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HISTORIC FORAGE PRODUCTIVITY AND COST OF CAPITAL FOR COW-CALF RANCHES IN CALIFORNIA

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HISTORIC FORAGE PRODUCTIVITY AND COST OF CAPITAL FOR COW-CALF RANCHES IN CALIFORNIA

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ABSTRACT

Much has been made of the low returns on investment for western rangeland ranching. However, little work has been done to empirically compare these returns to the return that would be demanded by financial markets from assets with similar risk and return characteristics. This study uses historical forage productivity data from three locations in California's Mediterranean rangelands to simulate financial statements for three hypothetical cow-calf ranches and measures the variability in return on investment from year to year. This performance is then compared to the actual performance of a diversified portfolio of investment assets using the Capital Asset Pricing Model (CAPM), from which the theoretical cost of capital for these hypothetical ranches is derived. Much like other agricultural enterprises, cow-calf ranching in California is found to have low market risk and a low theoretical cost of capital based on the CAPM, approximately equal to the risk-free rate of return, which averaged 4.8 percent for the period 1988-2007. This cost of capital is still significantly greater than the historical return on cow-calf ranching in the western U.S. of 2.0 to 3.0 percent, implying that ranchers are receiving benefits from their business beyond financial returns, and reinforcing the idea that they derive amenity or other environmental values from these investments.

Keywords: Bioeconomic Model, Capital Asset Pricing, Financial Risk, Rangeland Economics

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INTRODUCTION

Ranching in the western United States, and particularly in California, has been characterized as generating both commodity production and lifestyle and amenity consumption rather than being exclusively a profit-maximizing enterprise (Smith and Martin 1972; Huntsinger and Fortmann 1990; Sulak and Huntsinger 2002). Ranchers often choose or maintain this occupation because of personal lifestyle and amenity benefits, explaining the low returns realized by them when land appreciation is negligible or excluded from the profitability analysis (Torell et al. 2001), or even when this effect is considered (Campos et al. 2009).

Aside from meat production and amenity values, ranches provide valuable habitat for game, native pollinators, and rare and endangered plants and animals, while ranch management can protect and promote plant communities that help to control soil erosion and protect water quality (Bolsinger 1988; Myers et al. 2000). This partially justifies payments for ecosystem services and other incentive programs that, along with supplemental household income, can help ranchers to meet the financial requirements of their enterprises. However, they can be either transitory solutions or are still emerging markets and can decline when funding becomes scarce. Rancher dependence on these alternative sources of income may be risky since they rely on market conditions and can drop drastically with low economic cycles.

Thus, irrespective of social or amenity values, ranching sustainability still depends on the ability of the rancher to conduct a profitable business, and on available financing, in order to maintain the joint production of commercial ranching products, amenity consumption and ecosystem services in the rangeland working landscape. The failure of one or of all of the factors mentioned above can lead to the decline of ranching operations, especially if we add the threat coming from increasing urban development pressure.

In the particular case of California, increasing urbanization and land conversion is one of the major threats to ecosystem services from oak woodlands and grasslands and the loss and conversion of ranches could drive important ecological and socioeconomic changes in range landscapes (Newburn et al. 2006). The Natural Resources Inventory (NRI) of the U.S. Department of Agriculture estimated that between 1982 and 2003 rangeland use for ranching in California decreased 6 percent (USDA 2000, 2003). FRAP (2005) estimates that 30,000 acres of oak woodlands are converted to urban uses every year in California.

Knowing rancher financial requirements could help policy-makers, private managers and other stakeholders to understand what is needed to support the long-term sustainability of these enterprises, and preserve the private and public values derived from rangelands. The rancher's ability to finance her/his business enterprise is as important to its viability as any other factor, such as markets, resources, labor costs or business know-how.

