A framework for modelling financial risk in Southern Australia: the intensive farming (IF) model

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The Intensive Farming (IF) model: a framework for modelling financial risk in southern Australia

Tim Hutchings, Tom Nordblom, Richard Hayes, Guangdi Li, and John Finlayson

Abstract

Australian farmers operate in a financial environment, which is many times more variable than their competitors in the developed world, yet make decisions using static systems which ignore risk. This paper examines the use of dynamic modelling, using the Intensive Farming (IF) model, which can quantify and compare the physical and financial risks associated with various management scenarios on dryland farms in south-eastern Australia.

In this paper the Intensive Farming (IF) model is used to simulate the whole-farm, 10-year cashflow for a typical 1,000 ha farm in the region, with a farming system based on dryland crops and breeding Merino sheep. It shows that conventional budgets, based on annual average yields and prices at 80% equity, produce outcomes with similar median values to the more complex dynamic budgets, and predict a positive margin for average years. In contrast dynamic analysis shows that the 10-year cash margins are 38% more likely to be negative than positive. Such a farming system was therefore unlikely to be viable in the long term.

Dynamic budgeting also shows that the cropping enterprise is three times more variable (CV 50%) than the sheep enterprise (CV 18%). The effect of including risk reduces the crop gross margin by 14% and the sheep gross margin by 7% compared to static budgeting, which is based on annual average rainfall and prices.

Further analysis showed that whole-farm cash margins are very sensitive to debt, with the cost of a 20% increase in debt reducing the 10-year cash margin by 19%. Within-year tactical adjustments had little significant effect on the long-term margin, because such adjustments are usually made in years of low income, where the marginal dollar effect was small. This paper concludes that conventional budgets could encourage sub-optimal, and even loss-making farming practices, and should be replaced with whole-farm, long-term, dynamic budgeting systems, which explicitly account for the natural variability of key inputs.

Introduction

A successful model of the farm business operation must be able to reproduce both the strategic and tactical aspects of change or decision-making at the whole farm level. Such a model would have to allow for all management processes and would need to include:

1. The capacity to use all relevant information available to the farm manager (Makeham & Malcolm, 2002; Malcolm, 2004). This would encompass the multi-disciplinary nature of the farm business process.
2. The ability to replicate the decision-making process at both strategic and tactical levels for a range of sites and regions; that is to change both the value and timing of all manageable inputs over the period of the simulation at each location (Janssen & Ittersum, 2007; Schultz, 1939; Thompson, et al., 1996).
3. A range of reports, which make the process fully transparent to the user. This would include the ability to calculate movement in all common financial benchmarks including a statement of the change in net worth over this period (Malcolm, 2004).
4. An output which incorporates a validation and verification process which lends credibility to all aspects of the output (Cahane, 2008).

The intensive farming (IF) model, described here, allows multiple iterative selection of randomly sampled climatic and price sequences from the historical record, which allows the generation of a risk profile specific to the subject farm business. This approach quantifies the physical and financial risk for any chosen management scenario. Furthermore, because this risk profile is based on historical records for selected time-series for the two major sources of farm variability (price and climate), it can be used to assess the long term viability of the chosen management strategy on that farm, as measured by the gain in net worth of the whole business.

The model outline

The following points describe each module of the model, and the role of each model in the calculation of the 10-year cashflow budget for each iteration. The component lines in this cashflow, such as labour and fuel use, are calculated using independent sub-routines, which respond to variations in yields, rotations and other inputs. These inputs are summarised as follows:

1. The farming system, or rotation, can be set as any sequence of up to six dryland crops, and up to eight years of either lucerne or annual pasture. This pasture can be established using either direct sowing following the cropping phase, or sowing under the terminal crop (Nordblom & Hutchings, 2014).
2. The crop yields are calculated from rainfall using the French-Schultz method, as modified by Oliver et al (2009). A further modification is used to allow for the effects of waterlogging on crop yields (Hutchings 2013). This method produces yields which correlated (r^2>0.85) with long-term yield records for two farms in the Southwest Slopes region of NSW. On one farm, at Illabo in the east of the region, this correlation exceeded that for the APSIM model, which gave a lower correlation (r^2= 0.66) with actual 20 year yields for the same farm (Hutchings 2013).
3. The CSIRO Grassgro™ model (Donnelly et al., 2002) calculates the monthly net pasture energy production for the same site, for the 60-year period for the chosen pasture type, using a routine developed for this model (Moore, 2012). The annual pasture type was specified to include 30% of subterranean clover and native grasses.
4. The grazing energy demand is determined by the numbers of livestock, and the specifications for the sheep flock being analysed. The energy demand for the flock will depend on the sex of each age group, their monthly bodyweight and rate of growth, fertility and pregnancy status, and the sales and purchase program for each classification (ewes, lambs, wethers etc.). These characteristics can be entered for any flock type or breeding system.
5. The energy demand for any flock is determined by these specifications, and the number of sheep of each type present on a monthly basis. The annual sum of these monthly energy demands gives the annual average stocking rate, in dry sheep equivalents (dse) per hectare, which can be converted to megajoules (MJ) per year. In a stable breeding flock the number of ewes determines the number of each livestock class over time; the stocking rate can be reset by adjusting the number of breeding ewes present at any time.
6. The production for all commodities is priced using random sequences of prices generated from weekly price percentiles, CPI adjusted, for the previous five years for each commodity (Figure 1) to give estimates of income. These series are generated by an algorithm which maintains the price relationships between the commodities. These series also maintain the historical ranges, both between years in the series and within years for each commodity.

   These series correlate closely with the mean and variability of the CPI-adjusted prices based on the weekly prices (Melbourne port) for these commodities (Table 2).

