Conceptualising the effects of seasonal financial market failures and credit rationing in applied rural household models

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Abstract

A wide variety of farm household models have provided a valuable theoretical basis for empirical and conceptual analysis of interactions between production and consumption resource allocations of poor rural people. A weakness of common applications of many such models, and unfortunately of much analysis, is failure to routinely also recognise and adequately describe the fundamental seasonal nature of most agricultural production and the effects of pervasive seasonal finance market failures on poor rural people's behaviour and welfare. This is despite considerable theoretical work demonstrating the importance of seasonal financial market failures as constraints on agricultural development. A general model recognising this is presented, with graphical applications showing the potential importance of seasonal finance constraints on farm households' behaviour and welfare . Formal methods for allowing for the effects of seasonal finance constraints on household responses to policy and other change should be standard tools used by applied rural development economists.

Key words: credit rationing; farm household models; seasonality; seasonal finance market failures.

JEL classification: Q12

December 2011

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1. Introduction

Household models have played a significant role in advancing theoretical understanding and empirical analysis of the behaviour of (particularly poorer) rural people and economies. Their specific contribution lies in the modeling of two key features of (again poorer) smallholder people's livelihoods: the interactions between production and consumption decisions, and the effects of market failures in labour, product and credit markets upon these interactions. The models by and large successfully allow for these important features of farm households and for differences between households with different resource endowments and objectives. Many have, however, in both their conceptualisation and operationalisation, largely ignored another key feature of poor smallholders' livelihoods: the critical importance of seasonality in agricultural production leading, with poverty, to seasonality in market failures, notably in credit markets, and hence credit rationing. This has been associated with an unfortunate lack of attention in much empirical and policy analysis to the effects of seasonality on poor farm household behaviour. Seasonality is, however, a major feature of rainfed agriculture and plays a significant part in perpetuating poverty. This paper uses a relatively simple model formulation to address this and discusses a simple conceptual application of the model.

Following this introduction the paper provides a brief review of farm household model development and application. This leads on to a discussion of the importance and extent of seasonal credit market failures and credit rationing in smallholder agriculture and then the specification of a formal farm household model allowing for seasonal credit market failures and credit rationing . Insights from and benefits from the wider use of this model as compared with current standard models are demonstrated with relatively simple graphical application of the model to describe the situations of households affected by credit rationing. It then goes on to compare the effects of changes in prices, wages, and technology on affected and unaffected households. Significant differences from (improvements over) predictions of the standard model are shown for (generally poorer) households affected by credit rationing.

2. Farm household models

A wide variety of farm household models have provided a valuable theoretical basis for empirical and conceptual analysis of interactions between production and consumption resource allocations of poor rural people. Building on standard production economics and early 20th century analysis by Chayanov of peasant agriculture in Russia (Ellis (1993)), farm household models developed by Nakajima (1986) and by Barnum and Squire (Barnum and Squire (1979)) have been widely used to develop theoretical understanding of peasant farm households (by investigating theoretical properties of and inferences from these models) and for empirical investigation of the effects of different technical, market and policy changes on different peasant farm households' behaviour, welfare and interactions with produce and factor markets. Such models have been given significant attention by postgraduate agricultural and rural development text books such as Singh et al. (1986); Ellis (1993); Bardhan and Udry (1999) and Sadoulet and de Janvry (1995). Taylor and Adelman (2003) review these models with the explicit objective of providing a starting point for students and researchers to build models to investigate impacts of policy and market changes.

A limitation of the models presented in much of this literature (which both describes and influences theoretical and empirical work), is lack of integrated analysis of on the one hand simultaneous production and consumption decisions (the focus of farm household models) with, on the other hand, the behavioural effects of seasonal capital constraints[1]. Singh et al. (1986) includes no discussion of seasonal credit constraints or examples of models addressing this, although Iqbal (1986) allows for inter-year borrowing and saving. Ellis (1993) makes no mention of credit market failures in his chapters on farm household models. Sadoulet and de Janvry (1995, 164 ff) include discussion of a related literature that considers the effects of liquidity constraints on intertemporal household models looking at life-cycle, inter year liquidity constraints (rather than intra-year liquidity constraints). Bardhan and Udry (1999), in a chapter on household models discuss only land and labour market failures (not credit market failures) and in a subsequent chapter on credit markets explore credit market failures in terms of information economics, without reference to their impacts on household