Agents that provide financing (banks, entrepreneurs, private investors) must decide explicitly or otherwise whether the project that they are financing meets a certain threshold return to compensate for the financial risk taken. This threshold return is known as the cost of capital (Sharpe 1964; Lintner 1965; Merton 1973) and is used as the relevant benchmark against which to measure the value of future benefits of an enterprise to determine its viability. The cost of capital is the rate of return required by the shareholders and lenders to finance the operations of the business. In other words, it is the opportunity cost or the rate of return that a firm would have been able to earn had it invested in some other business at the same risk level.

For ranching purposes, knowledge of the cost of capital is needed when choosing to engage in new ranch operations (such as guided hunting, wood-cutting, or the addition of new kinds of livestock) and whether to implement range improvements to increase the productive capacity of the ranch. Textbooks, articles, and bulletins published to assist range managers and ranchers in decision making often rely on the ability of the user to adequately estimate a cost of capital. They also rely on an assumed cost of capital that is based on the author's best guess of the relative risk of any given ranch enterprise or project. However, ranching enterprises are site-specific, and without guidance on how to estimate a cost of capital, this vital input to planning becomes a rough "guestimate" that lacks analytic support and site-specific conditions.

The easiest way to estimate an appropriate cost of capital is to look at the rate at which lenders are willing to lend money to a rancher to implement a particular project. Often the most experienced small business lenders are commercial banks and we might expect these financiers to develop the best estimates of the appropriate cost of capital. However, these estimates are dependent on the ability of banks (or any other lender) to assess the relative risk of the particular project, which may not be accurate, as demonstrated by the ability of financial institutions to properly assess the risk in real estate lending in the recent past. If the risk of ranch projects is not being priced properly, then both the analysis of whether to implement particular projects

and the financial cost of these projects could be wrong.

To evaluate the cost of capital of investment projects, the theory of asset pricing has been extensively applied to investment portfolio management (Sharpe 1964; Lintner 1965). The Capital Asset Pricing Model (CAPM) is often used to estimate the efficient return on an asset given its covariance with a market return (the return on a completely diversified portfolio of all available assets).

Dusak (1973) applied the CAPM to the returns on three agricultural commodity futures for each of several months, giving 16 total estimates of risk. Barry (1980) estimated the risk-return characteristics of farm real estate for the United States as a whole and for various regions within the U.S. using CAPM. Arthur et al. (1988) estimated the risk-return characteristics of 13 agricultural commodities using CAPM and compared these results to the arbitrage pricing theory. All of these studies found that the risk-return characteristics of agricultural assets imply a low cost of capital and low market risk. While these studies provide an indication of the performance of the agricultural assets in general, they do not perform an analysis that directly looks at the returns from ranching at the enterprise level.

In this paper, we present an estimation of the cost of capital for cow-calf enterprises in California oak woodland and annual grassland using simulated financial statements in three ranch sites. The statements are built upon actual forage productivity data from these three sites and actual hay and calf prices for the period 1987–2007. We use this data in an application of the CAPM model to these three hypothetical ranches with their particular exposure to variation in rainfall, forage productivity, and cattle prices. The CAPM analysis provides three estimates of risk and cost of capital for ranching in California. These results offer benchmarks for planning ranch enterprises while also providing evidence of an empirically-derived level of market risk to justify particular lending rates to ranching enterprises from creditors. The analysis also provides empirical and quantitative evidence of the opportunity costs of capital faced by ranchers, given the costs of capital for other market assets.

THE CAPITAL ASSET PRICING MODEL (CAPM)

The CAPM estimates the risk composition of a particular asset by measuring the variability in its return above a risk-free rate relative to a diversified market portfolio (Sharpe 1964; Merton 1973; Barry 1980; Arthur et al. 1988). That is, it measures the part of the variation of the return of an asset that is correlated with market conditions and thus varies together with the returns from other assets in a diversified portfolio. The risk associated with this part of the returns of an asset is known as systematic risk. The risk associated with returns that vary independently of the returns of the other assets in the portfolio, such as the gain or loss of an individual contract, an accident that results in losses to the business, or particularly good or poor manager decisions, is known as unsystematic risk. Unsystematic risk is diversifiable by holding a broad range of assets. Systematic risk is not diversifiable and investors demand a higher cost of capital for assets with higher systematic risk.