Table 1: Comparison of actual and simulated price series

Canola	Actual	Model	%
Min	$399	$374	94%
Max	$871	$871	100%
Median	$549	$547	100%
CV	19%	17%	90%

Barley	Actual	Model	%
Min	$161	$151	94%
Max	$416	$416	100%
Median	$225	$235	104%
CV	29%	23%	80%

Wheat	Actual	Model	%
Min	$183	$173	95%
Max	$493	$493	100%
Median	$278	$273	98%
CV	26%	22%	84%

Lupins	Actual	Model	%
Min	$195	$187	96%
Max	$403	$403	100%
Median	$295	$291	99%
CV	20%	15%	75%

Ewes	Actual	Model	%
Min	$31	$35	110%
Max	$114	$110	96%
Median	$67	$59	88%
CV	30%	24%	82%

Lambs	Actual	Model	%
Min	$74	$71	96%
Max	$136	$125	92%
Median	$101	$93	92%
CV	14%	11%	78%

This comparison shows a very accurate fit for the crop commodities. The sheep prices show more variation from actual prices; this is to be expected, as the actual prices are averages for commodities which vary in breed, size, carcass quality and the value of the skins.

7. Gross margins for both crop and livestock are then calculated by subtracting the variable costs for each component enterprise in the chosen rotation, drawn from data published annually by the NSW Department of Primary Industry (*www.dpi.nsw.gov.au/farm-business/budgets/winter-crops).* The gross margins are further refined by including simulations of the cost of nitrogenous fertiliser applications for crops, and the cost of supplementary feed required by the livestock (at the nominated stocking rate); these two costs comprise the major variable cost components of the respective gross margins. The gross margins do not include any allocation of pasture costs between the enterprises.

8. The cost of establishing and maintaining the chosen pasture is included as a separate line item, because these cost are related to both crop and livestock performance. This model allows the choice of either annual (annual grass and subterranean clover) or lucerne-based pastures, sown either individually or sown under the terminal wheat crop. Sowing lucerne

under crops can increase the risk of pasture establishment failure (McCormick et al. 2014), and the model allows for occasional failures in years of low rainfall. This model allows for establishment failure to occur under user-defined conditions. Failed perennial pastures are assumed to be equivalent to annual pastures, and the area of such establishment failures is continued for the entire pasture phase of the rotation. The model will allow for these failed pastures to be re-sown if required.

9. The overhead costs are nominated by the user, usually based on historical records, adjusted to reflect the impact of any planned management strategy. These costs are also inflated cumulatively by a nominated percentage, taken from a long-term survey by van Rees (2015). In addition the variable component of these costs, including labour, fuel, repairs and shire rates, are adjusted for each enterprise mix, using criteria nominated by the user.

10. Capital costs include the living costs of the owner, adjusted for the cost of living, and the cost of capital replacement over time. The IF model allows the user to enter his machinery inventory, together with the age and expected life of each item. The cost and timing of the replacement for each item is then the difference between the inflated purchase price and the depreciated value at the predicted time of sale. The annual sums of the replacement costs across all capital items creates a true cashflow which more accurately reflects the uneven nature of these costs, which is specific to each farm business.

10. Income tax is calculated using either a standard percentage rate, or the five year income averaging system most commonly used by farm businesses. Income tax is charged in the year following the budget year, which allows for the normal time taken to prepare the tax estimate.

11. Finally, interest is charged at nominated rates (credit and debit) of the closing balance of the previous year. Interest is therefore cumulative, which simulates the likely net cash position of the business over time. The change in this cash position reflects the probable change in the viability of the business, given a stable asset value, and is the subject of this risk analysis.

12. The annual net worth can be calculated from the cash balance for any year, together with a user-nominated percentage increase in the value of the land asset.

13. All costs are adjusted for inflation over time. van Rees (2015) has shown that the different component prices in farm cashflows have inflated at different rates over the past two decades. In his survey data variable costs have increased by approximately 4% year-on-

year, while capital costs, including living costs, have inflated by 5% in the same period. Both these rates are higher than the inflation rate for fixed (overhead) costs, which have risen at 3% per annum, which is similar to the published national cost of living increase (RBA 2015).

Model outputs

Most model outputs can be expressed as either 60-year time series, or as probability sequences, such as cumulative frequency distributions (CDF), calculated from decadal sequences used in the Monte Carlo analysis.

Most physical variables are presented as 60-year time series; these include crop yields, nitrogen supply and demand, pasture yields from all sources, area of failed pastures, and supplementary feed required. One example is the 60-year time series of simulated crop yields (Figure 2).These same variables can be shown as CDFs, which show the probability of any level of output, within the calculated range.

