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Squeaky Wheel Gets the Oil: Incentives, Information and Drought Policy

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Abstract

Most economic assessments conclude there is no economic efficiency case for governments to provide drought assistance. However, significant public funds are allocated to farmers during droughts and there is a second-best case to improve drought policy design. In this article we show that the National Drought Policy suffers from adverse selection, moral hazard, incentive compatibility and government commitment problems. We use ABARE farm-level data that suggest that at least adverse selection was a problem in Victoria during the 2002–03 drought. These results are replicated at the national level. The current approach of the Commonwealth and state governments is ineffective because it is very difficult to design an efficient and fair drought policy that relies on ex post revelation of information. An alternative approach is investigated where incentives are designed so that farmers self-select into one of a number of drought policy agreements consistent with their capacity to prepare for drought.

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1. Introduction

Drought events have a severe financial impact on both individual farm businesses and the economy as a whole; they expose soil to severe degradation and can cause rivers and lakes to dry up for extended periods.[1] Agricultural producers bear much of the financial damage caused by drought and farmers can manage the risk imposed by drought in a variety of ways using both on-farm and off-farm measures. However, since the latter half of the twentieth century, governments have become increasingly drawn into providing assistance to farmers adversely affected by drought. In effect, governments now share some drought risk with primary producers. It is questionable, however, whether this assistance has been provided for the right purposes or to the right people (Martin et al. 2005).

1.1 Aim and Structure of the Article

The aim of this article is to examine drought policy as an economic problem and to systematically tease out the key features of a more efficient and equitable response that governments could employ in preparing for future droughts. First, we provide a historical overview of the performance of Australian drought policy. Second, we provide a brief overview of the relevant economic concepts. Third, the current National Drought Policy is analysed. Fourth, a principal-agent approach to solving the incentive problems of drought policy is presented. Fifth, other policy proposals are analysed using our framework.

2. Recent History of Australian Drought Policy

In 1992 drought policy was fundamentally altered with the agreement of the National Drought Policy (NDP) between the governments of the Commonwealth and the states/territories. The definition of drought changed from a 'natural disaster' to a normal part of the farm operating environment to be managed like other business risks. However, it was considered there could be 'exceptional' droughts for

Table 1 Analysis of Victorian FBSGs: 2002–03

	Recipients		*Non-recipients*		*All*	
Parameter	*Estimated mean*	*RSE*[a]	*Estimated mean*	*RSE*[a]	*Estimated mean*	*RSE*[a]
Population	2057		13611		15688	
Sample size[b]	39		199		238	
Physical						
Area operated, opening (hectares)	790	18	520	5	555	5
Area operated, closing (hectares)	795	18	527	5	562	5
Area cropped, average (hectares)	306	22	138	9	160	9
Sheep, opening (number)	976	22	1142	12	1120	11
Sheep, closing (number)	801	22	1036	14	1005	13
Beef cattle, opening (number)	32	78	116	14	105	14
Beef cattle, closing (number)	33	84	107	14	97	14
Dairy cattle, opening (number)	175	6	70	8	84	6
Dairy cattle, closing (number)	164	6	70	7	82	5
Stocking rate, opening (dse per hectare)[c]	11.8		12.45		12.36	
Stocking rate, closing (dse per hectare)[c]	10.66		11.68		11.49	
Stocking rate, average (dse per hectare)[c]	11.29		12.17		12.03	
Financial ($)						
Total capital, closing	1936152	10	1461499	6	1523820	5
Land capital, closing	1480727	10	1155497	6	1198198	5
Opening value of livestock	202802	10	177124	6	180495	5
Closing value of livestock	169648	8	117601	8	124434	7
Liquid assets ($)						
Total farm liquid assets	44802	15	149107	26	135412	25
Opening FMDs	742	93	17459	23	15264	23
Closing FMDs	1292	77	20064	15	17599	15
Shares public company	23717	20	71239	56	64999	54
Bank savings	10868	30	30386	36	27824	34
Debt ($)						
Total farm debt, opening	263461	15	144960	12	160851	10
Total farm debt, closing	317159	13	155303	12	177008	10
Equity, closing (per cent)	82	3	91	1	90	1

Notes: (a) RSEs are a measure of an estimate's sampling error, expressed as a percentage.
(b) Survey participants are farmers eligible to participate in ABARE's annual survey program for broadacre and dairy industries. Participants must have an Estimated Value of Agricultural Operations of more than $22500.
(c) The dry sheep equivalent (dse) of sheep was two dse, beef cattle was 10 dse and dairy cattle was 20 dse (Floyd 1999; Department of Primary Industries 2005).

Source: ABARE (2004).

which farmers could not be expected to prepare or manage and that government assistance would be required during 'Exceptional Circumstances' (EC).

Farmers in EC-declared areas are eligible to apply for Commonwealth welfare assistance (equivalent to 'Newstart' welfare available to all Australians) and/or business assistance (funded by both the governments of the Commonwealth and states/territories). Business assistance is offered in the form of interest rate subsidies (80 per cent) on new and existing loans up to a maximum of $100000 in any 12-month period, with a cumulative maximum of $300000 over the previous five years (subsidies are given as cash with no obligation to use it for interest payments).[2, 3] Eligible farmers can own up to $435000 in off-farm assets (Prime Minister of Australia 2005). Such assistance is not available to other Australian businesses that do not have an interest in primary production.

Despite the objective of 'self-reliance' and assistance only in rare and severe 'EC events', governments have been pressured to provide assistance earlier than EC policy prescribed in 2002–03. For example, New South Wales introduced transport subsidies in mid-2002 and Victoria introduced Farm Business Support Grants (FBSGs) in October 2002 (Stoneham et al. 2004). These measures were in response to intense media interest and pressure from farm groups and the broader community. Similarly, the Commonwealth responded to this pressure by introducing measures (prima facie EC and 'interim' income support) before events were officially 'rare and severe'

In the 2002–03 drought, assistance was provided to Victorian farmers in the form of cash grants (FBSGs). These grants were up to $20000 per farm to assist individuals who met eligibility criteria (Stoneham et al. 2004). Even though cash grants are widely perceived to offer a more neutral form of assistance than interest and other input subsidies, there remain significant targeting and incentive issues with this form of assistance. The Victorian Department of Primary Industries commissioned the Australian Bureau of Agricultural and Resource Economics (ABARE) to conduct a survey of the characteristics of farmers who received FBSGs. The results of this survey are summarised in Table 1, from which the following observations can be made:

- *Assistance was provided to farmers who did not prepare for drought*. The survey results indicate that recipients of FBSGs had over $100000 less total farm liquid assets than non-recipients on average. Notably, recipients did not take advantage of Farm Management Deposits (FMDs)[4] compared with non-recipients. FMDs were introduced to provide a tax-effective form of savings to 'self-insure' against agricultural risk (Douglas, Oliver and Hall 2002).

- *Assistance was provided to farmers with higher net asset values*. Recipients of cash grants had, on average, 50 per cent more land than non-recipients and nearly 30 per cent higher total capital farm value.