Following the CAPM model, it is expected that the higher the systematic risk of an asset, the higher the expected returns for that asset (Arthur et al. 1988). CAPM can be expressed in the general form:

$$E[R_i] = R_F + \beta_i (E[R_M] - R_F), \quad [1]$$

where $E[R_i]$ is the expected return on the asset of interest, R_F is the risk-free rate of return, $E[R_M]$ is the expected market return, and β_i is the estimated *systematic* risk. Subtracting the risk-free rate of return from either side of equation 1 results in an equation (Arthur et al. 1988) that can be estimated using Ordinary Least Squares:

$$r_t = \alpha + \beta r_{mt} + \varepsilon_t \quad [2]$$

where r_t is the return on the asset of interest above the risk-free rate, α is an intercept, β is the systematic risk of the asset of interest, r_{mt} is the return on a diversified market portfolio of assets above the risk-free rate, and ε_t is unexplained variation in the model.

If α is equal to zero, the CAPM model holds and the asset of interest is priced efficiently according to the market risk. An α above zero means that the enterprise is obtaining extraordinary returns above the returns implied by its systematic risk and thus the asset is priced too low. On the contrary, an α below zero means that there are low returns to the enterprise and thus the asset is priced too high. There may be cases where extraordinary returns are explained by factors other than the asset's characteristics. For example, the superior management expertise and know-how of some ranchers could generate extraordinary returns. These factors are not capitalized in the asset value because otherwise the extraordinary returns would disappear (Young 2005). In this particular case, we cannot state that the market is pricing the asset inefficiently, because the asset value is not capitalizing the value of the factors originating the extraordinary returns

As β reflects the systematic risk of the asset, its interpretation provides information about the higher or lower returns that the asset of interest generates according to the CAPM and a diversified market portfolio. If β is equal to zero, the asset has no correlation with the diversified market portfolio and would have systematic risk equal to a "risk-free" asset. If β is less than 0, the asset has less systematic risk than a "risk-free" asset and if β is more than 1, the asset has more systematic risk than a diversified market portfolio.

According to the CAPM, the expected return of the asset of interest if the market is efficient can be estimated using equation [1], substituting R_f by the average return of a risk-free asset for the analyzed period, $E[R_M] - R_f$ by the premium return of a diversified market portfolio over the risk free asset, and β by the value estimated for this parameter in equation [2].

MATERIALS

Building Financial Statements

We simulate three ranch financial statements, each using forage productivity data from three different oak woodland and annual grassland sites in California for a 20-year period data set. These cow-calf ranches were simulated with a herd of 300 breeding cows, as this is approximately the minimum size of a ranch herd commonly thought to be necessary to sustain one household (Forero et al. 2004).

For each cow-calf ranch in each different site, revenue was estimated by assuming that that 90 percent of the breeding cows produced a saleable calf each year (allowing for failed

pregnancies, death-loss, and herd replacement from the remaining 10 percent of breeding cows) and that the calves were sold at 600 lbs at the average market price for steers in June for each year, providing gross revenue equal to the June market price for calves in California (NASS 2007) times 1,620 cwt of calves per year.

Estimated forage costs were based on forage productivity data from three sites in California shown in Figure 1 (George et al. 2001; M. George and N. McDougald personal communication, October 2007; D. Flavell, personal communication, August 2007; C. Vaughn, personal communication, September 2007). These sites include UC's Sierra Foothill Research and Extension Center (near Brown's Valley, California in Yuba County), Hopland Research and Extension Center (near Hopland, California in Mendocino County), and San Joaquin Experimental Range (near O'Neals, California, in Madera County). Each of these sites is characterized by a Mediterranean climate with hot, dry summers; cool, wet winters; and high variability in precipitation from year-to-year and, therefore, in forage productivity. We refer to the three sites as the San Joaquin site, the Hopland site and the Sierra Foothill site, respectively.