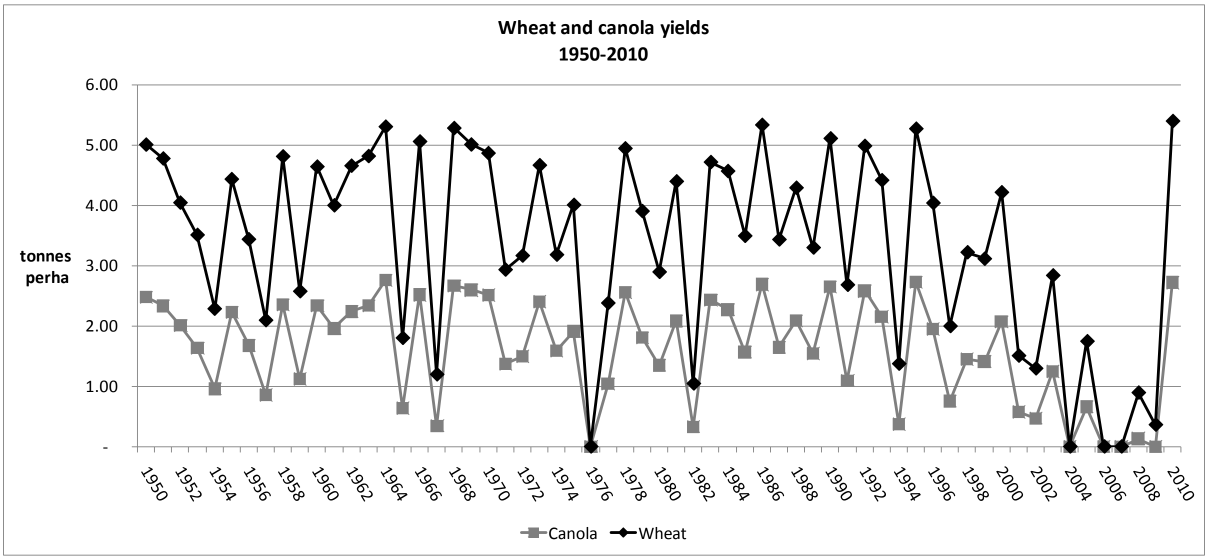

Figure 2: Example of 60-year time series for crop yields

The simulated energy yield of pastures can be similarly displayed (Figure 3). Note that the annual pastures have a more variable energy yield, with higher maximum and minimum yields than simulated for direct-sown lucerne.

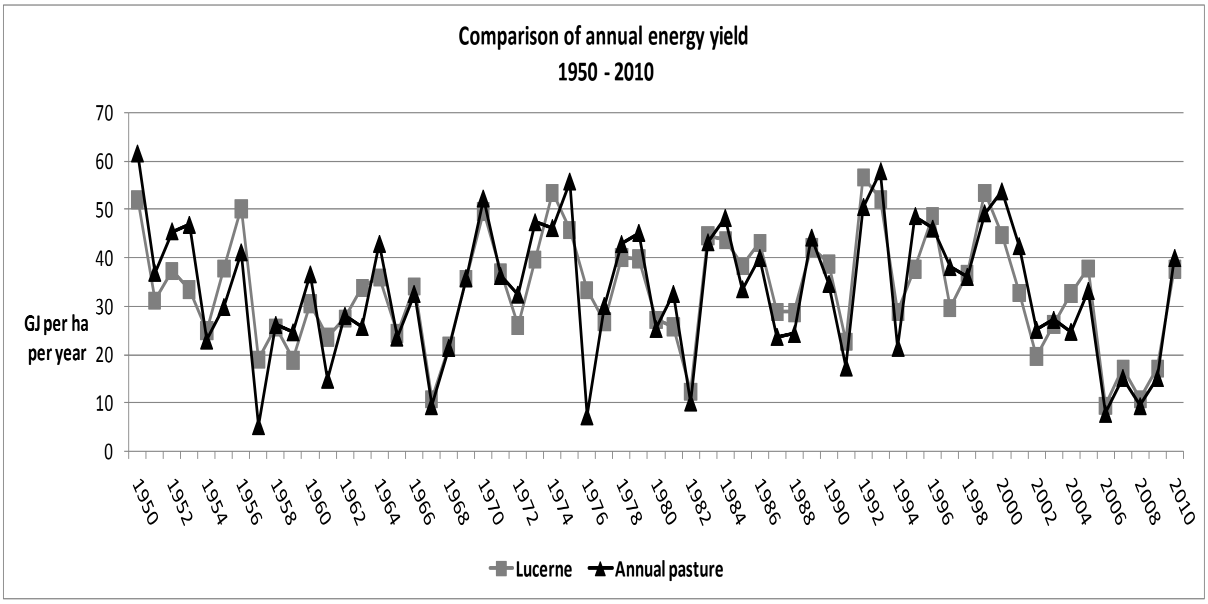

Figure 1: Example of 60-year pasture energy yields (after Grassgro)

The probable ranges for the cost of the supplementary feed required at any stocking rate over the 60-year time series can be calculated for any stocking rate on a decadal basis (Figure 4), based on the monthly energy supply and demand of the flock, summed annually.