- *Assistance was provided to 'risk-taking' farmers*. Recipients of drought assistance tended to be less cautious or not 'risk-averse' types. On average, their characteristics included *lower equity* (recipients had 9 per cent lower equity than non-recipients); *lower liquid assets*, fewer public shares (nearly $50000 less than non-recipients) and lower bank savings (nearly $20000 less than non-recipients); and *higher farm debt* (recipients had over 80 per cent more opening debt and 100 per cent more closing debt than non-recipients).

These findings are also consistent with a national survey conducted by ABARE (Martin et al. 2005). This suggests that the NDP is mimicking problems observed at the Victorian State-level (or vice versa).

3. Brief Overview of Relevant Economic Concepts

3.1 Is There a Role for Government?

Farmers, like other private firms or individuals, are not able to carry the financial impact of all contingencies. Generally, risk-averse firms

look for a risk-neutral partner (such as insurance firms and other financial institutions) to share these risks. These large organisations can carry risk in a less costly way than small firms. Conventional economic wisdom suggests that markets, such as commodity, capital and insurance markets, can be relied on to efficiently allocate resources, if there is a complete and efficient set of these markets. However, a role for government on economic efficiency grounds exists where:

(i) markets are inefficient or missing (the necessary but not sufficient condition); and

(ii) benefits of intervention exceed costs, if sufficient information is available.

In the past, most economic analysis of drought has concluded that the preconditions for efficient drought insurance markets are not substantially violated, suggesting no role for government on economic efficiency grounds (Freebairn 1983). However, there are two factors that limit the scope for risk markets to be employed to manage drought:

- *Systemic risk.* Drought events will mean premiums for drought insurance will be high. Bardsley, Abey and Davenport (1984) explain that private insurance companies will not be interested in offering insurance contracts when risk-pooling opportunities are limited. Where all farms go into drought at the same time (because of ENSO) insurance may not be offered because premiums will be too high.

- *Crowding out*. Governments have a history of providing assistance in times of drought which makes commercial risk management products less attractive.

Newbery and Stiglitz (1981) argue that systemic risk and consequent incomplete markets for drought risk may constitute market failure because insurance markets are missing. Where relevant risk markets are missing, farmers use commodity markets to perform both allocative and risk diversification functions. This imposes costs on the economy because commodity markets do not efficiently price risk. Whether because of systemic risk or crowding out by government, drought risk markets are limited and premiums will tend to be high. This suggests that the first condition for government involvement in drought, that markets are missing or inefficient, is met.

The case for or against government involvement then rests on whether the benefits of intervention outweigh the costs—that is, whether government can offer drought insurance at a lower price than private providers. This is unlikely for two reasons:

- *Ability to spread risk*. Just as insurance firms have discovered systemic drought risk leads to high premiums and low demand for insurance, Newbery and Stiglitz (1981) note that this also precludes government from doing any better. International insurance companies are large, have scope to underwrite risks, and hold diversified portfolios unrelated to Australian drought (Quiggin 1986a). Furthermore, private insurers are able to use reinsurance markets more efficiently than government to further reduce their portfolio risks, at least for a portfolio of uncorrelated risks (Froot 1999). It is difficult to believe they have less ability to spread risk than government.

- *Skills*. Insurance is not generally the business of government and governments do not have better information systems, actuarial skills or incentives to efficiently price risk than the private sector. Government is unlikely, therefore, to be capable of effective intervention in risk markets.

The economic efficiency arguments for government intervention in drought risk management are weak. While welfare is an important consideration it is difficult to argue that drought causes welfare problems that deserve special forms of assistance over and above those generally available. There is a case, however, to review drought policy because primary producers are able to successfully

lobby governments to provide assistance in times of drought. The way this assistance is provided can be shown to be poorly targeted, provide disincentives for self-reliance and generally reduce economic performance in the economy.

3.2 Economic Ideas Relevant to Drought Policy

There are a number of economic concepts that provide a framework for analysing drought policy. These are briefly reviewed in the following subsections as a basis on which to assess the current and alternative approaches to drought policy. See Stoneham et al. (2004) for a more in depth discussion of how these concepts relate to drought policy.

3.2.1 Risk

Risk-averse producers will only accept a risky alternative if they are paid a *risk premium* above the expected value of the proposition (Mas-Colell, Whinston and Green 1995). To a risk-neutral producer, risk is irrelevant, what matters is the expected value of the gamble.

Risk-sharing occurs when two (or more) parties spread risk between themselves. In drought, risk can be (theoretically) shared between farmers and another party, such as an insurance company. If an insurer has a portfolio of diversified risks that are uncorrelated, then the insurer's risk in holding this portfolio is zero because of *risk-pooling* (Goodwin and Smith 1995). When these conditions exist, firms or individuals can share the risk burden with these large organisations at a lower price than self-insurance. In Australia, at least, droughts often occur as a result of systemic influences, such as ENSO, making risk-pooling more difficult and costly (as argued in Subsection 3.1).

3.2.2 Asymmetric Information

Where government does become involved in providing assistance some explicit or implicit agreement forms the basis of risk-sharing between individuals and government. *Principal-agent* theory can be used to investigate the way parties interact and how agreements are negotiated (Laffont and Martimort 2002): the principal (for example, the government) wants to make some arrangement with an agent (for example, a farmer) that defines the way risk is shared.

The major impediment to the development of efficient agreements between these different parties is that the principal does not have access to all the information needed. This is referred to as the *asymmetric information* problem. Information asymmetry complicates drought policy design by introducing the problems of *adverse selection* and *moral hazard*.

Adverse selection is when individuals have incentives to misrepresent their private information (for example, financial situation) to gain *information rents*. The greater the information rents the greater is the incentive for individuals to misrepresent their type.

Moral hazard is a problem with most contractual arrangements because the principal is not able to perfectly *monitor* (if at all) the actions of the agent and cannot reward or penalise individuals who do or do not complete the actions contracted. Moral hazard is likely to be particularly important where agents operate in remote, unsupervised situations, such as farms.

Risk specifically affects the design of contracts or agreements through its link with moral hazard. If individuals are risk-neutral, government has greater scope to achieve allocative efficiency because it can exploit indifference to risk. It can reward individuals who undertake risk minimisation actions and penalise those who do not. A more realistic case is to assume that individuals are risk-averse. In this case risk-sharing procedures can be employed to lower (but not completely eliminate) risk to individuals to ensure that they undertake risk minimisation actions. Recall from 3.2.1, this entails the payment of a risk premium to the individual to bear some risk.

3.2.3 Government Commitment

Commitment is defined as the ability of an individual, firm or government agency to ensure that future actions comply with the terms of an

agreement (Salanie 1997). In the context of drought policy, *government commitment* means government being able to refrain from intervening in the implementation of ad hoc policies in the face of political pressure. Government commitment can affect the outcome of drought policy through *credibility* in both enforcing current policy and in implementing a more efficient drought policy. Botterill (2003) provides an account of how government commitment collapsed during recent drought events. Commitment may be difficult to maintain because of political incentives to abandon commitment. When such incentives exist, we say commitment is *non-credible*.

