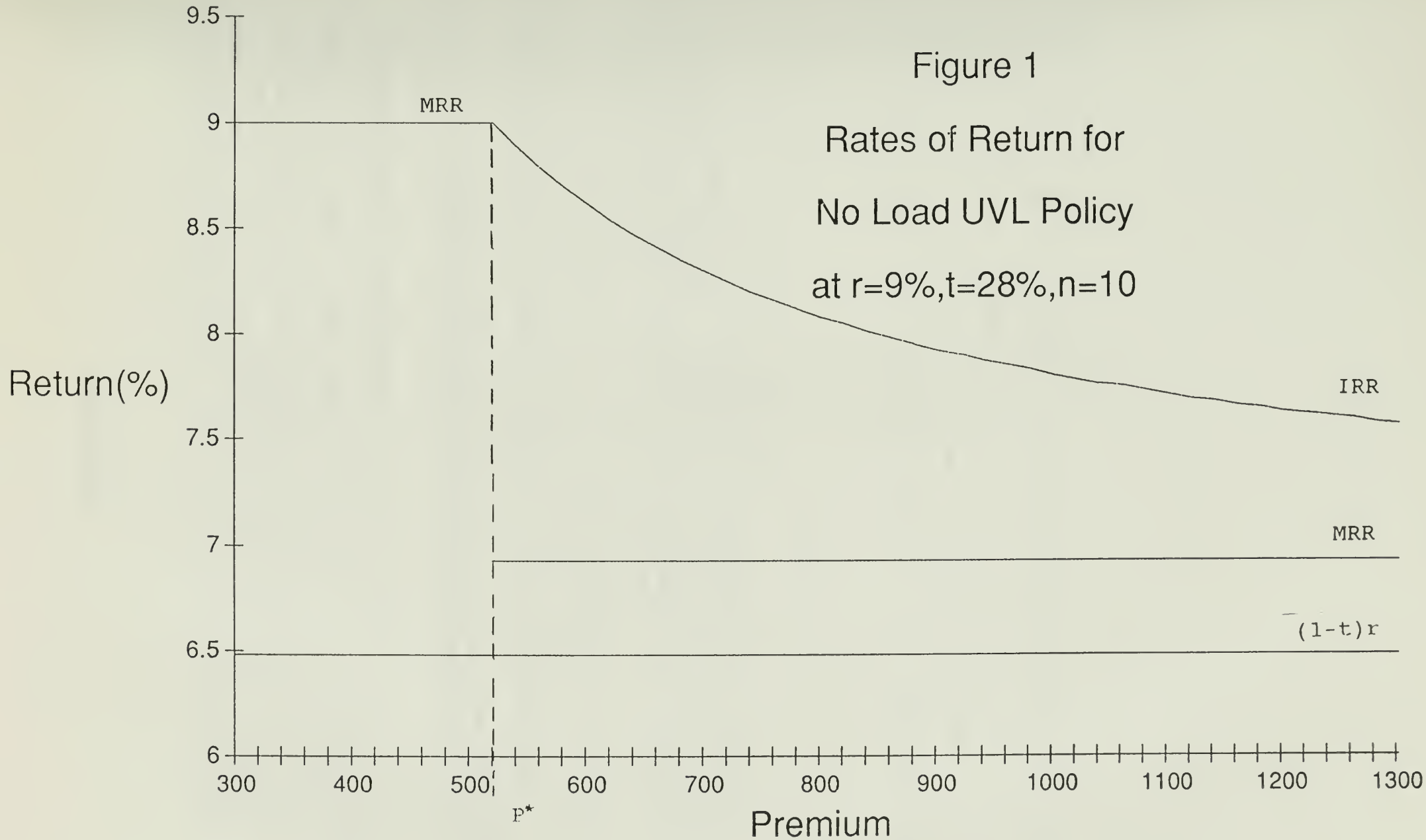
Figure 1
Rates of Return for
No Load UVL Policy
at r=9%,t=28%,n=10
Return(%)
9.5
9
8.5
8
7.5
7
6.5
6
MRR
IRR
MRR
(1-t)r
300
400
500
600
700
800
900
1000
1100
1200
1300
P*
Premium