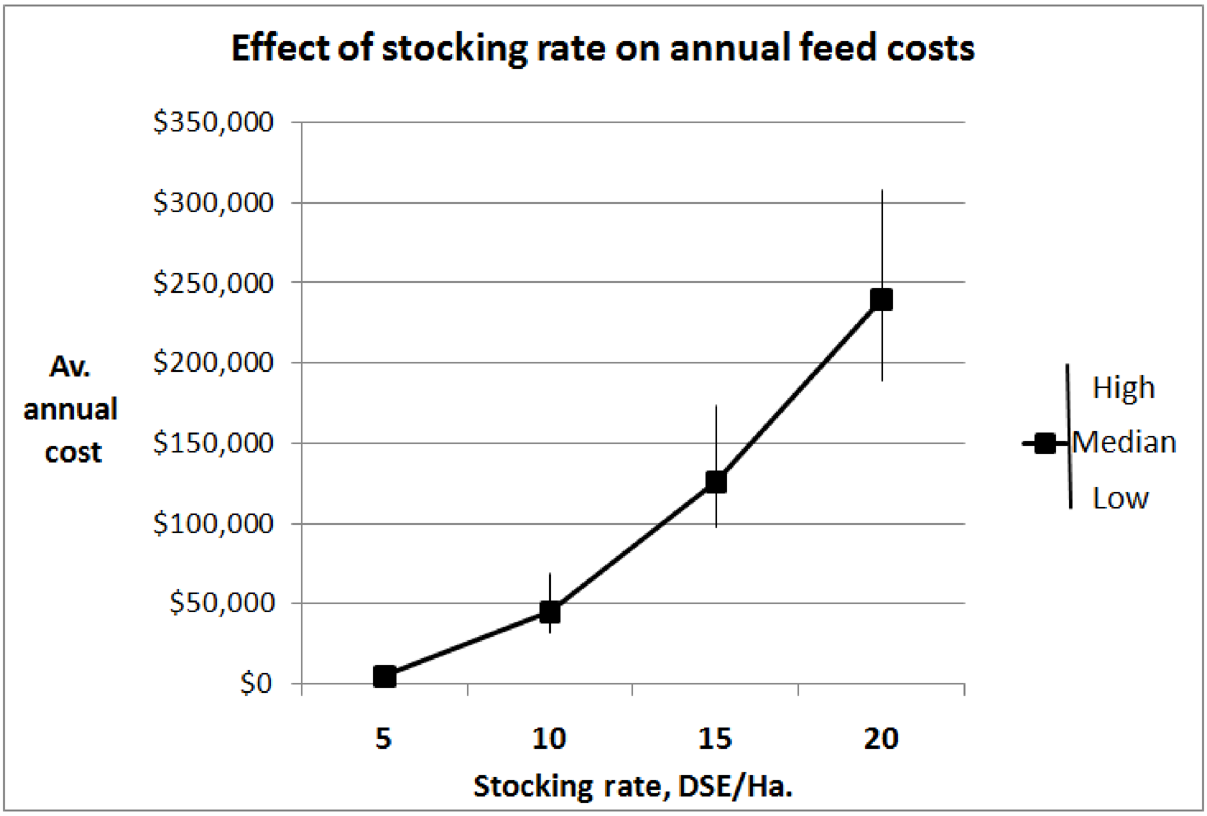

Figure 4: Probability distribution for supplementary feed requirement over 60 year time series

Financial outputs can also be shown as either 10-year time series or CDFs. These include gross margins (per hectare of per farm), earnings before interest and tax (EBIT), annual or decadal cash balances, decadal cash margins, and variable components of the cashflow, including income tax and interest costs or receipts.

The effect of the decadal rainfall on the decadal cash margin (closing minus opening cash balances) at all prices can be displayed as a probability distribution (Figure 5). This shows the very serious effect of the prolonged drought in the 2000 decade on cash margins, especially when compared with the 1960 and 1980 decades, which were essentially very similar. The median loss for the 2000 decade is calculated to be -$2.59 million, which would represent an unsustainable loss of equity.

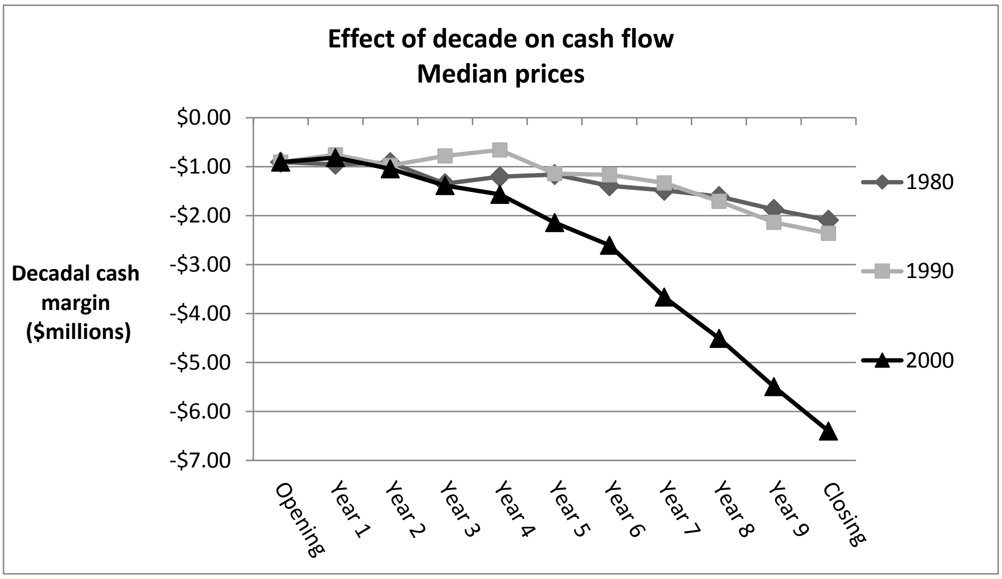

Figure 5: Simulated cashflows for three decades, using simulated price series.

These cashflow trends can also be viewed as the probability of achieving a range of DCMs in each decade, as shown in Figure 6. These CDF profiles show that there is a 100% probability of making a loss in the 2000 decade, compared to 33% for the 1990s, and 26% for the 1980s.