The most recent 20 years of forage productivity data for each of these sites was used to perform the analysis. For the San Joaquin and the Hopland sites the analyzed period was 1988 – 2007; for the Sierra Foothill site the analyzed period was 1987 – 1989 & 1991 – 2007 (as 1990 forage data was missing for this site). The time period of analysis provides 20 observations for each of the three simulations.

[Figure 1]

According to the average forage productivity data of each site in the analyzed period, we estimate the number of acres needed for the herd so that they will consume 50 percent of available forage (Holechek et al. 2004, p. 233–236). The estimated acres needed to graze a 300 cow-calf herd is estimated by dividing the total forage requirement for the herd by one half of the average forage production per acre for each site. The market value of this forage is then calculated as the number of acres leased multiplied by the lease rate per acre for rangelands in the region in which the forage productivity data came from (CASFMRA 2007). This amount is then charged as an annual cost in the ranching financial statement. Additionally, we assume that for any year in which forage consumption by the 300 head breeding cow herd exceeded 70 percent of available forage, ranchers substitute hay for forage on a 1-for-1 basis as is typical

in California, to avoid the long term impacts of herd culling or overuse. In these years, hay is charged in the financial statement as a cost based on the market price for alfalfa hay in California in the corresponding year (NASS 2007).

Assuming that the rancher does not own the land, and thus by charging only the market value of the grazing lease as a cost, we exclude confounding factors of real estate investment in our simulation. We include in the estimated financial statements only the necessary land inputs for a cow-calf ranch (i.e., grazing leases). Investment in real estate, while often associated with ranching, is not a necessary condition for ranching and ranching is not a necessary enterprise when investing in real estate. Our analysis attempts to avoid attributing financial performance related to real estate speculation to the ranching business.

Other costs are charged to the financial statement, \$90,000 in 2007, and this value was adjusted for each year prior to 2007 by the GDP Deflator (BEA 2008). These other costs are meant to capture costs of insurance, taxes, ranch improvements, maintenance, fuel, veterinary expenses as well as labor, which may often be an implicit cost that is incurred by an owner-operator, but often not explicitly accounted for. These costs of \$90,000 are roughly in line with cost estimates for a 300 head cow-calf operation in the Sacramento Valley (Forero et al. 2004). Investment value was assumed to be \$500,000 in 2007. This value was also adjusted for each year prior to 2007 by the GDP Deflator. This is meant to roughly estimate the investment in the breeding cow herd, a small base property, barn, truck, trailer, and any other assets. These other cost and investment values were assumed to be relatively stable and thus similar for the three ranch sites simulations. We do not conduct a sensitivity analysis for these costs and investment assumptions because adjusting them affected the estimate of return (α) in the model, but had little impact on the final estimate of risk (β). Return on investment for each year was then calculated by subtracting the total of costs from revenue, and dividing by investment, for each year.

Portfolio investment and risk-free asset

In order to apply the data from financial statements on the CAPM model we have to assume a portfolio of market investment to measure the risk variability of cow-calf ranching returns

over this portfolio. The annual average return of the 3-month T-Bill (Federal Reserve Board of Governors 2007) for the year ending September 30 was used as the estimate of the risk-free rate of return (R_f in equation [1]) and the total annual return on the S&P 500 stock market index (Standard & Poor's 2007) for the year ending September 30 was used as the estimate of the expected market return ($E[R_M]$ in equation [1]). This date was selected because it corresponds the start of a new forage production year (with the beginning of fall and winter rains) and the start of fall calving.

Ordinary least squares was used to estimate β and α in Equation 2. R version 2.6.2 was used for all of the statistical analyses (R Development Core Team 2008), although the estimation of β for an asset using OLS can be done with any basic statistical or spreadsheet program.