3.2.4 Incentive Compatibility

Well-designed policy will take account of all incentives that lead individual producers to make decisions and take actions that are aligned with broader objectives of drought policy, especially encouraging 'self-reliance' in managing drought risk—hence the term incentive compatibility. Drought policy cannot be considered in isolation but also needs to account for incentives producers face from the tax system (for example, for environmental protection), with respect to structural adjustment, and any other areas where governments intervene.

4. The Current NDP

4.1 The EC Game

In this section we use game theory to highlight the incentives set up by the NDP. We chose to use a game theory approach because we wanted to analyse the strategic interactions between farmers' lobbies and the state, territory and Commonwealth governments. Other tools for analysing the efficiency of drought policy would not provide insights into why the NDP fails to encourage farmers to self-insure against drought. For example, using cost–benefit analysis will only tell us that farmers were behaving 'irrationally'. This is clearly unhelpful for advising governments on diagnosing the source of the problem. However, as we will show using game theory, farmers are actually rewarded for seemingly irrational behaviour through the NDP.

The process of EC declaration can be described in theoretical terms as a 'sequential move' game (Tirole 1988); that is, each 'player' moves in turn. There are three sequences in this game. The players that move first are producer and/or community representatives, let us call these players 'lobbies'. They initiate this game by alerting their state or territory government on the perceived severity of the drought they are experiencing. The state or territory governments are the players who move next; let us call these players the 'non-Commonwealth' players. The non-Commonwealth players decide whether or not to write a submission in conjunction with lobbies to persuade the Commonwealth Government to declare the identified region an EC area. The Commonwealth is the last player. After receiving the submission from non-Commonwealth governments, the Commonwealth decides whether or not to declare the lobbies' area is experiencing EC.

If EC is declared, producers are able to access EC Relief Payments and interest rate subsidies as their 'pay-offs' (Agriculture, Fisheries and Forestry, Australia (AFFA) 2003). For a typical agricultural household, the EC Relief Payments may be nearly $700 per fortnight and may last for up to two years (Centrelink undated). Even if EC was not declared, producers were able to access 'interim income support' payments during 2002–03 (AFFA 2003). Affected businesses are also entitled to interest rate subsidies if EC is declared[5] (AFFA 2003). State and territory governments also commonly provide independent drought assistance schemes such as the FBSG described in Section 2 (see AFFA 2003 for more schemes).

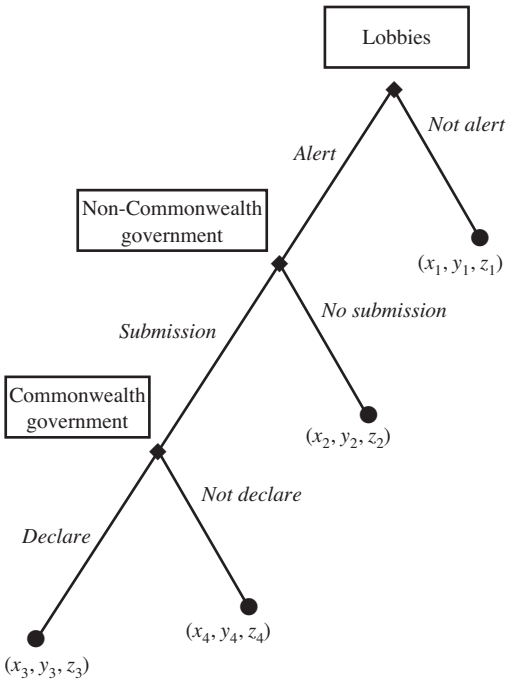
The pay-offs for non-Commonwealth governments may be both political and financial. Political, because lobbies can use their local influence to 'reward' or 'punish' governments at election time by influencing how local people vote by using drought as an issue. Hence, non-Commonwealth governments may be vulnerable to political pressure. The financial pay-offs may be the higher payments made if the non-Commonwealth governments acknowledge the

existence of a severe drought by preparing a submission for the Commonwealth government to consider. The pay-offs for the Commonwealth government are similar for non-Commonwealth governments except that it may be more vulnerable to political pressure especially if drought is nationwide.

Figure 1 is the extensive-form game of the 'EC game'. The name of each player is in a box box, associated with a 'decision node' for each player represented by a diamond-shaped node. A decision node is where the player is faced with a choice; the choices are given in italics next to the 'branches' emanating from each decision node. These branches either lead to the next player's decision node (for example, from lobbies to non-Commonwealth governments) or to 'terminal nodes' which are the circular nodes. When the game reaches a terminal node, the game ends and each player receives their pay-offs. The value of pay-offs are given in the brackets; the x value represents lobbies' pay-offs, the y value is non-Commonwealth pay-offs and z represents Commonwealth pay-offs. The subscripts are assigned to each pay-off to assist in identifying which decisions have been played. For example, a subscript 4 means lobbies have played 'alert', non-Commonwealth has played 'submission' and Commonwealth has played 'not declare'.

We assume that lobbies prefer the following pay-offs (in descending preference): x_3, x_4, x_2 and x_1. What this preference ordering tells us is that lobbies unambiguously prefer the non-Commonwealth government to write a submission for EC declaration and the Commonwealth government to declare EC which leads to x_3. This outcome maximises drought assistance from both Commonwealth and non-Commonwealth for lobbies whereas x_4 and x_2 only yield non-Commonwealth assistance. At pay-off x_1, lobbies receive no assistance from either tier of government. Hence, lobbies have an incentive to play 'alert' in order to access drought assistance; that is, 'squeaky wheel gets the oil'. However, the decision to play 'alert' may be conditioned on repeated interactions such as gaining a reputation for manipulating the politics of drought to access implicit insurance from governments. There is anecdotal evidence that individual farmers are concerned about their reputation as 'whinging cockies' (see Wahlquist 2003), but it is arguable that this reputation has not limited the effectiveness of lobbies' efforts. Given this ordering of pay-offs we can predict that lobbies will always play 'alert' and never play 'not alert' given our arguments here.

Figure 1 The EC Game



The non-Commonwealth government's assumed preference ordering of its pay-offs in descending order is assumed to be y_1, y_4, y_3 and y_2. That is, the non-Commonwealth government prefers it if lobbies play 'not alert' in the first place because this would not require government assistance. But if this does not occur, non-Commonwealth prefers the Commonwealth government to not declare rather than declare (for similar reasons). The non-Commonwealth government will not play 'no submission' because, given our previous discussion, the lobbies punish them by campaigning against them in the next election. We assume here that the political costs of 'submission' outweigh the fiscal costs of unbudgeted drought assistance. This assumption may depend on several conditions such as the timing

of the drought (that is, did it occur close to an election) and the budgetary situation of the non-Commonwealth player. With the latter, most non-Commonwealth governments have generated consistent budget surpluses. However, a perverse consequence of budgetary discipline is that governments are less able to politically defend withholding drought assistance when lobbies play 'alert'. It is conceivable (in theory at least) that a non-Commonwealth government that had a persistent budget deficit may be able to ignore calls for additional drought assistance because the consequences of lax fiscal discipline are costly (for example, reduced investors' confidence). Botterill (2003) shows how financial considerations drove drought policy reform in 1989. Given this argument, we assume that non-Commonwealth players are not financially constrained to provide additional drought assistance and to support submissions for EC declaration. This applies in the case in Victoria at least. Therefore, given this assumption the non-Commonwealth government will always play 'submission' when lobbies play 'alert'.