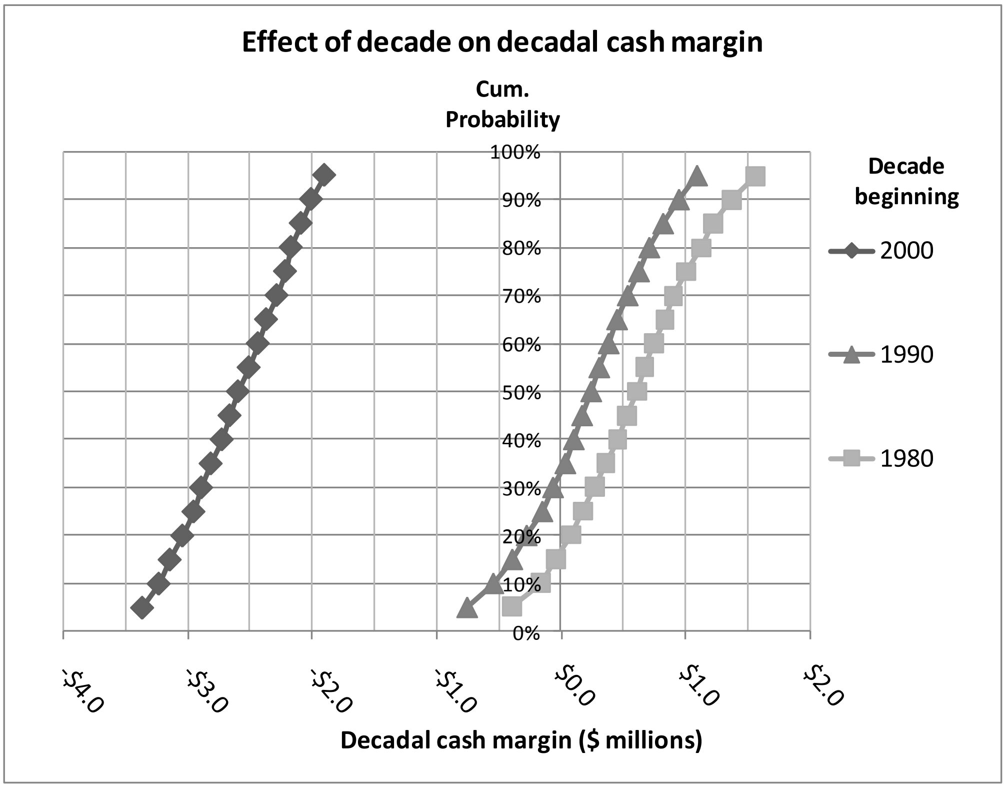

Figure 6: The effect of different decades on the decadal cash margins

These few examples illustrate the range and capabilities of the IF model, and demonstrate the potential impact of risk on farm performance. Including all transactions, as in a cashflow, and the variability of production and prices, has profound consequences for farm management decision-making.

Results

Current best-practice management recommendations are often based on simple gross margin analyses, calculated at average yields and prices. This approach may have been sufficient to guide farmers in the past when margins were relatively high, and fixed and capital costs low (as a percentage of total costs). However in the current low-margin business environment, small changes in fixed and capital costs can often negate any differences in gross margins, which can often result in the farm operating at a loss (Hutchings & Nordblom, 2013). Furthermore the changes associated with a novel management practice often affect the fixed and capital costs structures, the effects of which are rarely reflected in the simplified gross margin analysis criticised above. Conventional static analysis also ignores the effects of cost inflation and the compounding effect of cash surpluses or deficits, which can significantly alter the financial result of a change in management practice.

The IF model is designed to capture all these changes as cashflows over time. It presents the probability of a range of outcomes for whole-farm returns over randomly selected decades. In doing so it captures all the historical variability of both rainfall and price and presents a risk profile for any scenario, which can be compared with other scenarios for the same farm, or farms in different regions of southern Australia. This form of analysis is therefore termed dynamic; that is it offers a range of solutions, with their probability of occurring, in contrast with the conventional, static, single point solutions offered by standard analysis.

Table 3 shows the effect of increasing levels of risk on a variety of financial benchmarks for the sample farm used throughout this analysis. There are four levels of risk modelled:

1. A static one-year budget, based on average growing season rainfall (GSR) and prices for the area. This is the normal method used by managers and research personnel to evaluate management changes. It makes no allowance for fixed and capital costs, cost inflation, accumulation of debt, or variability from any source.
2. A static ten-year budget, extrapolated from the one-year budget above, but which includes the effect of cost inflation and accumulation of debt (or credit).
3. A dynamic ten-year budget, based on randomly sampled decadal sequences of growing season rainfall, drawn from the period 1950-2010, and using median prices. Consequently this budget includes the effect of rainfall, which is the major source of variability, or risk, faced by the farmer (Hutchings 2013). This budget also includes the effects of cost inflation and debt accumulation.
4. A similar budget to (3) above, but including the historical variability of commodity prices, drawn from actual weekly prices for the past five years. This budget includes the three major sources of financial risk (debt, price and rainfall) affecting financial performance of farmers in this region (Kingwell, 2011).

Table 2 shows the differences in the values of a range of financial key performance indicators (KPI) as the analysis moves from a static to a dynamic base, incorporating increasing levels of risk in the process.

Table 2: The effect of varying levels of risk on the median value and variability of chosen financial benchmarks for a representative 1,000 ha farm in southern NSW

1,000 ha farm, 5 yrs crop, 4 yrs pasture, Merino/prime lamb flock
12.5 dse/ha, 80% equity, direct sown lucerne

Period		1 year	10 years	10 years	10 years
GSR		Av	Av	All	All
Prices		Av	Av	Av	All
Crop GM/ha		431.20	381.39	429.73	415.53
	SD			*134.21*	*207.74*
	CV			*31%*	*50%*
Sheep GM/ha		640.90	562.55	545.06	551.56
	SD			*76.62*	*100.93*
	CV			*14%*	*18%*
Pasture cost/ha		-94.10	-133.94	-133.94	-133.94
	SD			*0*	*0*
Farm GM/ha		454.01	362.14	393.16	396.39
	SD			*82.68*	*108.85*
Crop GM		215,598	190,695	214,897	207,765
	SD			*67,106*	*103,869*
	CV			*31%*	*50%*
Sheep GM		256,359	225,021	218,025	220,624
	SD			*30,650*	*40,371*
	CV			*14%*	*18%*
Pasture GM		-37,640	-53,574	-53,574	-53,574
				0	*0*
Farm GM		454,014	362,141	393,157	396,388
	SD			*82,675*	*108,850*
	CV			*21%*	*27%*
EBIT		153,107	-7,342	37,485	41,458
	SD			*65,154*	*40,371*
	CV			*174%*	*97%*
Cash bal		-813,328	-1,075,765	-1,099,857	-1,044,244
	SD			*808,317*	*1,106,250*
	CV			*73%*	*106%*
Decadal cash margin		65,363	-196,801	-278,104	-222,471
	SD		*0*	*808,317*	*1,106,250*
	CV		*0%*	*291%*	*497%*

The variability of all the financial benchmarks increases as the level of financial risk increases from left to right across Table 2. For instance, the crop gross margin per hectare declines 13%, from $478.25, without risk, to $415.53, including price and production risk. At the same time the variability of the crop gross margin, measured by the coefficient of variation (CV), increases from zero to 50%. For comparison, the CV of the sheep gross margin only increases to 18%, or approximately one third of the value for the cropping enterprise; this demonstrates the stabilising effect of diversifying into sheep (without losing margin, in this example).