[1] There are of course other weaknesses with the farm household models, most importantly their failure to describe the nature and effects of intra-household relations and their limited ability to describe market linkage equilibrium effects. These issues are, however, widely recognised by analysts and in the text books discussed earlier, and a range of formal models have been developed to address these issues - see for example McElroy and Horney (1981), Smith (1998), Quinsumbing (2003) and Seebens and Sauer (2007) on intra-household relations and Taylor and Adelman (2003) on market linkage effects.

behaviour. Taylor and Adelman (2003) mention a small literature on household models showing or describing credit market failures, but make no mention of seasonality, and do not consider credit market failures in further discussion of the application, development or weaknesses of models. de Janvry and Sadoulet (2006) draw attention to the impact of seasonal financial failures on farm household behaviour, and suggest that treatment of this in a static annual model can provide valuable insights into the way that farm household behaviour can be constrained by seasonal liquidity constraints. Their conclusion, however, is that policies for agricultural production must be complemented by policies promoting working capital by improving access to both credit and savings opportunities

Financial market failures (including in some cases seasonal market failures) are examined in a literature that explores and demonstrates the existence of credit rationing and constraints and their impacts on farm productivity and household welfare (see for example Eswaran and Kotwal (1986), Carter and Wiebe (1990), Feder et al. (1990), Carter and Olinto (2003), Carter and F.J. (2000) and Boucher et al. (2008), with reviews in Petrick, M. (2005) and Boucher et al. (2009)). Important and valuable though these studies are in highlighting the extent of credit rationing and its impacts on productivity and welfare, there has been little follow up outside this literature in studies not specifically concerned with credit *per se.* , for example in studies of the effects of price changes or new technologies on farm household behaviour and welfare. Thus although Skoufias (1993) and De Janvry et al. (1992) do describe models that allow for seasonal (intra-year) credit constraints affecting production and consumption decisions within and between seasons, this approach is rarely cited or followed in studies of the impacts of changes in other variables (for example input or output prices or technology): the wider impacts of seasonal finance constraints on farm household responses to such change are therefore often forgotten. Recommendations tend to be made about improving access to seasonal financial markets, not about taking the failures of these markets into account when developing other policies and analysing their effects on farm household behaviour and welfare.

3. Seasonal credit market failures

The particular seasonal nature of much agricultural production (particularly rainfed crop production) is one of the characteristics of agriculture that have traditionally set it apart from other industries or sectors, even in wealthier economies where agriculture is a relatively unimportant part of the

economy[2]. The effects of this on farm household and sectoral behaviour and welfare are particularly severe among poorer farm households living in poorer rural areas. Such households face greater seasonal constraints from shortages in working capital, must use such working capital for both consumption and production, and face particular difficulties in accessing seasonal finance markets – but seasonality, poverty and reliance on low productivity agriculture are inherent and mutually reinforcing features of many poor rural economies (see for example Newberry and Stiglitz (1981), Feder et al. (1985), Binswanger and Rosenzweig (1986), Binswanger and McIntire (1987), Dorward (1996), Dorward (2006), and papers referenced above on credit rationing).

The difficulties facing poor rural households from interactions of consumption and production objectives and activities in the context of seasonality and financial market failures have been recognised in a long standing literature on seasonality and, for example, hungry gaps (periods of particular difficulty for poor rural households with low food stocks, high demands for labour and other crop production investment, high risks of illness, and adverse wage rates and food and asset prices). Much of this literature has been descriptive, focussing on identification and description of seasonal constraints affecting different types of rural households and their responses to these constraints Chambers et al. (1981), Longhurst (1986), Corbett (1989), Davies (1989), Gill (1991), Ellis (2000)). As noted earlier, a significant literature has explored non-separability in farm household models as a result of credit rationing and demonstrated that credit rationing is a significant issue affecting farm productivity and welfare for many poor smallholder farmers. A separate branch of modelling has involved the construction of linear and non-linear programming models for specific farm systems rather than the estimation of more generalisable econometric models (see for example Holden (1993), Dorward (1996), Alwang and Siegel (1999), Dorward (1999), Dorward (2006)). These studies have not generally examined the impacts of seasonal finance constraints as their primary focus of interest, but have modelled their effects as one critical element in the wider set of constraints on poor