The Commonwealth government's assumed preference ordering in descending order is z_1, z_2, z_3 and z_4. That is, the Commonwealth prefers lobbies keep quiet, but if this does not happen then it prefers that the non-Commonwealth government refuses to write a submission to avoid committing its resources to drought assistance. But if the lobbies play 'alert' and the non-Commonwealth government plays 'submission' then the Commonwealth always plays 'declare' to avoid being punished at the next election by the lobbies. We assume here that the Commonwealth player prefers to avoid the political punishment by lobbies at the expense of additional budgetary outlays. The reasoning for this assumption is the same for non-Commonwealth players.

The outcome of this game is then for lobbies to start the game by playing 'alert', the non-Commonwealth playing 'submission' and the Commonwealth playing 'declare'. The pay-off from this outcome is (x_3, y_3, z_3); in game theory this is called a *Nash equilibrium* because this is the outcome of rational and intelligent players doing the best they can given their understanding of what the other rational and intelligent players do (Myerson 1991).

Notice that this Nash equilibrium may not be efficient because both the non-Commonwealth and Commonwealth governments are better off if the lobbies do not play 'alert'. This is because y_1 is greater than y_3 and z_1 is greater than z_3. Conversely, the lobbies are nowhere better off than at the Nash equilibrium. This result relies on the assumption that the lobbies can credibly commit to punish both tiers of government. We also assume that wider society is irrelevant in the implementation of NDP. This is based on the observation that urban Australians are sympathetic to the perceived misfortune of farmers and support drought assistance measures. See Wahlquist (2003) for an account on how the Australian media generated popular support for drought-affected farmers. Given this, while there may be some sections of society that oppose drought assistance, it is clear that they are currently less organised and credible than the farm lobby in enforcing their political threats. See Becker (1983), Grossman and Helpman (1994) and Posner (1974) on how the organisation of sectoral interests acquire government protection or assistance at the expense of society as a whole. As a result, it is not unreasonable to assume that broader society is currently irrelevant in analysing the NDP.

Also note that punishment by the lobbies is not a discrete action by the lobbies but is instead implicit in the actions of the non-Commonwealth and Commonwealth players. This means punishment by the lobbies is contingent on the actions of the other players. In this way, we have simplified the game. In our EC game, an implicit assumption is that lobbies are able to credibly commit to punishment if either the non-Commonwealth plays 'no submission' or the Commonwealth plays 'not declare'.

Our simple game theory model highlights the flaw of the current EC system: there is an institutional bias towards EC declaration. The current process provides perverse incentives for lobbies to apply political pressure because they are able to achieve the highest pay-off from doing so. Lobbies can choose to access 'prima facie' interim income support if the

Commonwealth is in the process of considering the non-Commonwealth submission for EC declaration[6] (Centrelink 2003). This means there is an incentive for the lobbies to play 'alert' even when they might not be experiencing an EC event because the prima facie payments are not dependent on EC declaration but on non-Commonwealth playing 'submission' (Centrelink 2003; Stoneham et al. 2004). Lobbies are better off from lobbying than not. The EC process actually provides incentives for lobbies to punish governments. This makes credible government commitment impossible to achieve because each tier of government knows it will be punished if it 'deviates' from the Nash equilibrium outcome.

The lack of credible government commitment encourages producers to view governments as 'insurers of last resort'. It may be more accurate to say producers view governments as 'insurers of first resort' given the lack of insurance options. Lack of credible government commitment allows producers to shift the risk of drought to governments. This is because producers have a reasonable expectation that government will provide government assistance if they apply political pressure. Because of this expectation, there is a reduced incentive to invest in costly drought minimisation strategies. The implication of the lack of government commitment encourages moral hazard because producers know they can gain near *perfect insurance* from the government without paying any insurance premiums. Even if private insurance for drought were available, the provision of near perfect insurance by the government would be a more attractive option than the partial insurance provided by private insurers. Therefore, even if drought insurance were theoretically viable without subsidies, government would crowd out private insurance.

4.2 Perverse Incentives of Eligibility Tests

Income tests provide perverse incentives to produce less output to gain government assistance. This perverse incentive can be viewed as moral hazard because some producers would put more time and effort into production in the absence of income tests.

Similarly, asset tests may distort producers' investment decisions by providing producers an incentive to defer income-producing investments in order to satisfy the asset test. Asset tests could be seen to accentuate the perverse incentive of income tests.

For both income and assets tests, what is included in the test is important. For example, non-farm assets worth $435000 are only included in the asset test for the EC payments and interest rate subsidies, which provides perverse incentives for producers not to diversify their income sources away from agriculture.

EC is declared for a specific geographic area. However, the boundaries of these areas may be arbitrary and this provides an opportunity to apply political pressure. For example, some producers may be located outside an EC-declared area but may be affected by drought. These producers may apply political pressure by asking (reasonably) why they were excluded. See Botterill (2003) for further discussion of the 'line on the map' controversy.

5. Drought Assistance Contracts

In this section we draw on ideas developed in the field of principal-agent theory (specifically, contract design) in an attempt to design an improved drought policy mechanism. This mechanism specifies the way farmers interact with government to manage drought risk. Salient features of modern risk management contracts, developed principally to deal with the problems of adverse selection, moral hazard and incentive compatibility, are woven into this approach to drought policy.

5.1 Drought Assistance Contracts and Adverse Selection

The first problem for an efficient drought policy is to identify the different 'types' of producers and assign them to efficient classes of agreements or contracts—one agreement will not suit all. Sen (1995) argues that targeting must take into account the incentive and informational aspects of the problem by linking assistance to a measure that is correlated with the need of applicants. Those in need will then

'self-select' by participating in such programs. Besley and Coate (1995) apply this idea of self-selection in social security by showing how a work requirement to receive social assistance reduces adverse selection problems—those who are in need are more likely to complete work requirements than those who are not.

There are significant advantages to be gained if government can know whether individual farmers consider that they are *viable* (those that have long-run prospects as primary producers) or *non-viable* (those likely to exit from farming). As noted above, the information needed to make this assessment is held privately by farmers who may be unwilling to reveal this information to others. One approach to the adverse selection problem is to construct a set of incentives that induce farmers to reveal or signal relevant information rather than have the government make this assessment. Once 'type' is known different farmers can be offered drought assistance appropriate to their circumstances.

The insurance industry does this by offering a menu of contracts together with carefully constructed incentives so that individuals use their private information to *self-select* into the right (or efficient) contract. Translating this idea to drought policy would see the government offering farmers a menu of contracts each with a different bundle of benefits and eligibility requirements. A producer would self-select by choosing the contract that provided the highest net benefits, but each contract would involve actions that are not costless. By offering a menu of contracts and incentives that facilitate self-selection, the government saves on administrative costs by not collecting farm-level data while improving the quality of information needed to target specific groups (Sen 1995). Instead, producers voluntarily reveal this information by their choice of contracts. They reveal their type out of self-interest, thus dealing with the problem of adverse selection.