The median value for all benchmarks also falls as the budgeting period increases from one year to 10-years, at median values for the GSR and prices. This illustrates the impact of cost inflation on farm financial returns in the long term. This effect is amplified by the cumulative effect of these cost increases on cash flows, changing a positive one-year cash margin (closing minus opening cash balance) of $53,019 to a loss of $177,141 after 10-years. It is therefore important to prepare long-term budgets to better understand the long-run viability of any farming system.

In all cases the variability of the benchmark values increase with the variability of the inputs. Thus the standard deviation of the scenario including all risks (all years, all prices) is always greater than for the scenario run at median prices (all years, median prices), even when the median output is lower. The difference between the standard deviation of these two scenarios must therefore be due to an increase in risk due to the multiplicative effect of rainfall and price variability.

These issues are better explained by CDF curves than by such conventional, static, statistical analysis. All the issues raised above are well demonstrated in the following graphs showing the risk profiles for sheep and crop gross margins (Figure 7). In these graphs the vertical lines represent the outcome for conventional budgets, based on average prices and rainfall. Budgets such as these ignore risk; their output remains unchanged for all values of cumulative probability. The outcomes for static sheep and crop gross margins give values close to the median outcomes for the CDF curves, especially when these budgets were run over 10-years. However, static budgets fail to quantify, or compare, the risks associated with each enterprise, when the downside risks of operating that enterprise may not be acceptable to a farm with high debt or low returns.

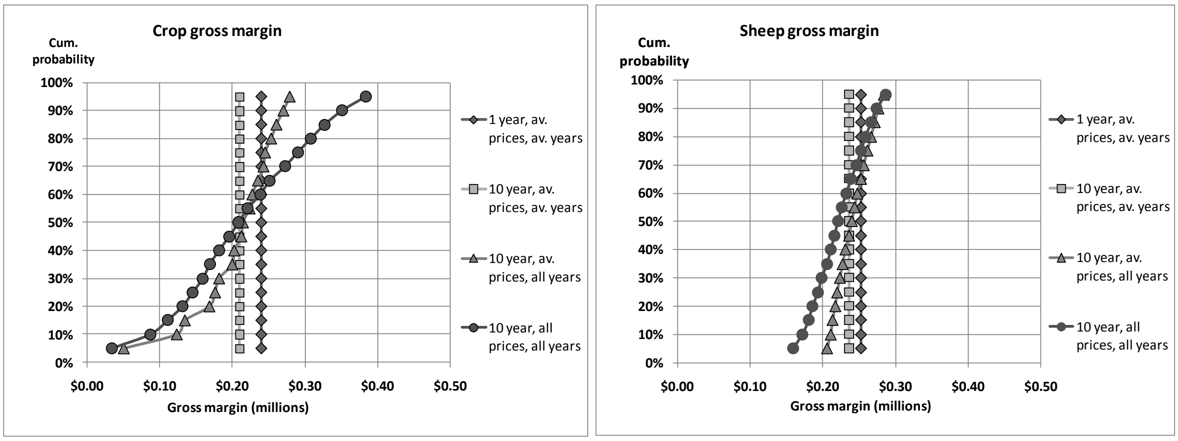

Figure 7: Whole-farm gross margins for sheep and crop enterprises

The level of risk in Figure 7 is illustrated by the slope of the line for each scenario; the flatter the curve the greater the variability, because the range covered by the line is greater. Thus the sheep enterprise shows a slightly higher gross margin than the crop enterprise in all scenarios. However, the range of outcomes, or risk, is much greater for the cropping enterprise under both dynamic scenarios; cropping shows a much higher downside risk, as well as upside risk, compared with the more vertical curves for sheep.

The discussion to date has been limited to gross margins, which are positive for each enterprise. This margin decreases rapidly when fixed and capital costs are subtracted, as shown by the EBIT (earnings before interest and tax). Table 3 shows that EBIT, which is a standard performance measure in non-farm businesses, decreases by 76%, from a median value of $236,138 (with median prices and yields), to $41,458 with the full range of prices and 60 years of yield data. Interestingly the lowest value for the EBIT, $29,893, occurs in the 10-year static budget. This contrasts with the results for the first dynamic scenario, which has a marginally higher value of $37,485. This difference, if it is significant, suggests that there is a slight skew towards more positive yields over the full 60 years.

The most informative KPI for a farmer is the decadal cash margin (DCM). This is the difference between the opening and closing cash balance for the chosen decade and mirrors the change in the bank balance. If the DCM is positive this indicates that the business is capable of generating sufficient income to pay all costs for the period, after inflation and the cost of compounding interest. This releases funds for investments which could be used to increase operating efficiencies or diversification to maintain the growth of margins into the future.

Table 3 shows that the DCM for this representative farm is negative for any budget longer than one year, with the range in variability of outcomes rising rapidly with increasing risk. The standard deviation of the DCM for the full dynamic budget (all years and all prices) is $1,106,250, nearly five times the median value of the DCM (-$222,471). This variability is better illustrated by the CDF curves in Figure 8.