[2] Other features of agriculture that set it apart from other sectors are the relatively inelastic demand for many agricultural (particularly food) products; the particular importance of food to human consumption; the dispersed nature of crop production; agriculture's dependence and effects on renewable natural resources ; and, in poor agricultural economies, the large proportion of employment and GDP associated with agriculture (particularly in rural areas where poverty incidence and severity tend to be highest); the integration of consumption and production in subsistence and (more commonly) semi-subsistence farm households; and financial (savings, credit and insurance) market failures (particularly in poorer areas and among poorer households predominantly producing food crops).

rural people's welfare and behaviour[3]. A related literature has explored (with more qualitative approaches) the extent and effects of seasonal poverty traps (Chambers (1983)) while quantitative and qualitative analysis of more general asset poverty traps has been associated with resurgent interest in risk, uncertainty, vulnerability and social protection (for example Carter and Barrett (2006), Carter and Barrett (2007), Barnett et al. (2008)).

It appears then that the lack of explicit attention to problems arising from seasonal finance market failures represents a critical flaw in the general application of agricultural household models to analysis of poor rural people's livelihoods. First, models' focus on household achievement of consumption requirements from own production is generally concerned only with future consumption (in the harvest, post harvest and subsequent pre-harvest seasons), not with consumption for current survival (in the immediate pre-harvest season) - but current survival is a major pre-occupation of poor rural people that can compromise their ability to invest in future production. Second, common conflation of income from crop production at or after harvest with pre- harvest income and expenditure associated with buying and selling of labour fails to describe capital constraints on livelihood options. These failings are not merely academic and conceptual: seasonal finance constraints restrict poor people's options so that analytical mis-specifications ignoring these constraints can lead to serious errors (a) in diagnosis of the problems facing poor rural people and (b) in policy and other prescriptions to address these problems.

The remainder of this paper demonstrates that

- the standard farm household model as described by Sadoulet and de Janvry is easily extended to take account of seasonal finance constraints;
- such extensions can provide valuable analytical and policy insights where significant numbers of farm households do face serious seasonal finance constraints; and
- consequently 'seasonal farm household models' should be considered the standard default for modelling poor farm household behaviour in the absence of effective credit markets and routinely implemented unless it is demonstrated that they are not relevant to the research question being addressed.

[3] Dorward (2006), for example, shows widely differing responses to and welfare effects of maize price and wage rate changes for poor and less poor people, with backward sloping supply responses to maize prices and wages for the poorest households, as a result of seasonal credit constraints.

4. A formal farm household model allowing for seasonal credit market failures

The introduction of seasonal finance market failures into algebraic models is conceptually simple, involving the separation of pre-harvest (growing season) from harvest and post-harvest variables for consumption, income and leisure / household reproduction time in the utility function, and a similar separation, with new seasonal capital and labour equations, for labour and capital allocations. A minimalist standard seasonal farm household model[4] can then be represented as

$$\text{Max } U = u(C_1, C_2, V_2, L_R, H_R) \qquad \text{(1, utility function)}$$

where u is the household utility function with utility U determined by pre harvest and post harvest consumption (C_1 and C_2), by value of post harvest cash and stocks (V_2), and by harvest and pre harvest 'leisure' and household reproduction time , or disutility of household labour, (L_R and H_R)

such that

$$L_T = L_O + L_F + L_R - L_I \qquad \text{(2, pre-harvest labour)}$$

$$H_T = H_O + H_F + H_R - H_I \qquad \text{(3, harvest labour)}$$

$$V_1 = V_0 - p_1C_1 - V_S + V_B - V_F - w_1 L_I + w_1 L_O \qquad \text{(4, pre-harvest capital)}$$

$$V_2 = V_1 + p_2(Y - C_2) + (1+i) V_S - (1+i)V_B - w_2 H_I + w_2 H_O \qquad \text{(5, harvest capital)}$$

$$Y = y(L_F, H_F, V_F, D) \qquad \text{(6, production function)}$$

where L_T = household pre-harvest labour supply; L_O = hiring out of pre-harvest labour; L_F = on farm pre-harvest labour use; L_I = hiring in of pre-harvest labour; H_T, H_O, H_F, H_R and H_I defined as for L_T, L_O, L_F, L_R and L_I but for harvest labour; V_0 = value of pre-seasonal cash and stocks (working capital); V_1 = carry forward of pre-harvest cash and stocks; w = wages for labour hire; V_F = pre-harvest on-farm investment of working capital; V_S = pre-harvest savings/ lending of working capital at interest rate i; V_B = pre-harvest borrowing of working capital; p_1 and p_2 = respectively pre-harvest and harvest prices of farm produce and purchased commodities ; and Y is harvest time production expressed as a production function y of pre-harvest and harvest farm labour use, pre-harvest on-farm investment of