RESULTS

Table 1 show the results from applying CAPM to the three simulated ranches in California for the period 1987-2007 and compares them to the results obtained in three previous studies of risk and return for agricultural assets (Dusak 1973; Barry 1980; Arthur et al. 1988)

[Table 1]

The estimated β for the three sites fall in the low range of all 41 assets analyzed in previous studies as well as the group of seven assets that are most closely related to the type of cow-calf operation studied here. Like the seven assets shown in Table 1, the estimated β are not statistically significantly different from zero. Thus, the cow-calf ranching operations analyzed for the studied sites represent low risk investments.

According to the estimated risk levels (β) in equation [2] (Table 1), and assuming that the market is efficient, we estimate that the expected returns for the three simulated ranches in California are 5.35 percent, 4.40 percent and 5.04 percent for the San Joaquin, Hopland and Sierra Foothill sites, respectively (Table 2).

[Table 2]

Table 2 shows these values estimated for the cost of capital for each site with their respective confidence intervals, as well as the coefficient of variation of the estimated return of investment with each ranch financial statement and of the forage productivity for each site. We

observe that the magnitude of the coefficient of variation on year-to-year forage productivity does seem to be related to the estimated risk and expected return. Thus, the higher variation on forage productivity the higher expected return estimated with CAPM. However, we cannot see a relation between the coefficient of variation on year-to-year simulated ranch investment return and the estimated risk and expected return. It seems that forage productivity could be a more important influencing factor in ranching performance than other factors.

In Figure 2, the estimated β s in the three simulated ranches in California line on to the x-axis to illustrate in the y-axis the expected efficient return for each simulation based in the estimated CAPM function. The result on the y-axis shows an estimate of the required cost of capital in each case.

[Figure 2]

Since the risk levels (β s) estimated in our regressions are both relatively small and not statistically significant, it is expected that the returns for the three simulated ranches would correspond to the expected return on the risk-free asset. This implies that investment in ranching should produce at least the same return than the risk-free asset. However, the return of the risk free asset in our analyzed period averaged 4.8 percent, ranging from 1.1 to 9.0 percent (confidence interval at 95 percent), while traditional estimates of ranching in the Western U.S. ranges from 2.0 to 3.0 percent (Workman 1986; Torell et al. 2001). This supports the idea, generally accepted, that ranching produces more than just commercial returns (Pope 1985, 1987; Campos et al. 2009; Huntsinger et al. 2010), since taking his/her money from the ranching investment, the rancher can get more commercial return by investing in a risk-free asset.

The low systematic risk in ranching could make this kind of investment attractive for diversifying risk in portfolio investments, if it was possible to expect to earn a return at least equal to the risk-free rate. While for some investors the amenity production that justifies the gap between risk-free asset return and ranching return is an additional reason for entering in this kind of investment, other investors would be dissuaded by the low return of this investment if they do not have an amenity orientation.

DISCUSSION

The CAPM applied to estimating the systematic risk of ranching enterprises, exclusive of other economic activities and land speculation, and built upon the simulation of ranch financial statements based on real forage productivity data, and hay and calf prices in three oak woodland and annual grassland sites in California, provides insights into the economic analysis of ranching, reinforcing findings already observed and highlighted in the literature but hardly quantified.

Consistent with prior studies of the market risk and return of agricultural assets, this study estimates that cow-calf enterprises in California possess low systematic risk and should require a relatively low cost of capital (about 5.0 percent). Notably, this cost of capital is lower than the bank prime loan rate, which is roughly the lending rate that a business would expect to pay on loans. Using this analysis and applying the methodology used here to actual ranch financial statements to derive site-specific risk and cost of capital may provide evidence to support negotiating lower interest rates on loans for financing ranch projects.