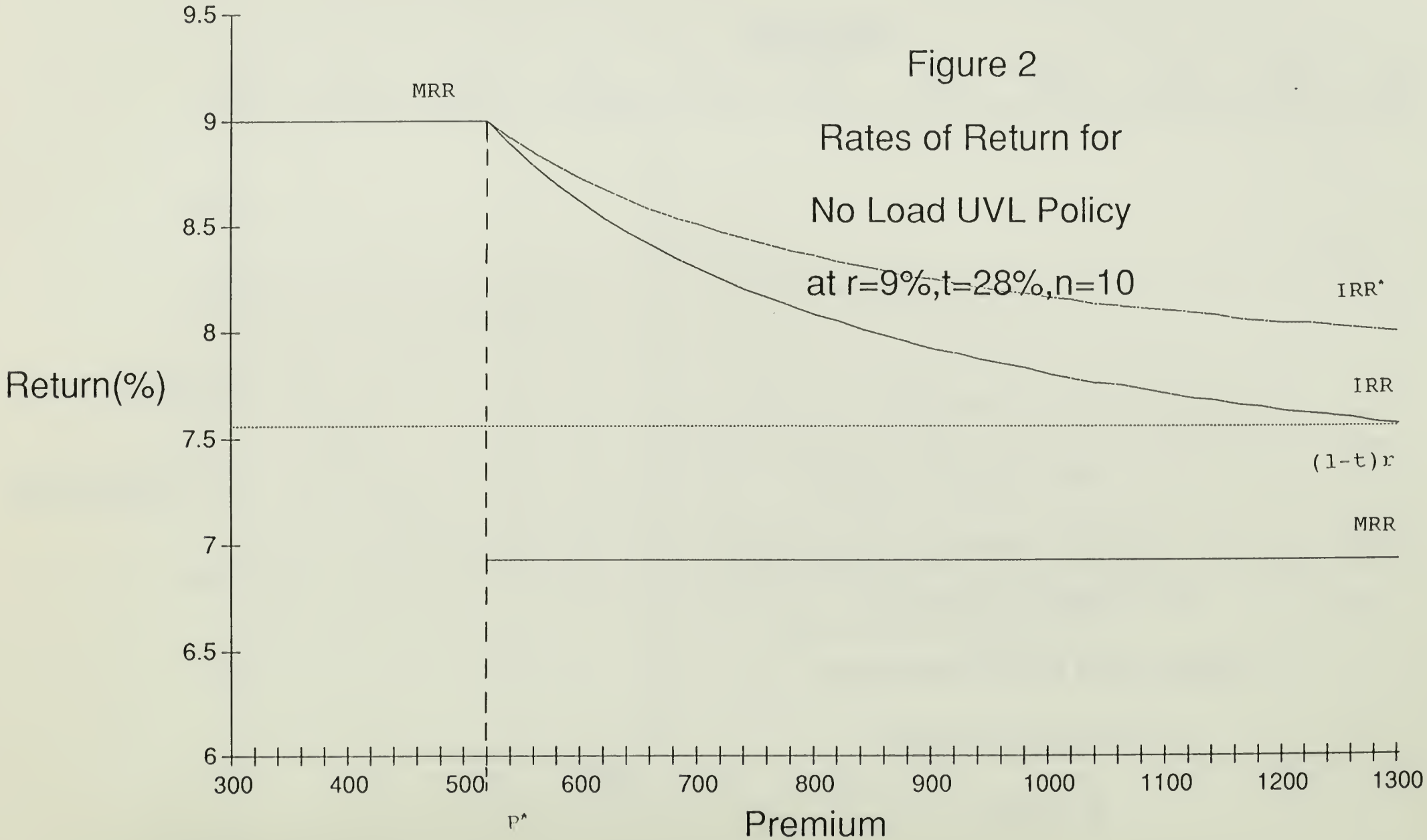
Figure 2
Rates of Return for
No Load UVL Policy
at r=9%,t=28%,n=10
Return(%)
9.5
9
8.5
8
7.5
7
6.5
6
MRR
IRR*
IRR
(1-t)r
MRR
300
400
500
600
700
800
900
1000
1100
1200
1300
P*
Premium