[4] The model follows de Janvry and Sadoulet (2006) in using a static annual model and considering production, consumption and income use in different periods as different commodities. It is similar in many ways to those presented by Skoufias (1993), Petrick, M. (2004) and Dorward (2006), but with two time periods (as in Petrick, M. (2004)), with the 'pre-harvest' period including planting and growing.

working capital and land use (D). Note that where there are credit market failures then the value of V_B may be constrained.

It should be noted that the model can be extended in a number of ways, for example to allow seasonal and/or differential buying and selling wage rates and/or prices, further differentiation into more periods within the pre-harvest period, land rental, separation of farm and purchased consumption, and different farm production and off-farm activities (see for example Dorward (2006)). The standard farm household model presented by de Janvry and Sadoulet is a special case of the general seasonal farm household model presented above, where V_0 is large relative to p_1C_1 and/or V_B is unconstrained and i is low such that equation 4 does not constrain equations 5 and 6, and equations 2 and 3 can consequently be conflated, as can equations 4 and 5, with removal of C_1 from equation 1 and the simple summation of L_R and H_R in equation 1.

The model in equations 1 to 6 should be amenable to econometric estimation from farm household data sets, subject to the normal difficulties of obtaining the necessary (reliable) data and of specifying and estimating tractable and appropriate functional forms. Examples of such models are, however, regrettably rare, Skoufias, 1993, being a significant exception. Incorporation of seasonal consumption objectives and constraints in programming models is much more common. Linear programming models generally represent pre-harvest consumption objectives and disutility of household labour use as constraints (to allow post harvest income maximisation in a linear objective function – see for example Holden (1993), Alwang and Siegel (1999), Dorward (2006)). However pre-harvest consumption and leisure/ household reproduction objectives can also be explicitly built into the objective function, as, for example, with the use of a Stone-Geary utility function (for example Dorward (2006)).

5. A conceptual model of seasonal credit market failure effects

Graphical representations of household models can make the insights from these models more accessible to those not familiar with algebraic models or lacking the necessary skills to work with them. They do, however, require some familiarity with micro-economic use of indifference curves and production function analysis, and also require some simplification of underlying algebraic models. We now develop a graphical representation of the model presented above and use it to investigate key relationships described by the model.

The separation of objectives, resources and constraints between two time periods in the seasonal farm household model presented above contains too many dimensions to be properly represented in simple graphical models. However important and insightful elements of the model's application to situations can be presented graphically by (a) simplifying the objective function to conflate some of the variables that are treated separately in the algebraic analysis outlined above, and (b) identifying particular scenarios with different values for specific variables and presenting these in different graphs[5].

We begin by assuming that decisions on labour and capital allocations in the harvest period are separable from those in the pre-harvest period, given pre-harvest decisions allocating labour and capital to farm production. For poor households we further postulate that for poor households with low levels of pre-harvest consumption C_1 there is effectively a lexicographic ordering that prioritises C_1 for immediate survival. We also ignore harvest labour and capital constraints, assuming that household labour is sufficient and/or easily replaced by hired labour without financing constraints.

The problem can then be represented as follows:

$\text{Max } U = u(C_1, Y, L_R, Z)$ (7, utility function)

such that

$L_T = L_O + L_F + L_R - L_I$ (8, pre-harvest labour)

$V_1 = V_0 - p_1C_1 - V_S + V_B - V_F - w_1 L_I + w_1 L_O$ (9, pre-harvest capital)

$Y = y(L_F, V_F, D)$ (10, production function)

$V_B <= V_{BMax}$ (11, pre harvest credit constraint)

$Z= V_1 + V_S(1+i) - V_B(1+i);$ (12, harvest capital)

[5] It should be stressed that the approach taken in this section is intended to show how important it is that standard policy oriented analysis with household models should take account of seasonality. It does not address seasonal risk and uncertainty (which also need more attention in standard policy oriented analysis) nor methodological issues important for researchers trying to identify which households face credit rationing due to risk constraints and/or supply constraints (as discussed, for example, in Petrick, M. (2005), and Boucher et al. (2009)).

where V_{BMax} is the maximum that credit rationed households can borrow, all variables are greater than or equal to zero and $(H_R, V_2)= f(Y, Z, V_1)$ for households with given H_T.