While this cost of capital is lower than values used in cost-benefit analyses of ranch projects and the bank prime loan rate, it is still higher than the 2.0 – 3.0 percent historical return to ranching (Workman 1986; Torell et al. 2001). Given that there seems to be a trend of ranches failing to meet their cost of capital—and carrying the assumption that ranchers are acting to maximize their own utility, this discrepancy suggests that ranchers are deriving amenity values from their operations and they are subsidizing this shortfall through other income streams or reductions in potential income. This empirical evidence supports studies that have found that considerations other than profit are important for rancher decision making (Smith and Martin 1972; Huntsinger and Fortmann 1990; Torell et al. 2001; Sulak and Huntsinger 2002; Rimbey et al. 2007; and Campos et al. 2009).

Against the amenity orientation line of reasoning, it is argued that ranching or other rural-related investment are held as long-term investments or for speculative reasons (i.e., land development potential). The results obtained in our CAPM shows that other save investments, such as risk-free assets, produces higher financial returns than the traditional range of 2.0 to 3.0 percent return on ranching. Thus, without amenity or other environmental motivations, ranchers would be making poor financial decisions when investing in ranching. Land speculation

could add further explanation for ranching investment beyond its risk free nature. However, attractiveness based on land speculation depends on specific market conditions and investor expectations, while amenity consumption by ranchers has been documented from the 60's (Martin and Jeffries 1966) and continues to be identified as an important reason to explain why investors maintain investment in spite of the low returns given by them and even considering land appreciation (Torell et al. 2001; Campos et al. 2009).

This study uses specific rule-sets for simulating ranch enterprises that may not accurately reflect rancher behavior. For instance, use of grazing lands in areas with forage production that is less correlated with the production of the base ranch (such as high elevation Forest Service Grazing Allotments in the vicinity of these three sites or grazing land in the adjacent intermountain west region) will tend to reduce the year-to-year variability in forage costs for a rancher. Changes in herd sizes or use of irrigated pasture or crop land in response to forage variability will also impact the actual variability in forage costs and return on investment.

While there is an insufficient number of sites in this study to draw definitive conclusions about the characteristics of forage productivity and their relationship with cost of capital, the observed positive correlation between the size of the coefficient of variation on forage productivity and the cost of capital does suggest that year-to-year variability in forage productivity has some effect on market risk and the cost of capital (Table 2). Given the high level site-specific uncertainty in climate change predictions, it is difficult to make predictions of exactly how climate change will affect the profitability and risk of ranching in California. However, given the general pattern of low risk in agricultural assets, the risk and cost of capital of ranching in California will likely remain low with respect to climate change.

MANAGEMENT IMPLICATIONS

The CAPM results show a low systematic risk for ranching enterprises (each estimated β is low and not significant in the models) and a benchmark for the cost of capital (around 5.0 percent) in three oak woodland and annual grassland sites in California. These results provides information that may be used as a starting point for ranch planning and analysis purposes while assessing the performance of a specific ranch enterprise using historical financial statements that reflect actual rancher behavior, market conditions and forage productivity. Most importantly, the low

cost of capital estimated with the CAPM provides evidence to support negotiating lower interest rates on loans for financing ranch projects.

While the estimated cost of capital is low, it is still higher than the 2.0 – 3.0 percent historical return to ranching. The main implication is that, according to the CAPM, ranchers incur opportunity costs in their investments, since they could invest in risk-free assets that provides larger commercial returns. This result can be explained by the amenity consumption motivation of ranchers in western United States (Martin and Jefferies 1966; Grigsby 1980); thus, seeking to maximize their own utility, ranchers would be deriving amenity or other environmental values (e.g., altruistic) from their investments. On the other hand, investors coming from outside the ranching business could feel, due to its low systematic risk, ranching could be seen as a potential for diversifying risk in portfolio investment. But portfolio diversification as an exclusive motive for investing is not sufficient, because the return on risk-free assets are more attractive for pure commercial investors. If ranching needs to pay its own way to finance its operations, the presence of amenity values is relevant since they guarantee, at least to some extent, that current ranchers or potential ones are willing to pay or give up earnings for maintaining these operations in the rangeland working landscapes.