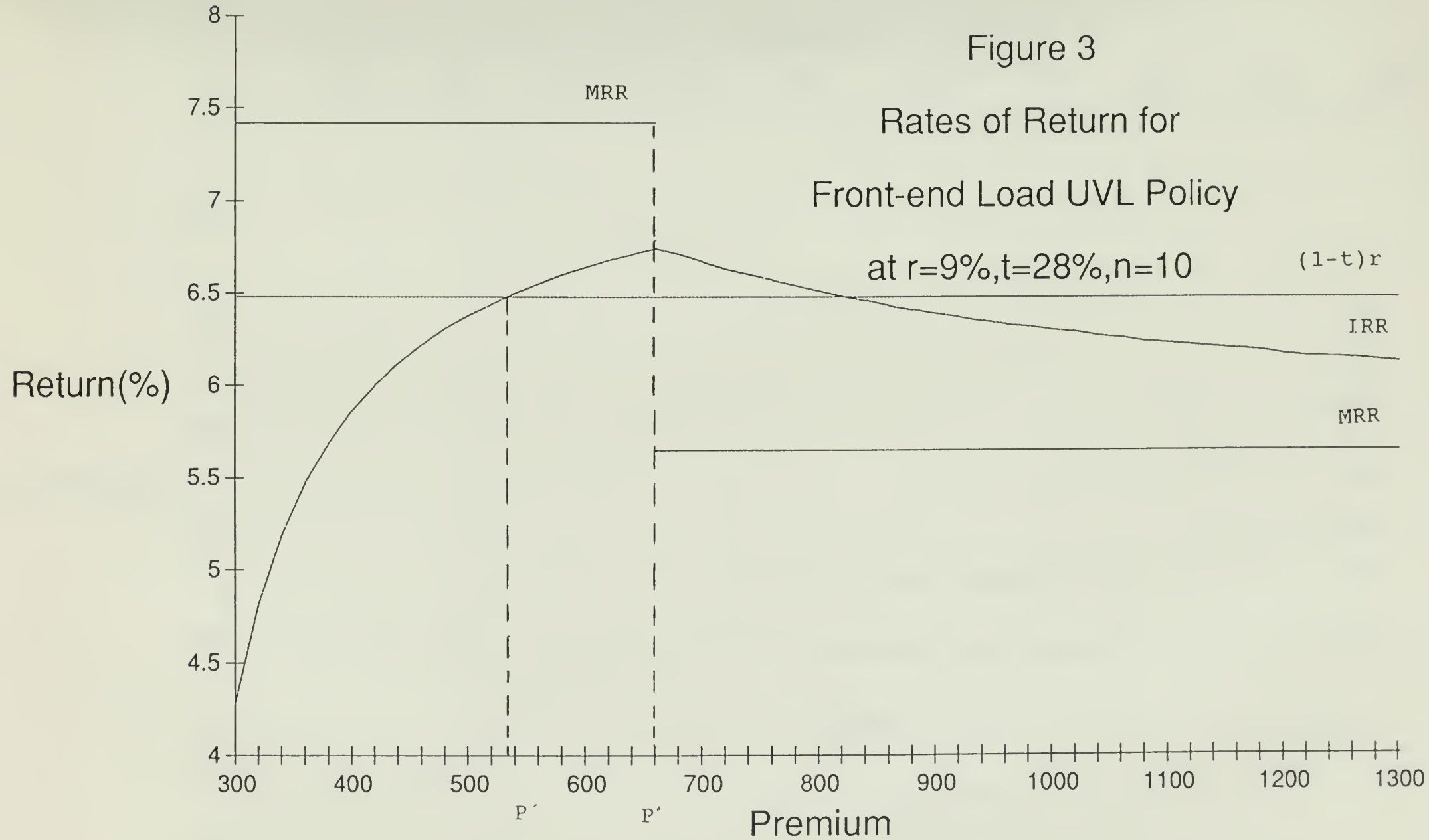
Figure 3
Rates of Return for
Front-end Load UVL Policy
at r=9%,t=28%,n=10
MRR
(1-t)r
IRR
MRR
Return(%)
8
7.5
7
6.5
6
5.5
5
4.5
4
300
400
500
600
700
800
900
1000
1100
1200
1300
P´
P*
Premium