We then re-arrange equation 9 to give

$$(V_0 + V_B) – (p_1C_1 + V_F) = (V_1 + V_S) – w_1 (L_O – L_I) \quad (13)$$

This shows that if pre-seasonal capital and pre-harvest borrowings $(V_0 + V_B)$ are less than minimum pre-harvest consumption and farm input use $(p_1C_1 + V_F)$ then these must be financed by hiring out household labour (with $(L_O – L_I)$ greater than zero since pre-harvest lending and saving $(V_1 + V_S)$ cannot be negative).

We follow standard graphical analysis of household models, examining the interactions between (a) indifference curves for pre-harvest leisure/ household reproduction time L_R against Total Value Product (TVP) curves of farm production Y and (b) costs and returns from hiring pre-harvest labour in our out. However, we add (c) the proviso that in the allocation of pre-harvest labour, priority is given, if necessary, to hiring out labour to ensure that pre-harvest consumption and farm input use $(p_1C_1 + V_F)$ can be provided for by pre-seasonal stocks, borrowing and pre-harvest labour earnings $((V_0 + V_B) + w_1 (L_O – L_I)$, from equation 13). This allows the graphical representation to ignore C_1 in (a) focussing only on Y and L_R in equation 7 (Z can be ignored for poor households for whom it will normally be very small).

Figure 1 shows the Total Value Product (TVP) curve (per ha) obtained from the use of pre-harvest labour for two farm-households which have identical characteristics apart from credit rationing. Farm household A has insufficient pre-harvest capital resources $(V_0 +V_{Bmax})$[6] to meet pre-harvest capital requirements for consumption and farm input use $(p_1C_1 + V_F)$, and therefore as specified in equation 13, labour has to be hired out to meet the shortfall. The amount of labour needed depends upon the size of the shortfall and, as we shall see, upon the pre-harvest wage rate. Farm household B has sufficient pre-harvest capital resources $(V_0 +V_{Bmax})$[7] to meet pre-harvest capital requirements for consumption and farm input use $(p_1C_1 + V_F)$, and there is no need to hire labour out to cover any deficit and so the household has more freedom to apply labour to the farm or other activities.

[6] We assume that under these circumstances the household borrows up to the maximum available, $V_{Bmax.}$

[7] The household may or may not need to borrow up to the maximum available, $V_{Bmax.}$