Menu of contracts are widely used in the private insurance industry. One example is health insurance where insurers offer different benefits for different premiums. Health insurers typically offer low-benefit, low-premium contracts to attract healthy individuals and also offer high-benefit, high-premium contracts for more risky individuals such as older people who are more likely to need high-cost health care. Private insurers benefit from using a menu of contracts by being able to construct a portfolio comprised of unrelated risks thereby allowing them to exploit the Law of Large Numbers. This allows them to exploit profitable opportunities that are subject to adverse selection.

5.2 *Drought Assistance Contracts and Moral Hazard*

When producers are risk-averse, a straightforward way of mitigating moral hazard is through risk-sharing. That is, the principal does not perfectly insure farmers against the risk in question. Instead, the principal limits the amount of benefits paid in an effort to force the insured to bear some of the risk. The purpose of this strategy is to align the incentives faced by the agent (the farmer) with the incentives of the principal so that the agent takes measures to reduce the impact of the risk in question—thus minimising moral hazard.

Eliminating moral hazard when producers are risk-neutral depends on the extent of liability producers have for managing drought risk. It is likely that producers will not bear the full risk of drought because of lobbying arguments already presented. Even though risk-neutral producers are impartial to risk, this does not mean they are not better off from exerting political pressure to gain more drought assistance. Given this, the relevant question is how to eliminate moral hazard when the producer bears limited drought liability. A *limited liability rent* could be paid to eliminate moral hazard when risk-neutral producers face limited drought risk (Laffont and Martimort 2002); this rent is analogous to information rents for the adverse selection case except that it is designed to be at least as good as the limited liability but also discourages moral hazard. This is because the producer has less incentive to self-insure through costly investments because of limited liability. Applied to drought policy, this suggests that the government could pay a

limited liability rent to encourage producers to self-insure.

5.3 A Producer's Choice of Contracts

We use decision trees to analyse how farmers choose an incentive contract given a menu of incentive contracts. We assume producers are rational and intelligent when making economic decisions. Initially we assume the government can credibly commit to the menu of contracts for drought policy and that the tax system does not incorporate any distortionary taxes (except for a progressive income tax schedule). We make these assumptions for simplicity and to focus on the producer's choice of contracts, but we relax these assumptions later to investigate whether the approach needs to be modified to minimise non-credible government commitment and a distortionary tax system. We also assume for simplicity that there are only two types of producers — 'viable' (that is, producers who operate long-term profitable farms) and 'non-viable' (that is, producers who operate farms that are not profitable in the long term or short term).

We will consider the following menu of contracts:

- *Contract 1*. Allow the opening of Risk Management Deposits (RMDs). RMDs are a similar concept to the existing FMDs but with a different set of incentives specifically designed to ensure that farmers' contract choices match their 'type'. Pre-tax income deposited in an RMD could be rewarded with tax benefits or some form of subsidy. Tax is payable at the producer's prevailing marginal tax rate at the time of withdrawal. Like FMDs, RMDs encourage depositing income in high marginal tax rate years and withdrawals in low marginal tax rate years. In this example, we assume RMDs confer a tax benefit per dollar of pre-tax income deposited (that is, they only pay tax at the prevailing marginal tax rate when funds are withdrawn). RMDs also do not have restrictions on deposit size and off-farm income (unlike FMDs). Another option is to offer both RMDs and weather-related insurance.
- *Contract 2*. The farmer elects to have social security payments over six months.

5.3.1 Menu of Contracts with Credible Government Commitment and a Non-Distortionary Tax System

Figure 2 is a decision tree for the case of credible government commitment and a non-distortionary tax system. The analysis starts at the left of the decision tree at the node labelled 'Farmer's choice'. At this node, the producer has a choice of either contract 1 or contract 2. Let us examine the contract 1 branch first. If the producer chooses contract 1, the next decision (at the 'Contract 1 (RMD)' node) is to determine how much cash to invest in an RMD. We assume for simplicity that the producer can invest a 'high' amount of $\$x$ or a 'low' amount of $\$y$ and assume x and y are positive numbers; algebraically, this means $x > y > 0$.[7]

The next decision occurs during drought in the 'Drought' space (indicated by the oval-shaped area). During drought, a producer can choose to withdraw all or none of his/her RMD deposit; again we have assumed that the choice is binary for simplicity. Note that the producer is under no obligation to withdraw any cash from his/her RMD; this will depend on the individual circumstances of each producer. Recall that the RMDs encourage deposits during high taxable income years and withdrawals during low taxable income years. Not all producers will suffer low taxable income years during drought especially if they destock; these producers may choose to deposit *more* during drought. The point is that RMDs give producers flexibility to manage their drought response according to individual circumstances.

The next decision is to choose whether or not to lobby. By lobbying, a producer can receive more government funds than he/she otherwise would. We assume lobbying is costless but this is clearly unrealistic. However, with credible government commitment, governments would not reward lobbying efforts so pay-offs are unaltered. So the reward to lobbying is $a = 0$.

Pay-offs are given at the right of the decision tree. We assume that the producer withdraws all his/her funds during a drought for simplicity.