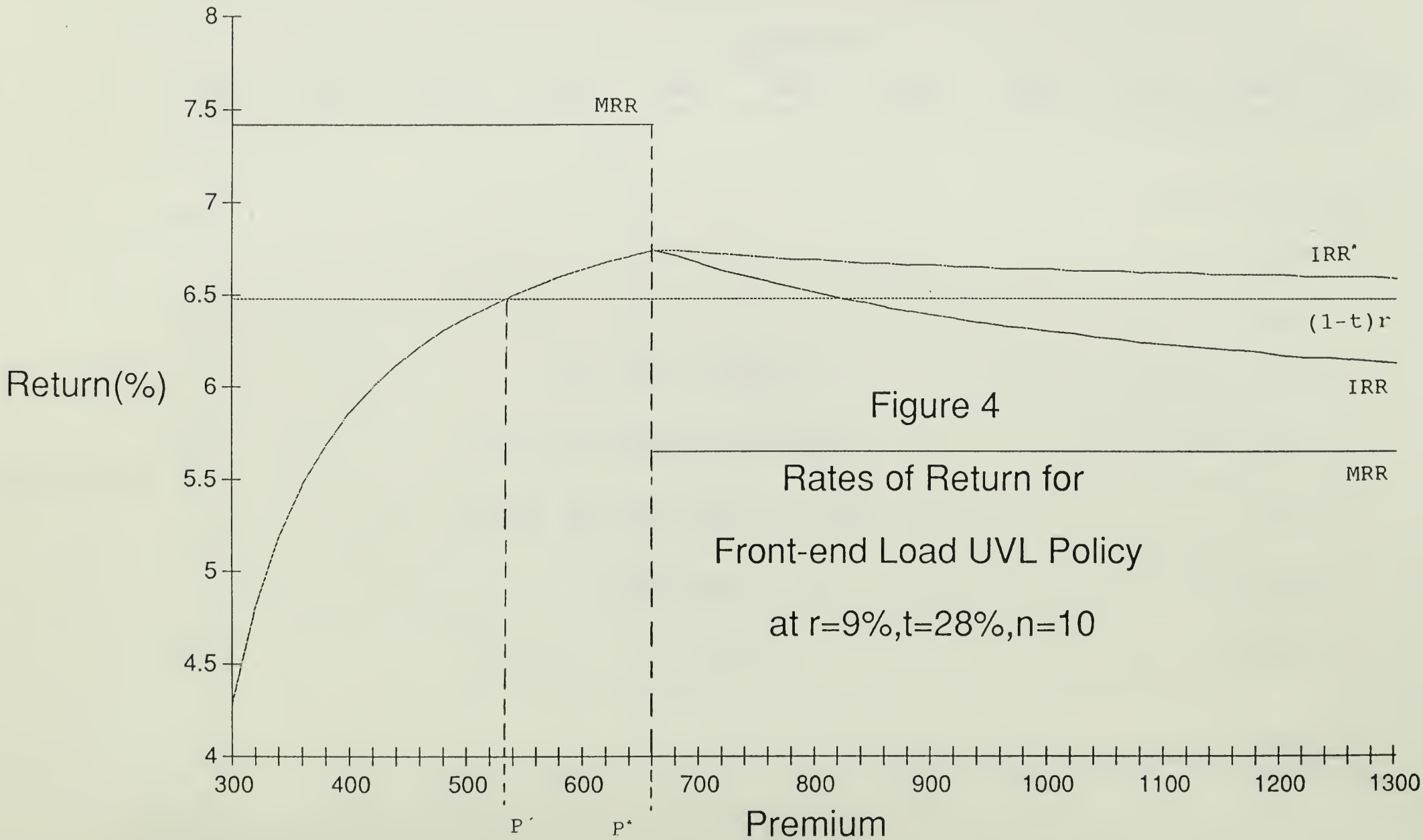

Figure 4

Rates of Return for

Front-end Load UVL Policy

at r=9%,t=28%,n=10

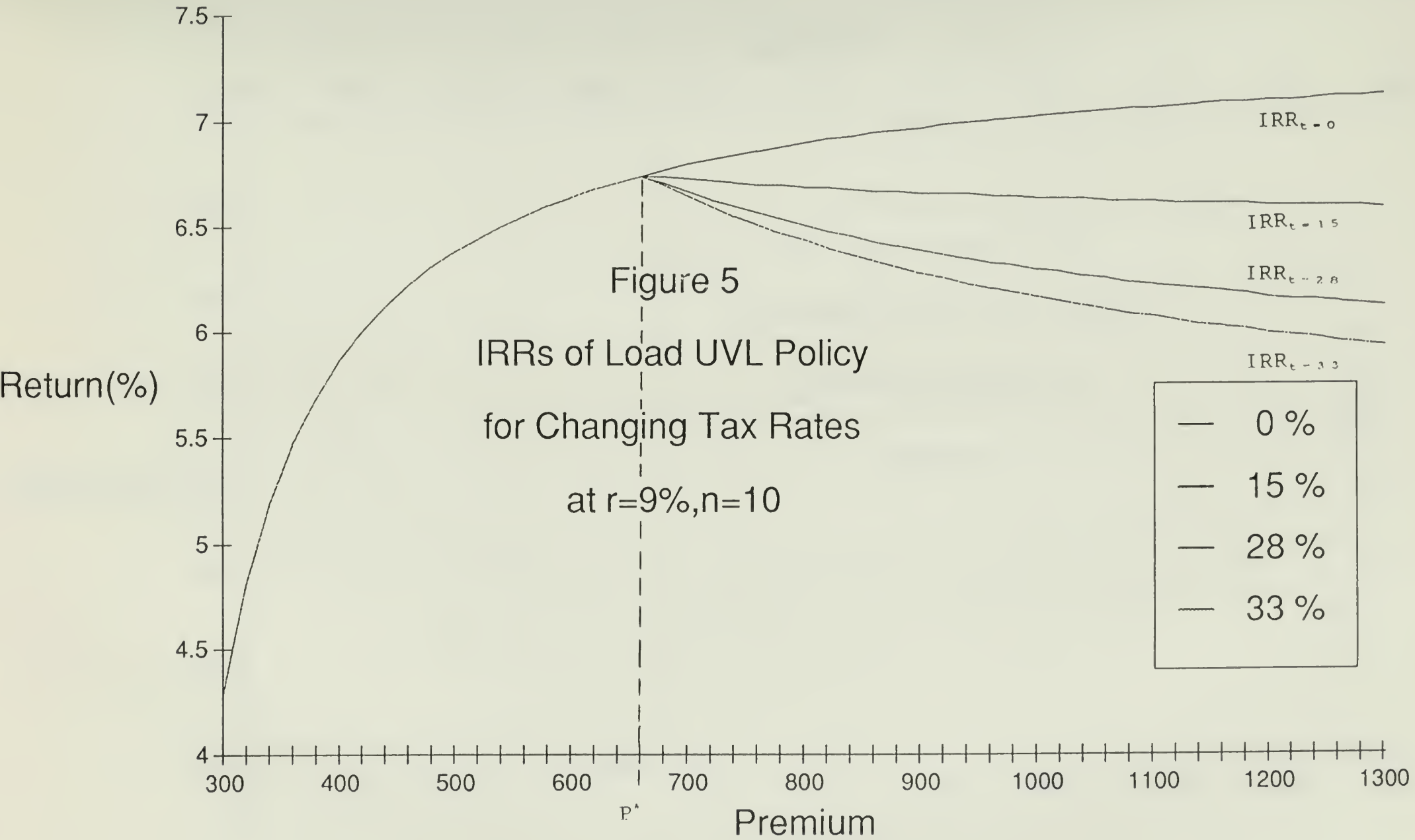
Figure 5
IRRs of Load UVL Policy
for Changing Tax Rates
at r=9%,n=10
Return(%)
Premium
P*
7.5
7
6.5
6
5.5
5
4.5
4
300
400
500
600
700
800
900
1000
1100
1200
1300
IRR$_{t=0}$
IRR$_{t=15}$
IRR$_{t=28}$
IRR$_{t=33}$
0 %
15 %
28 %
33 %