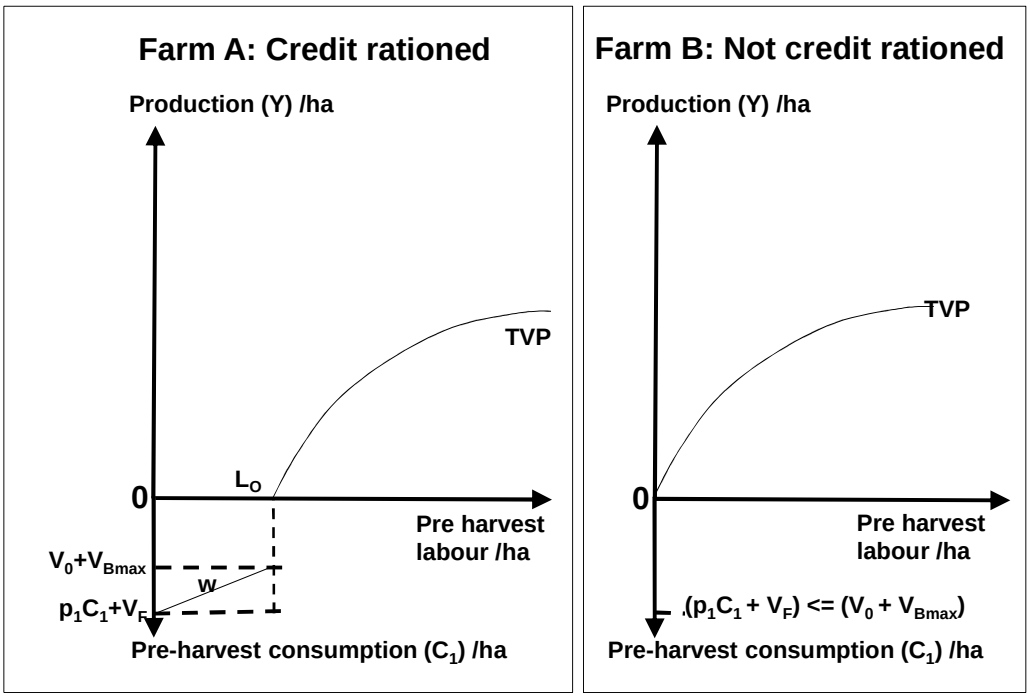

Figure 1. Total value product of pre-harvest labour for credit rationed and non-rationed households

We now build on figure 1 to find utility maximising allocations of seasonal working capital to food consumption and production. Figure 2 therefore adds indifference curves describing the trade-offs between the dis-utility of allocating labour to working on and off farm, rather than leisure and household reproduction, (on the horizontal axis) against benefits from farm production (on the vertical axis) [8]. Figure 2 shows utility maximising allocations of seasonal working capital to food consumption and production for both household types[9]. Family labour allocations to different activities and (for farm household B) on-farm hired labour use are summarised in a panel at the top of each graph.

[8] As in standard graphical analysis of farm household models, conventional indifference curves are rotated 90° anticlockwise.

[9] It is assumed for simple exposition that farm technology and input use are identical across the two farm households, and that purchasing and sales prices are the same, as are net wages for hiring in and out. Variation in input use and transaction costs leading to buying and selling price differences can easily be introduced. Variations in household member wage potentials could also be introduced (as with Low (1986)) with lowest earners working on farm tasks where farm MVP is higher than wages, and high wage earners applying labour first to C_1 earnings (this would provide an additional explanation to Low's analysis of off farm employment) and then to further earnings.

Since farm-household type A has to hire out labour (L_O) to cover its pre-harvest capital deficit, there is less household labour available for on farm production (as shown in figure 1). This means that despite high marginal returns to labour, only a low level of welfare is achieved (as shown by the TVP/ indifference curve tangency at an indifference curve $\mathbf{I_A}$ which is relatively close to the L_T and zero production lines . Farm household B has no need to hire labour out to cover any deficit and so can apply more labour to the farm – and indeed with sufficient capital can apply some of this to hiring labour in, as shown in figure 2. If this is the case it reduces the amount of family labour applied to the farm (L_F) and achieves the indifference curve $\mathbf{I_B}$ which is much further from the L_T and zero production lines than is the case for indifference curve $\mathbf{I_A}$ for farm household A[10].

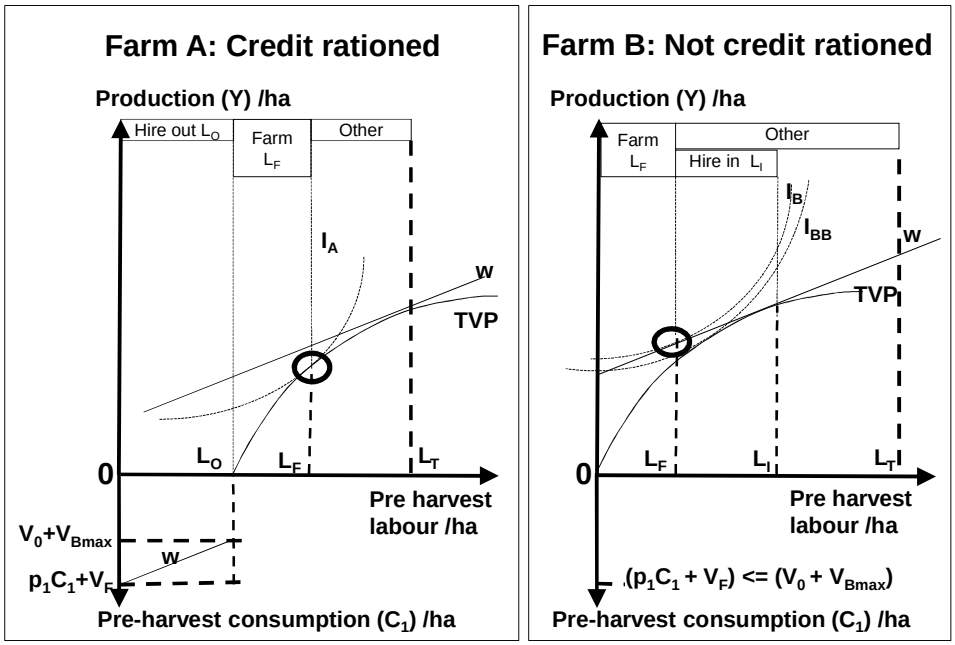

Figure 2. Utility maximising labour allocations & production by household type (per ha)