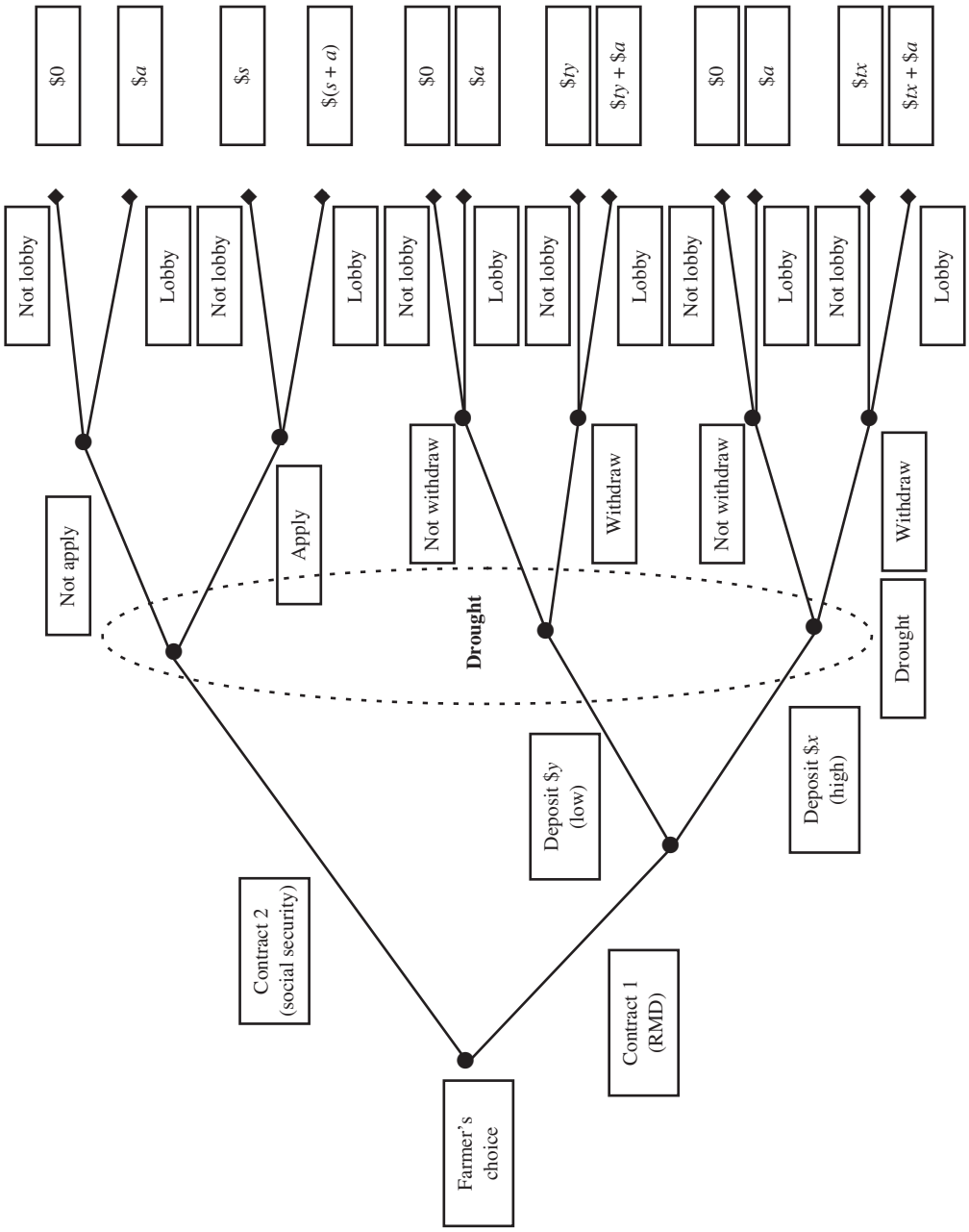


Figure 2 Producer's Contract Choice

Of course, in reality, a producer may make partial withdrawals. For the purpose of our analysis, it is immaterial if producers make full or partial withdrawals, only that they make some non-negative withdrawal. However, it is relevant how much they initially invested in the RMD since this determines the maximum returns attainable. The pay-off from withdrawing is multiplied by whatever the initial deposit amount was (that is, either x or y), where t is the tax benefit from withdrawing funds during a low-income year. In other words, the producer receives a gross pay-off equal to the principal of his/her investment *plus* the tax benefit of withdrawal (that is, the gross pay-off is $(1 + t)x$ or $(1 + t)y$ respectively for x or y), but the *net* pay-off is the tax benefit of the withdrawal (that is, the net pay-off for x or y is tx or ty respectively). We consider net pay-off from using contract 1 in our analysis since this is the return they receive from using this contract and depositing x or y amount. Note, $t > 0$, because rational producers withdraw only during low marginal tax years. The pay-off from not withdrawing is \$0 since the pay-off is increasing in how much is withdrawn.

A producer who signs contract 2 only has to decide whether or not to apply for social security at the 'Drought' space. The producer can also choose to lobby but, since there is no benefit from lobbying, the lobbying decision is irrelevant to the producer's pay-offs. The pay-off from choosing to apply for social security benefits is \$$s$ (assume \$$s$ is a positive number) but otherwise the producer receives \$0.

This menu of contracts approach can solve adverse selection and moral hazard but it depends on the values of x and s; y is irrelevant as we shall see. Consider two types of producers, a 'rich' producer who can deposit $x > y > 0$ in RMDs and a 'poor' producer who cannot invest any funds into RMDs (that is, $x = y = 0$). Adverse selection is solved if the pay-off from investing in RMDs is greater than the pay-off from social security payments; that is, $tx > ty > s$. If this is the case, rich producers will choose contract 1 whereas poor producers will choose contract 2; hence, adverse selection is solved. This is called a *separating equilibrium* in game theory (Tirole 1988). If payments from social security exceed tx (that is, $s > tx$), then even rich producers will choose contract 2 and no one will choose contract 1; this is called a *pooling equilibrium* (Tirole 1988). There may exist some values of x and s where there is a hybrid of separating and pooling equilibria where some rich producers choose contract 2 (Potters and Van Winden 1990). As a result, truthful revelation of the menu of contracts policy is possible depending on the values of x and s.

Is it possible for this menu of contracts to reduce the incentives for moral hazard? In the decision tree, moral hazard is when the rich producers choose to invest y rather than x under contract 1. This is because the rich producer can invest more and therefore bear more drought risk; that is, the investment is less than second-best. But the producer gains most when he/she invests x because the tax benefit is increasing in the deposit size. Therefore, the producer will always gain the most by investing x rather than y and will always choose to invest x and will never choose to invest y. As a result, moral hazard is eliminated because the producer has an incentive to invest as much as possible under contract 1.

5.3.2 Menu of Contracts with Non-Credible Government Commitment

We have shown that a menu of contracts can be designed to provide incentives for producers to truthfully reveal their private information and for producers to refrain from moral hazard. However, this hinges on the assumption of government credibility. In this subsection we will explore the implications of non-credible government commitment on the design of a second-best menu of contracts.

If producers lobby, they will receive a positive amount of \$$a$ in addition to their pay-offs given their contract and decisions made at each decision node of Figure 2. Lobbying is assumed to result in a certain or riskless pay-off of \$$a$, which is unrealistic since the amount a government may pay is dependent on the budget situation, sensitivity to lobbying and the personalities of the government. We make this assumption for convenience. Regardless of the realism of the pay-offs from lobbying, the point

is that if there is no credible government commitment, then the producers have an incentive to lobby regardless of the choice of contract. Notice that the choice of contracts does not change, only the decision to lobby. This is because the producers still have an incentive to reveal their type and to refrain from engaging in moral hazard, but they are unambiguously better off from lobbying regardless of the choice of contract.

Pay-offs from lobbying may change if they differ given contract type. For example, the government may engage in ratcheting behaviour by using the information gained from the choice of contracts to refuse to give funds to producers who choose contract 1 but give $\$a$ to producers who choose contract 2 (Laffont and Tirole 1993). If producers expect the government to behave this way, this may encourage adverse selection by encouraging viable producers to choose contract 2 if $s + a > tx$. If government cannot avoid lobbying, it may be a second-best response to pay the same amount to all farmers to avoid distorting their choice of contracts.

5.3.3 Menu of Contracts and a Distortionary Tax System

An unreformed tax system is likely to bias producers towards contract 2 with only the most profitable producers accepting contract 1. This is because the current tax system has similar benefits to RMDs without requiring the producer to invest surplus cash. Producers can use the averaging provision to lower tax payable during high income years without investing surplus cash (Douglas and Davenport 1995; Douglas, Oliver and Hall 2002). The adoption rate of RMDs is likely to be low.