Further research should address the question of what would happen with ranching if commercial operations start declining and ranchers consider the amenity orientation as the main, or even the exclusive, motive to maintain their properties. Would this drive changes in the landscape due to change in management? Would ranchers need such an extensive woodlands to keep their lifestyle and amenity benefits? Although meeting the costs of capital is important for the persistence of ranching, the low estimations for this cost of capital and the apparent importance of amenity consumption in ranch investment decisions may imply that the challenges to the ranching industry in California, and maybe across the western United States, are likely due to factors larger than the ability of an enterprise to meet its cost of capital. Finding ways to increase income streams, reduce costs, and maximize both amenity and production values are important to the long term sustainability of ranching.

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FIGURES

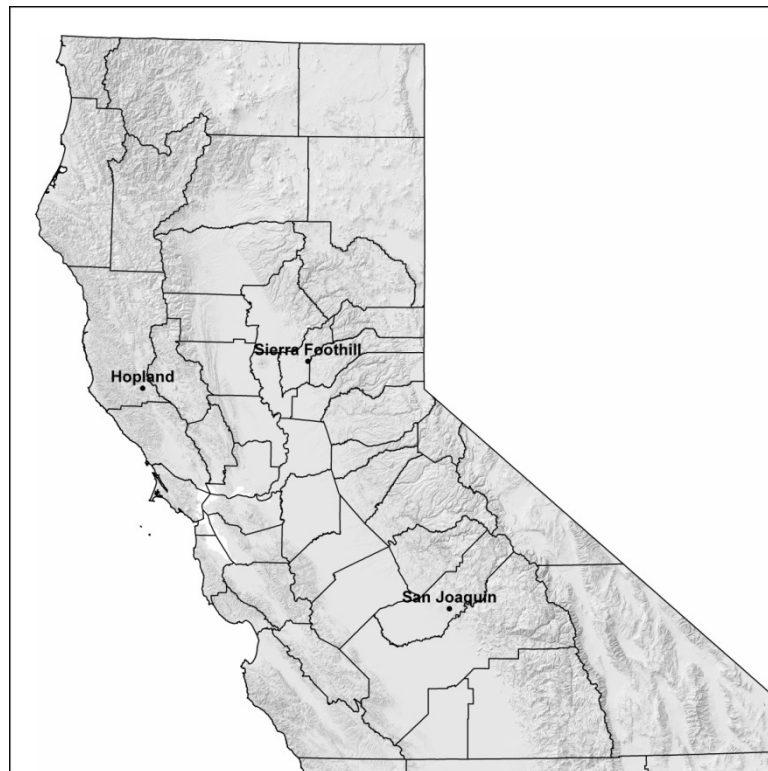


Figure 1. Three sites from which historic forage productivity for 1987-2007 was used to construct ranch financial simulations using a Capital Asset Pricing Model