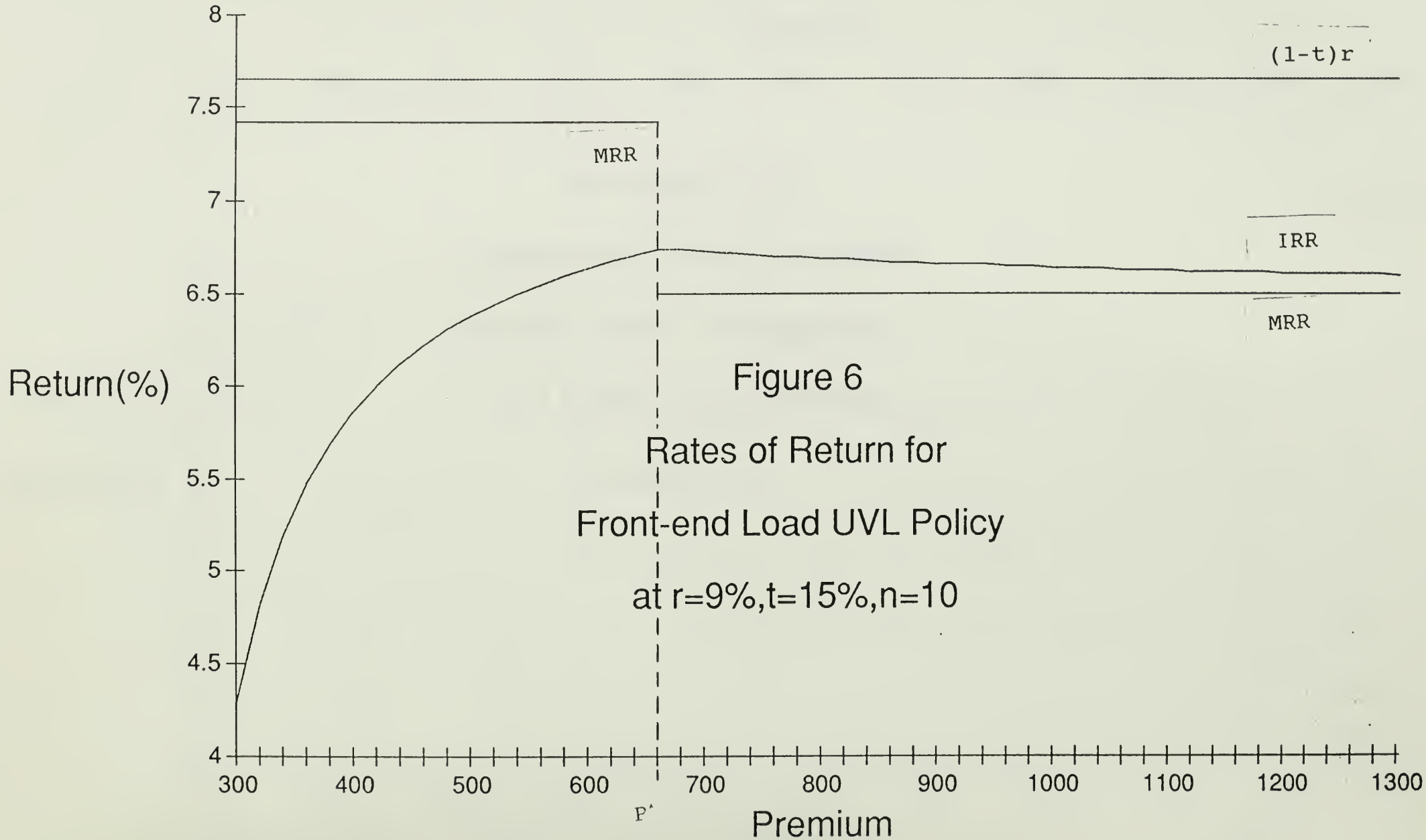

Figure 6

Rates of Return for

Front-end Load UVL Policy

at r=9%,t=15%,n=10

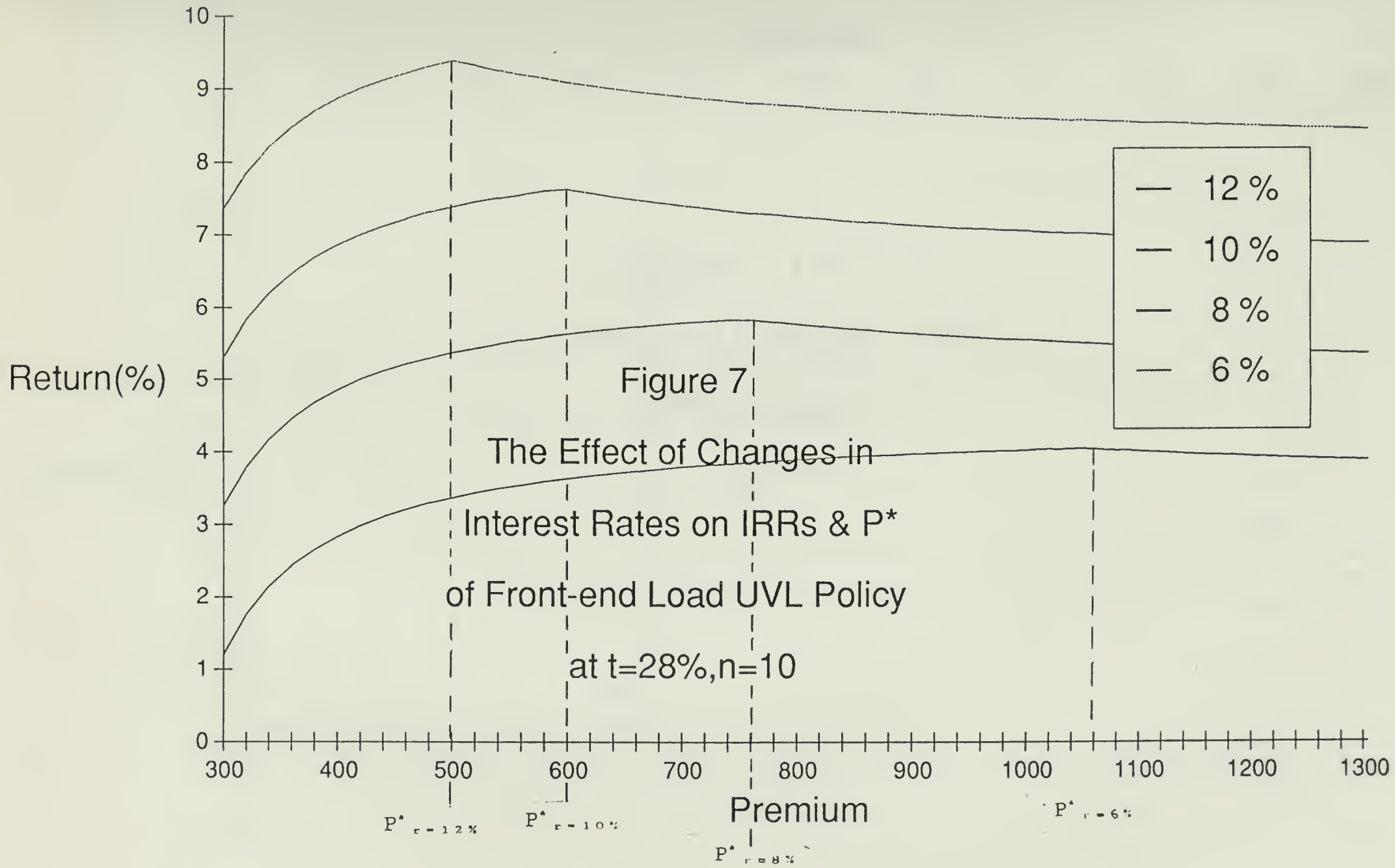