This analysis is clearly different from standard farm household analysis as it shows that allowance for credit rationing can lead to substantial differences in farm household welfare, farm production, and labour market engagement from that predicted by the standard farm household model, implicitly without credit rationing, in otherwise identical farm households. A specific prediction is that relaxation

[10] The diagram for Farm B in figure 2 also shows the indifference curve I_{BB} which could be achieved if there was not enough capital to hire in labour. This gives lower welfare than indifference curve I_B but welfare that is still considerably higher than from indifference curve I_A on farm A.

of working capital constraints can lead to reduced hiring out of labour, a specific impact of cash transfers reported in Malawi by Covarrubias et al. (2012)[11].

Welfare and behavioural difference between this analysis and standard farm household analysis become more pronounced when we examine farm household responses to and welfare effects of exogenous changes. It is these differences, we suggest, that mean that standard farm household analysis that ignores seasonal credit rationing constraints can be highly misleading when examining the effects of change on poor farm households.

6. Analysing wage changes, output price changes and investments in new technology

We now examine four types of change and their impacts on the two different household types: in wages, in farm output prices, and in unsubsidised and subsidised investments in new technology.

6.1. Analysing wage and output price changes

Changes in wages are represented graphically with a wage fall (represented by a shallower slope for the wage line, w'_1 replacing w_1). Figure 3 shows the impacts of falling wages on the two households' labour allocations, production, and welfare. These are summarised in table 2.

Table 2. Impacts of fall in wages on households with and without credit rationing

Farm/hh type	Wage fall effects			
	Labour Hire		Production	Welfare
	In	Out		
A: credit rationed	N/A	+	-	-
B: not credit rationed	+	N/A	+	+

[11] Covarrubias et al. (2012) report a drop of 61% in low skilled agricultural wage activities for poor farm households receiving unconditional cash transfers.