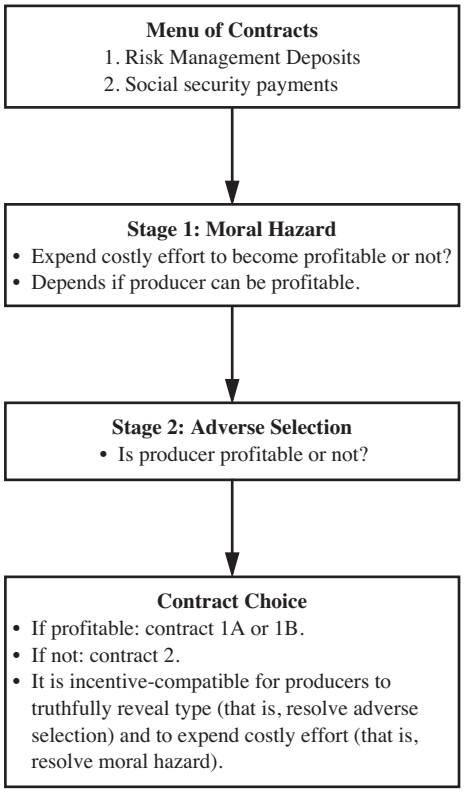
The introduction of a menu of contracts approach requires comprehensive tax reform to maximise the benefits of drought policy reform. Without tax reform, adverse selection and moral hazard will still be a problem.

5.3.4 Sequencing

As noted by Laffont and Martimort (2002), there are significant efficiency implications associated with the *sequencing* of adverse selection and moral hazard. If moral hazard precedes adverse selection, the moral hazard stage involves the producer choosing the type of production strategy and the amount of management effort to exert and this (imperfectly) determines how viable the enterprise is. The adverse selection stage is where the producer decides which contract to accept. Assuming the producer is rational and intelligent, he/she will understand the implications of choosing contract 1 or 2. That is, he/she will know that choosing contract 1 reveals viability and ability to manage drought. Conversely, choosing contract 2 reveals that the producer is a marginal or non-viable producer, unable to survive drought without assistance.

This two-stage problem is solved by the use of backwards induction—adverse selection is solved first. We use Figure 3 to illustrate sequencing. The producer will choose the contract that will make him/her better off.

Figure 3 Summary of a Producer's Choice of Contract



However, this decision depends on the moral hazard stage: is the producer better off operating a viable or non-viable enterprise? If the producer is viable, choosing contract 1 is best because of benefits from limited liability rent (if risk-neutral) or risk premium (if risk-averse) plus an information rent. A viable producer will not choose contract 2 because he/she is better off from contract 1, assuming that the social security payment is lower than what a viable farmer can receive from investing in RMDs. Conversely, if a producer is non-viable he/she will choose contract 2 to receive partial insurance against drought. Contract 1 requires the investment of a producer's surplus cash in an RMD in order to receive any benefits, but by definition non-viable producers do not generate sufficient surplus cash, so they cannot benefit from contract 1.

Working our way backwards, we now consider the moral hazard stage, in which the producer decides on the value of exerting costly effort to become viable, or not doing so. Imagine the producer can choose to manage his/her farm efficiently or inefficiently. If the farm can be managed efficiently, the producer generates a profit; efficient producers will have an incentive to choose contract 1 over contract 2 if the gains from RMDs are greater than $\$s$. Conversely, if a producer chooses to be inefficient, there is an incentive to choose contract 2. Assuming there are no costs from choosing to be efficient or inefficient, producers in general will choose to be efficient if $tx > s$. Therefore, a menu of contracts approach can provide producers with a dynamic incentive to adopt more efficient practices. This eliminates the incentive for some producers to choose inefficiency but depends on the relative costs of farming practices, which in turn depend on many factors such as the quality of the land and education level.

Some producers may be marginally viable but may not generate enough surplus cash to warrant the use of RMDs; these producers will probably choose contract 2. Some producers may be viable enough to generate substantial surplus cash and so will find it advantageous to use RMDs; these producers gain from generating profits and gaining rents, and they will choose contract 1. In summary, we can predict the following under the assumptions made:

- Non-viable producers cannot be profitable under either contract and will cease production.
- Marginally viable producers do not generate substantial surplus cash flow and will choose contract 2.
- Viable producers make a profit at or above commercial rates of return and also generate substantial surplus cash flow. They will choose contract 1.

Laffont and Martimort (2002) argue that in a game where moral hazard is followed by adverse selection, the result is second-best. This means that there is an improvement in welfare but it does not necessarily globally maximise welfare. Rents are still paid by the government, but the producers make efficient self-insurance decisions.

5.4 Sensitivity of Results

Our results are based on the assumption that there are two groups of farmers: viable and non-viable. In reality, there may be more than two groups of farmers. For example, there may be three types of farmers who are in different stages of their business life-cycle such as younger farmers who are focused on expanding their business, more mature farmers who are consolidating their gains and farmers looking to retire or exiting the industry. In this case, younger farmers may be cash poor and may not be able to take advantage of contract 1. The implication of missing a type of producer in our two-menu contract may result in some viable but cash-poor farmers using contract 2 which may blunt their incentives to self-insure for drought. Alternatively, the sequencing of the contract choice may encourage viable but cash-poor farmers to restructure their farm businesses to generate higher cash flows (see 5.3.4). As a result, even if there is more than one type of producer, their type may be endogenous on their choice of contract which in turn

may reduce the number of types to two. Further research is needed to explore this.

Another assumption was that pay-offs from lobbying were riskless and did not differ between contract types. We recognised that the pay-offs from lobbying were probably not riskless in likelihood or quantum. However, producers probably expect some form of assistance is forthcoming if they lobby (recall our discussion in 3.2.3). As a result, assuming that lobbying pay-offs are positive and riskless is a reasonable approximation for our purposes. Provided that the pay-offs from lobbying did not differ between contracts, there is also no incentive for producers to adversely select into the wrong contracts. However, lobbying pay-offs may differ between contracts. For example, producers under contract 2 may lobby for more assistance claiming that social security was insufficient compared with the returns from using RMDs under contract 1. If producers believe that lobbying pay-offs are higher under one contract, adverse selection may occur. For example, let b be the pay-offs for lobbying under contract 2 and a be the pay-offs from lobbying under contract 1. Viable producers will choose contract 2 when $s + b > tx + a$. Conversely, non-viable producers will choose contract 1 when $s + b < tx + a$. As a result, adverse selection may occur but this depends on the relative pay-offs from lobbying under either contract.

6. Other Drought Policy Reform Alternatives

In this section, we will examine some commonly proposed alternatives to the NDP using the economic concepts developed in Subsection 3.2. Alternatives to the NDP are multi-peril insurance, weather-related insurance and a HECS-type scheme respectively. See Stoneham et al. (2004) for more in depth discussion than is presented here.

6.1 Multi-Peril Insurance

The systemic nature of droughts causes premiums for multi-peril insurance to be high, and therefore demand is low (Bardsley, Abey and Davenport 1984). Multi-peril insurance is plagued by adverse selection and moral hazard problems (Goodwin and Smith 1995). Hertzler (2004) argues that farmers know more about expected yields on the farm than the insurance company and this puts the farmer in an advantageous situation with respect to the insurance firm and the contracts that would be developed. With multi-peril insurance, farmers can also take actions that are unobservable to insurance companies (for example, reduce inputs so that crops fail) to exaggerate the effects of drought and thereby receive an insurance pay-out. The cost of dealing with this moral hazard problem destroys the viability of multi-peril insurance. Sigurdson and Sin (1994) estimate that Canada's crop insurance program costs three times more than the premiums collected. Hazell (1992) shows that this ratio is around 4.5 for the multi-peril schemes in Brazil and Japan. Goodwin and Smith (1995) show that the US multi-peril crop insurance program had a ratio of nearly 1.6 times insurance pay-outs to premiums collected.