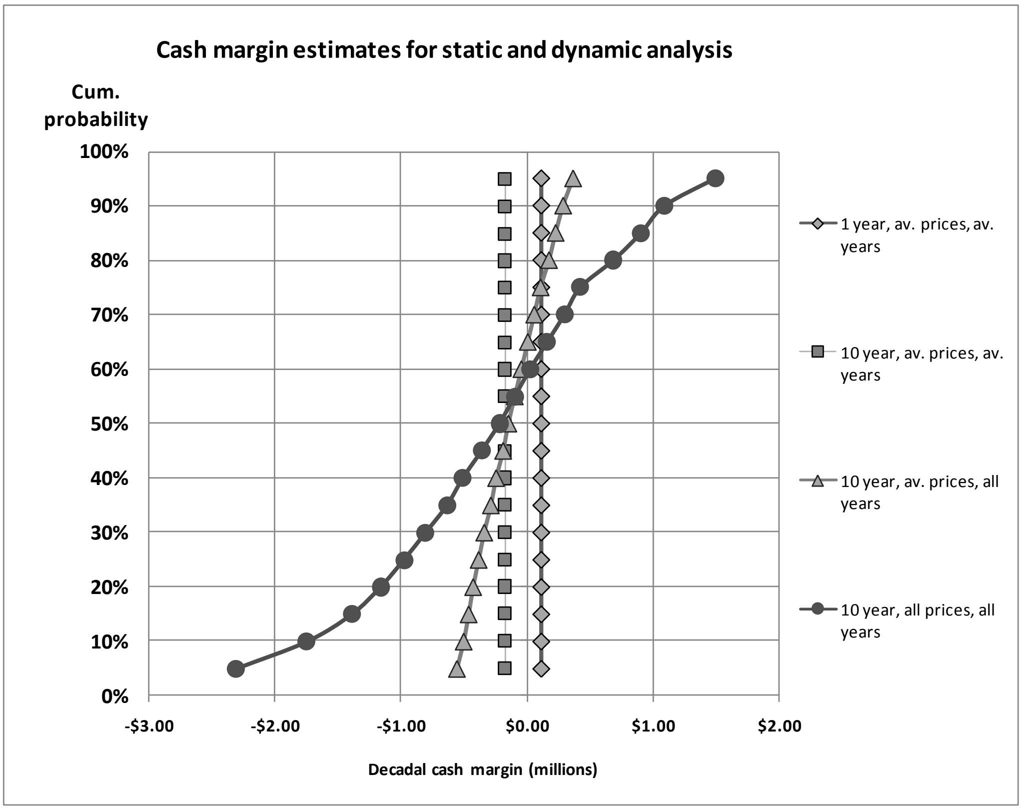

Figure 8: Risk profiles for the cash margin under a range of scenarios at 80% equity

This graph confirms that the median DCM for both static and dynamic budgets are similar. However the positive result suggested by the conventional one-year budget, based on median prices and median yields, could encourage investment which would almost certainly result in losses in the longer term.

The median DCM for all the 10-year budgets is negative, indicating a loss between -$177,141 for the static budget, increasing to -$222,471 for the full dynamic budget; more-over this dynamic budget shows that there is an equal 25% chance of a DCM between $421,838 and a loss of -$982,229. This confirms the fact that there is a 58% risk of loss, or that the risk of loss is 38% greater than the risk of a positive margin over the full range of historical variability. This large negative bias to long term performance would discourage further investment in this business.

Figure 8 also shows that there is a large difference between the variability, as defined by the standard deviations (SD), calculated at median prices (SD $808,317) and variable pricing (SD $1,106,250). This suggests that prices are more variable than yields; however income is the product, rather than the sum, of yield and prices. This multiplier effect gives rise to the relatively large increase in variability for the scenario which includes the full range of rainfall and prices. This scenario illustrates the full range of possible outcomes, amounting to $4,578,341 after 10-years,which occurs when the variability is not artificially constrained by the use of median values for either of these inputs.

The effect of debt

Debt (or credit) costs arise the consequence of accumulating margins over time; it is the trend of these costs which is important. If the trend is negative then the debt rises, which reduces the ability of that business to service the capital and interest payments on the growing debt. In the long term this can render the business non-viable even when it retains some equity. Furthermore debt accumulates at about three times the rate of credit growth; this is because the interest rates on debt are at least twice that for credit, and profits are taxed, which further reduces the rate at which credit balances accumulate.

Debt has two effects on cashflow. The first effect is that the opening balance sets the starting point for the cashflow; a high initial debt will increase the difficulty of returning to credit. Secondly the interest costs in the long-term cash flow are cumulative, so that the interest cost will reflect both the opening balance, and the cash balances in subsequent years. Consequently a high initial debt will increase the fixed costs, and so decrease the operating margin.

A good estimate of the long-term viability of a business is its risk of loss, which should be less than 50% if a business is to be certain of its ability to generate surpluses sufficient to pay its future costs. Many mixed farming businesses, such as the representative farm used in this analysis, have a long-term risk of loss greater than 60% (Hutchings 2013). This suggests that much of the industry is not viable in the longer term. The conventional response to this finding is to discover methods of increasing production efficiency. However the yields in this model were calculated at 75% of potential and are unlikely to be exceeded, because there is growing evidence that many Australian farms achieve the maximum feasible water-limited level of production, at about 80% of technical potential (Hughes et al., 2011; Kingwell, 2011). Cassman (1999) suggests that the remaining 20%, or “yield gap”, is due to uncontrollable factors in the production process, which cannot be altered by management.

This study indicates that the level of equity (the inverse of debt) was the variable which most affected the decadal cash margin (or bank balance) of the farm, far outweighing the effect of any differences in production variables. Figure 9 shows this effect; every 20% decrease in equity linearlydecreased the median decadal cash margin by $835,048.This confirms the conclusion reached by Hutchings (2013), that cost minimisation should be given the highest priority when designing novel farm management systems.