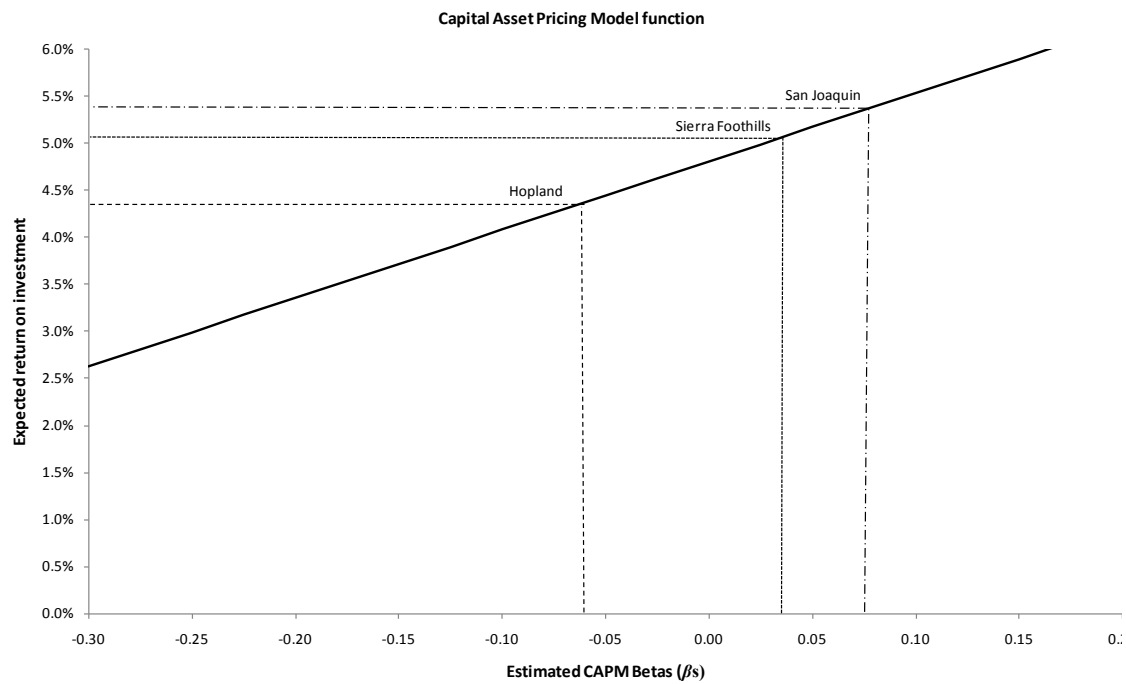


Figure 2. Capital Asset Pricing Model results for ranch simulations, with estimated β s projected onto the x-axis to show in the y-axis the expected return on investment in the San Joaquin, Hopland and Sierra Foothill sites

TABLES

Table 1. Results from Capital Asset Pricing Model for three simulated ranch sites in California with comparison to the results from previous studies analyzing agricultural assets.

Ranch sites in California	α (SD)	β (SD)	df	Time period
Cow-calf, San Joaquin site (0.024)	-0.006 (0.126)	0.075	18	1988-2007
Cow-calf, Hopland site (0.016)	0.046*** (0.083)	-0.057	18	1988-2007
Cow-calf, Sierra Foothill site (0.023)	-0.035 (0.112)	0.035	18	1987-2007 (1990 excluded)
Previous studies in agricultural assets	α (SD)	β (SD)	df	Time period
Agricultural real estate, Pacific ¹ (0.011)	0.058*** (1.750)	0.140	26	1950-1977
Agricultural real estate, Mountain ¹ (0.014)	0.052*** (0.909)	0.100	34	1950-1977
Hay ² (0.046)	-0.070 (0.410)	0.550	34	1976-1984
Meat ² (0.028)	-0.020 (0.241)	0.070	34	1976-1984
Steers ² (0.024)	0.010 (0.250)	0.030	34	1976-1984
Hog ² (0.046)	-0.050 (0.386)	0.270	34	1976-1984
Farmland and dividend ² (0.000)	0.000 (0.148)	-0.040	34	1976-1984
25 th percentile of 41 agricultural assets ³ N. A.	-0.020 N. A.	0.037	N. A.	N. A.
Median of 41 agricultural assets ³ N. A.	0.000 N. A.	0.100	N. A.	N. A.
75 th percentile of 41 agricultural assets ³ N. A.	0.043 N. A.	0.215	N. A.	N. A.

Asterisks (***) denote significance at the 1% level.

N. A.: not applicable.

¹Data from Barry (1980).²Data from Arthur et al (1988).³Data from Dusak (1973), Barry (1980) and Arthur et al (1988).

Table 2. Expected returns after mapping estimated β s through the CAPM and the corresponding coefficient of variation of return on investment and forage productivity for each site.

Site	Expected return based on CAPM Lower bound	95% confidence interval		Coefficient of variation	
		Upper bound	Simulated return on investment	Forage productivity	
San Joaquin site	5.35%	3.55%	7.15%	1.846	0.436
Hopland site	4.40%	3.21%	5.58%	0.707	0.220
Sierra Foothills site	5.04%	2.62%	7.43%	5.138	0.300