Figure 7

The Effect of Changes in

Interest Rates on IRRs & P*

of Front-end Load UVL Policy

at t=28%,n=10

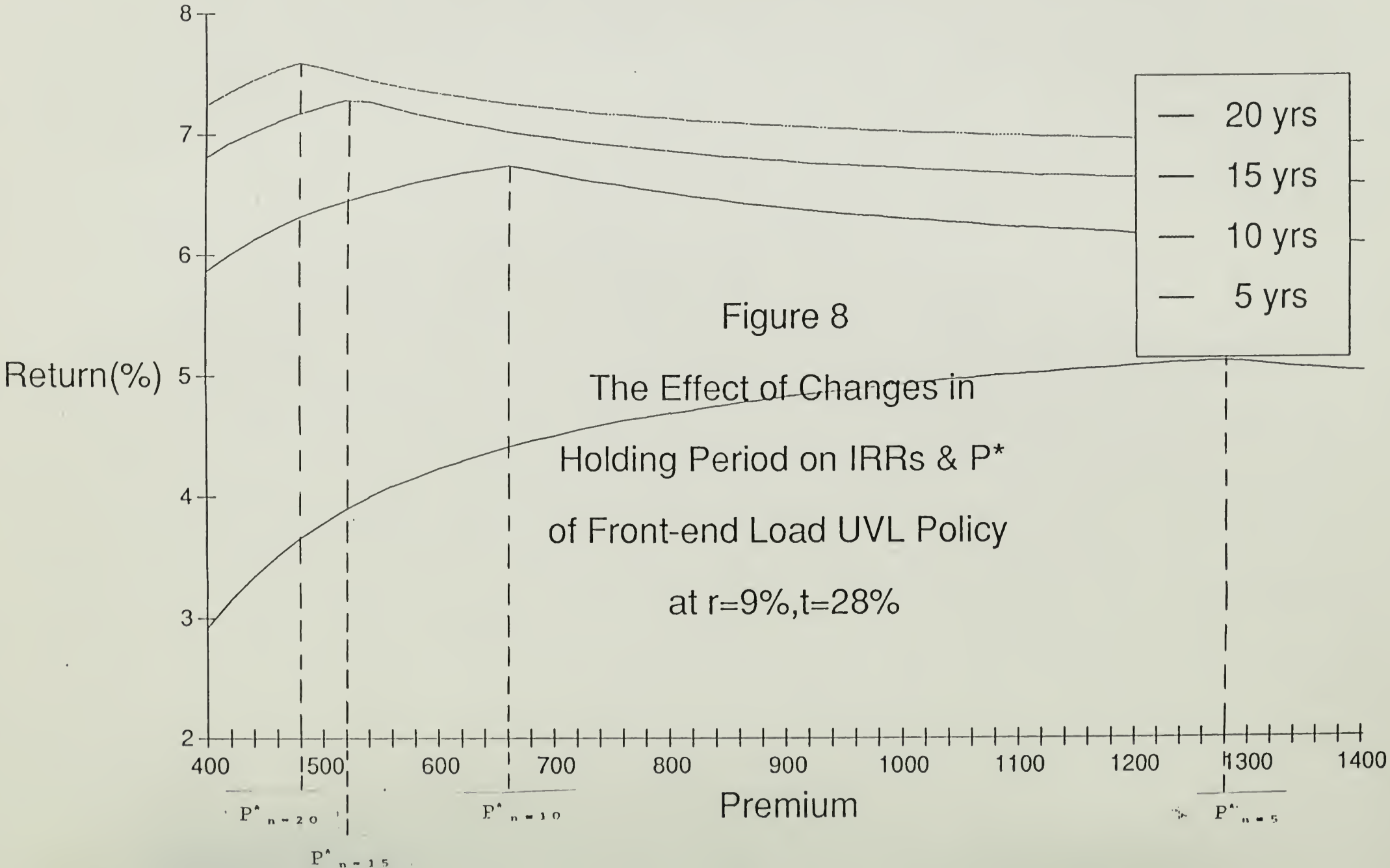

Figure 8

The Effect of Changes in

Holding Period on IRRs & P*

of Front-end Load UVL Policy

at r=9%,t=28%

UNIVERSITY OF ILLINOIS-URBANA
3 0112 060296024