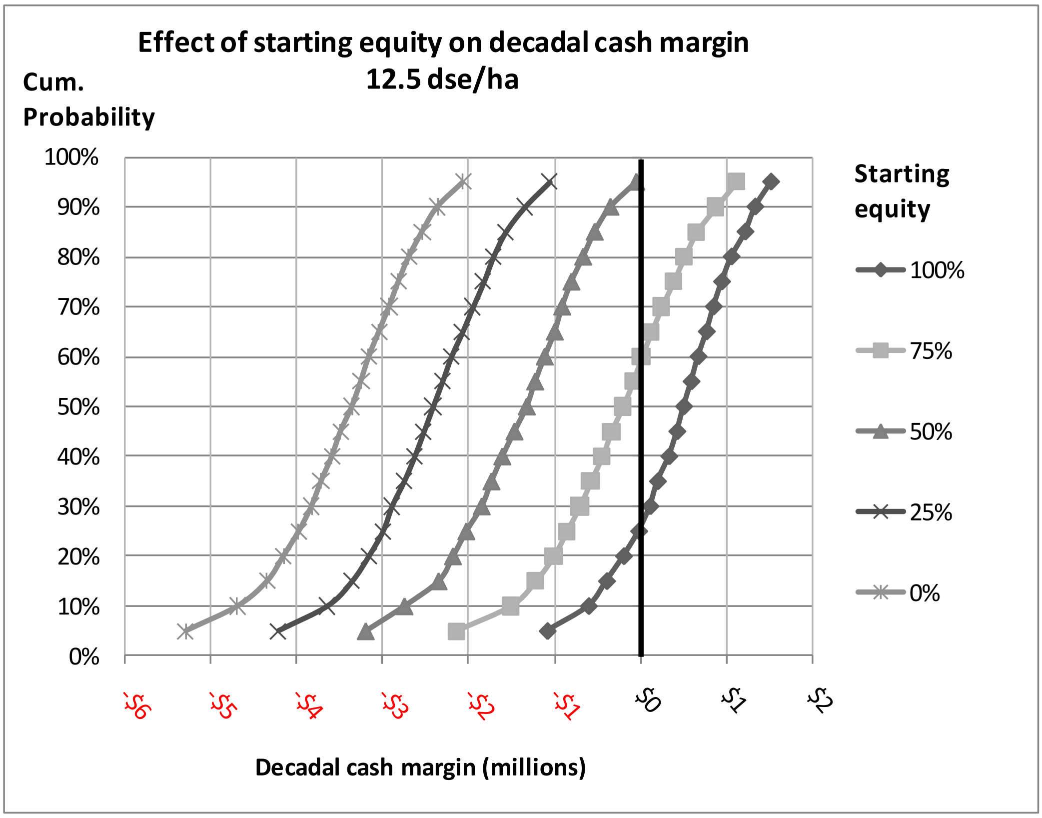

Figure 9: The effect of equity % on the long-term cash margin

The debt on this farm has accumulated at a greater rate than would be explained by compounding interest costs, which indicates an underlying series of losses.

This conclusion is also supported by the trend of the cashflow over a selection of historical decades. The cashflows in Figure 5, calculated at median commodity prices, show negative trends in the past three decades. The extremely negative trend shown in the 2000 decade, or the "*millennium drought*", accurately reflects the situation of many farm accounts in this period, and may explain a large part of the current high debt levels on farms in the region (Hutchings 2013).

Conclusion

These results highlight the deficiencies of conventional static financial analysis, which does not reflect risk; in fact averaging removes risk. Furthermore most conventional analyses in the literature do not analyse all costs. Gross margin analysis only includes 30-40% of total costs, and profit excludes the cost of capital replacement, living costs and taxation, without which the farm would not survive. In addition one-year analyses do not include either the compounding effect of cost inflation and the cumulative effect of interest charges over time. Conventional financial analysis therefore inevitably over-estimates farm returns.

The simplest example of this is the common use of gross margin analysis, where strongly positive enterprise gross margins are often associated with negative whole-farm cashflows. This scenario can result in a recommendation for additional expenditure, which may not be either appropriate or affordable. This example illustrates the dangers of promoting broad-based recommendations to an industry without understanding the over-all farm performance and debt level.

The farm used in this analysis represents the majority of farms in the region, where 64% are smaller than 1,000 ha. Furthermore the productivity level assumes best practice management, with a water-use efficiency of 75%. Further increases in productive efficiency are therefore unlikely, or the associated expenditure is unlikely to significantly increase cash margins. This is the reason that farm productivity has been static for the last 15 years in Australia (Hughes et al., 2011; O'Donnell, 2011; Sheng et al., 2011), while costs have been rising at greater than the national cost-price index (CPI) (van Rees 2015). Consequently farm margins in southern New South Wales have been declining over this period, to a point where they may well be negative for the majority of farms, as suggested by this analysis, which is supported by data from the National Australia Bank client database (O'Dea, 2009).

This decline in whole-farm margins has not been reflected in national statistics, which are based on conventional static (one year) KPIs, such as gross margins and profit. These KPIs are based on the margin of income over a partial sample of total costs. Hutchings (2013) showed that, when these static KPIs show large surpluses, sufficient to meet the "missing" costs of capital replacement, living costs and income tax, they can be a useful indicator of real whole business margins. However when the static margins, such as profit and EBIT, are small they correlate poorly with whole-farm margins, and risk-adjusted measures such as the risk of loss, or the median return over time (Hutchings, 2013). Consequently they cannot be used as reliable measures of business performance under the current conditions of low returns and high risk, as demonstrated in this paper. These conditions are likely to deteriorate further under the twin influences of cost inflation and climate change, highlighting the need for the development and use of dynamic, risk-weighted analysis in formulating farm business and policy initiatives in the future.

Risk-based dynamic analysis has been regularly used in the analysis of farm practice and policy in the USA (Richardson et al., 2000), in an environment which carries significantly lower climatic and financial risk (Kimura et al., 2010). Methods such as the Sequential Multi-variate Analysis (SMA) method (Nordblom & Hutchings, 2014), used as the framework of the IF model, could be used to re-define best practice at the farm and industry level. This paper presents evidence that current best practice methods, based on simple static analysis, may be sub-optimal, a finding supported by Hutchings & Nordblom (2014); in fact many farmers may be suffering financially from following the current emphasis on maximising productivity.

This is not to say that dynamic analysis is more predictive than static analysis; the actual outcome in the next year is still uncertain. However, over the longer term only dynamic analysis is able to quantify the risks faced by the farm in continuing operations into the future, given constant weather and current market variability. Dynamic analysis isalso the only technique which can compare the effect of a range of alternative management systems on financial risk and farm viability in the long term and thus indicate the need for structural change.

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