6.2 Rainfall Insurance, Weather Derivatives and Yield Index Insurance

Rainfall insurance and weather derivatives are often suggested as a means of minimising the moral hazard problems associated with multi-peril insurance because weather cannot be manipulated by individuals. Rainfall insurance relies on a predetermined rainfall event to trigger a pay-out. Adverse selection is unlikely because rainfall data are collected by an independent third party (for example, the Bureau of Meteorology) and are common knowledge to both insurers and farmers. Transaction costs associated with writing contracts are low because standardised contracts can be used and assessing crop damage is unnecessary. Hertzler (2004) argues that systemic risk is manageable through reinsurance, but that rainfall insurance suffers from *basis risk* which makes it less attractive to farmers. Basis risk refers to situations where yield is imperfectly correlated with rainfall so insurance pay-outs are imperfectly related to actual damages.

One approach to reduce basis risk is through weather derivatives. Weather derivatives are currently available to firms or individuals whose business or costs are directly influenced by inclement weather events, such as excess rainfall. They can be derived from any event, including too little rainfall or extreme temperature recorded at weather stations. Hertzler (2004) notes that reliable data series allow premiums to be calculated with confidence and the transaction costs and systemic risk problems will be lower than rainfall insurance. These contracts may not, however, *eliminate* basis risk.

Yield index insurance (YII) is another approach that warrants consideration (Quiggin 1986b; Skees 1999). The key difference between YII and rainfall insurance is that YII contracts employ a non-linear relationship between rainfall and yield. Instead of receiving a set pay-out when rainfall is less than some defined trigger, YII employs a contract that translates rainfall into yield based on non-linear increments. By specifying insurance contracts in this way, the pay-out received by a farmer might increase as rainfall decreases. Further investigation of these risk mitigation mechanisms is required to determine whether basis risk can be reduced to acceptable levels and contracts specified whilst avoiding excessive transaction costs.

6.3 HECS Approach to Drought Policy

Another approach to drought policy that has been considered recently is based on the Higher Education Contribution Scheme (HECS) (Botterill and Chapman 2002; Botterill and Fisher 2003; Chapman 1997; Kelly, Chapman and Botterill 2004). HECS is an *income-contingent loan* (ICL) in that the amount of debt repaid by the student each year depends on the level of income earned. While the underlying justification for the HECS scheme is that capital markets have limited information about students on which to base lending decisions, this reasoning does not hold for farmers. Freebairn (1983) notes that producers are able to secure financing at the prevailing market interest rate and the Drought Policy Task Force (1997) provides anecdotal evidence that financial institutions are willing to provide finance to producers whom they consider profitable in the long term.

The HECS approach does not explicitly deal with adverse selection, in fact it exacerbates it. ICLs reward farmers who do not prepare for droughts by providing credit at concessional rates regardless of drought preparedness. ICLs would provide no incentive for producers to reveal capacity to invest in drought preparation.

ICLs for drought may cause moral hazard by allowing all producers in EC-declared areas to receive ICLs regardless of actual circumstances. This weakens incentives to self-insure. ICLs have perverse incentives that discourage producers to become more efficient.

The combination of an ICL scheme and the current system of EC declaration is unlikely to strengthen government commitment to maintain ICLs as stated. Instead, it may accentuate the problem because producers would have incentives to lobby for more attractive terms and less rigorous monitoring and enforcement.

Finally, the non-commercial terms of ICLs provide producers with perverse incentives; that is, it is not incentive-compatible to self-insure against drought but instead makes it attractive to take on more debt.

7. Conclusions

Past (and proposed) solutions to drought policy have been (and are) inefficient because they do not take explicit account of asymmetric information and the implications for adverse selection, moral hazard, systemic risk, uncertainty, credible government commitment and the perverse incentives of the Australian tax system (Stoneham et al. 2004). In this article we have proposed a drought policy framework that explicitly accounts for the information problems that plague drought policy. This approach has been developed by drawing on the techniques developed in principal-agent theory and applying these to drought policy. To our knowledge, this is the first proposal that attempts to jointly resolve adverse selection and moral hazard in drought policy.

Although further quantitative analysis is required, economic theory suggests that the cost

of these inducements to farmers to self-select into efficient classes of contract will significantly lower the public cost of drought. In other words, this approach should result in significant savings to government besides being more efficient. A pilot of the ideas developed in this article would be informative to both government and private sector interests. Experimental economics is also an option in further exploring these ideas.

Although these mechanisms in principle appear to offer many advantages, they will be ineffective without credible government commitment. Stoneham et al. (2004) provide a discussion of various strategies that could be employed to address the government commitment problem. These are not easy to design or implement, but there are a number of alternatives that deserve closer examination. Further analysis will be needed to design these institutions and to gain a better understanding of community support and lobbying processes. For example, why do the majority of Australians support relatively wealthy individuals' claims for government support during drought despite most of them being unlikely to receive preferential treatment themselves in difficult times? Finding answers to these questions will help the design of an institution to impose credible commitment on government.

Reform of the tax system is highlighted as necessary to remove perverse incentives against self-insurance. Reforming the tax system can generate positive environmental impacts through the removal of perverse incentives to overstock and remain on marginal land (see Douglas 2002). Removal of these tax concessions, and incentives for efficient farm management, can promote self-reliance and reduce farming pressures on the Australian environment.

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Endnotes

1. Australia is the only continent where the overwhelming influence on climate is a non-annual climatic change, the 'El Nino Southern Oscillation' (ENSO) (Flannery 1994). Severe 'droughts and flooding rain' have been observed from both geological and human records. There have been eleven major droughts recorded since 1864 (Botterill and Fisher 2003).

2. In addition to assistance during droughts, farmers also receive assistance to prepare for drought, primarily through the Australian Government's *Agriculture – Advancing Australia* program that includes FarmBis to promote new skills (state and Commonwealth funded); Rural Financial Counselling services to assist farmers assess their situations and consider their future (state and Commonwealth funded); FarmHelp to assist non-viable farmers leave agriculture (Commonwealth funded); research on climate variability; and Farm Management Deposits to promote self-management of financial risks (funded via foregone taxation). Spending by the Australian Government on this program is estimated at around $1 billion since 1997.

3. In 2006, this cap was increased to $500000 (Department of Agriculture, Fisheries and Forestry 2006).

4. FMDs are cash flow and risk management tools that confer tax benefits by allowing producers to deposit pre-tax income with tax payable at the depositor's marginal tax rate at the time of withdrawal (Douglas, Oliver and Hall 2002; Martin et al. 2005).

5. Interest rate subsidies were funded 90 per cent by the Commonwealth with the remainder funded by states/territories.

6. Prima facie is not necessarily declared on receipt of a submission. The Commonwealth can refuse to consider a submission further.

7. Of course, the producer in reality has a continuous choice of deposit amounts rather than the binary choice we have assumed for simplicity. x can be interpreted as the maximum amount of surplus savings the producer is

willing to invest in an RMD whereas *y* is the minimum.

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