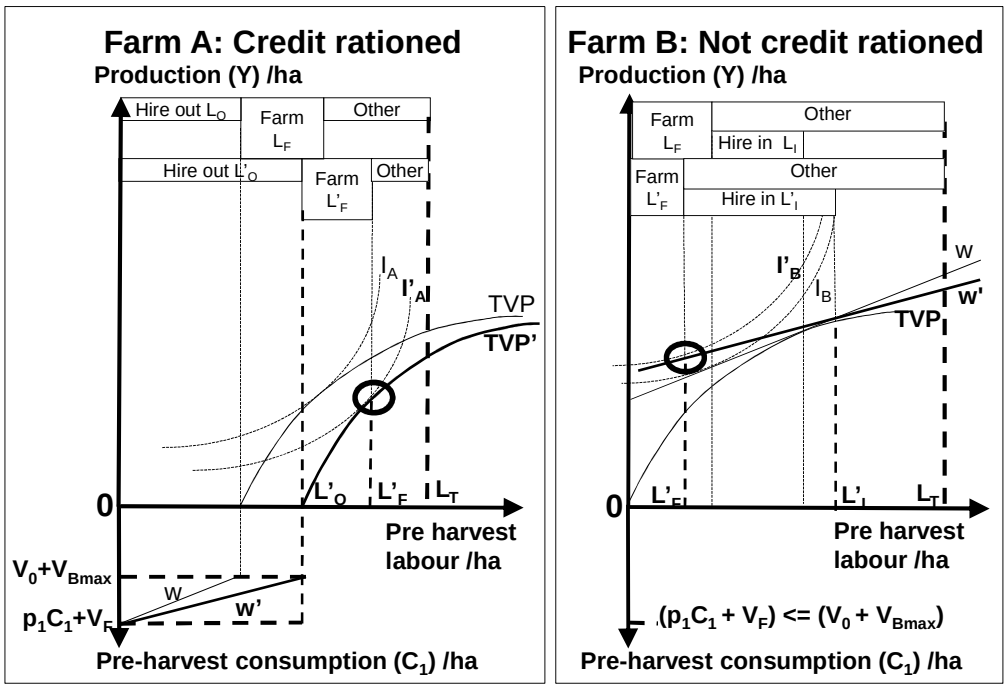

Figure 3. Impacts of rise in output prices or fall in wages

For farm household B (not constrained by seasonal capital constraints) the analysis is again identical to that of a standard farm household model, as higher production and welfare are achieved with increased hiring in of labour and leisure/ household reproduction time but reduced on farm family labour use (as shown by the panels at the top of the graph). However for farm household A, with serious credit rationing constraints, the analysis and impacts are quite different. The fall in returns to hiring out labour means that more labour has to be used to earn enough to make up the pre-harvest working capital deficit between available pre-harvest working capital and that required for consumption and farm input purchases ($(p_1C_1 + V_F) – (V_0 + V_B)$). As a result less labour is available for farm production, shifting the TVP curve to the right. The result is that a fall in wages for these households leads not only to reductions in welfare (with TVP/ indifference curve tangency at an indifference curve below the previous indifference curve) but a rise in hiring out of labour and a fall in production, with a backward sloping supply curve for labour.

The effects of a rise in food staple output price can be examined using a similar analysis if the vertical axis in figure 3 is measured using real prices expressed in equivalent physical units of staple food output. A rise in the price of staples leads to a fall in the value of wages relative to (a) the pre-harvest ability of hired out labour to buy staples and (b) the value of harvest and post-harvest staple

production. The former will differ between households according to the proportion of the pre-harvest working capital deficit (($p_1C_1 + V_F$) – ($V_0 + V_B$)) required for staple food purchases. This proportion will tend to be higher for poorer households as (a) poorer people spend a greater proportion of their income on food, and (b) the analysis above suggests that more credit rationed farm households (who are likely to be poorer) are likely to produce and hence store less staple food. Thus, for example, for a household for whom 50% of their working capital deficit was accounted for by staple food purchases prior to any price change, a 100% staple food price rise will lead, *ceteris paribus*, to a 50% increase in the amount of hired out labour needed to finance their pre-harvest working capital deficit[12]. For such households, therefore, a rise in the price of staple foods leads to a reduction in the labour available for their production and again a backward sloping supply curve or forward sloping demand curve[13]. This analysis is consistent with results from non-linear programming models reported in Dorward (2006) for different types of household in Malawi.

6.2. Analysing unsubsidised and subsidised investments in new technology

A change in technology is most simply represented graphically by an upward, anti-clockwise swivelling of the TVP curve in the analysis for each household. If this requires no extra labour or other capital investments prior to harvest then there are limited differences in outcomes from analysis with the standard farm household model: production and welfare achievements increase across all households and hired labour demand increases for household B. This applies only if direct and immediate household impacts are considered, with no consideration of consequent wider market impacts beyond the household. If these market effects are considered then the increased production and demand for labour should exert pressures that depress produce prices and/or increase wages (if these markets are to some extent separated from wider markets), and as shown above the impacts of these will be different where seasonal finance constraints are considered – with particular benefits for poorer households.

[12] More generally, $(L'_O-L_O)/L_O = bd$ where $(L'_O-L_O)/L_O$ is percentage increase in hired out labour needed to finance the working capital deficit, *b* is the proportion of working capital deficit accounted for by staple food purchases before the price change, and *d* is the percentage increase in the price of the staple food.

[13] Strictly speaking such households are food deficit producers so that the staple food price rise leads to a reduction in production and an increase in purchases of food staples in the subsequent year, and hence a backward sloping production response and, in terms of market interactions, an equally anomalous forward sloping demand curve.

This analysis is however changed if the new technology requires some initial investment in, for example, extra or more costly labour, seed or fertiliser. This can be represented in the diagrams used here by an increase in input purchases and hence in pre-harvest capital requirements if the technology is adopted ($p_1C_1 + V'_F$). For household A this would require more hiring out of labour to provide this pre-harvest capital. The steeper TVP curve (TVP') therefore starts from a position to the right of the original TVP curve. The welfare effects of adoption are then determined by the relative positions of the new TVP curve (dependent upon the increase in hired out labour required to finance increased pre-harvest investment and the increase in labour productivity) and the indifference curves.

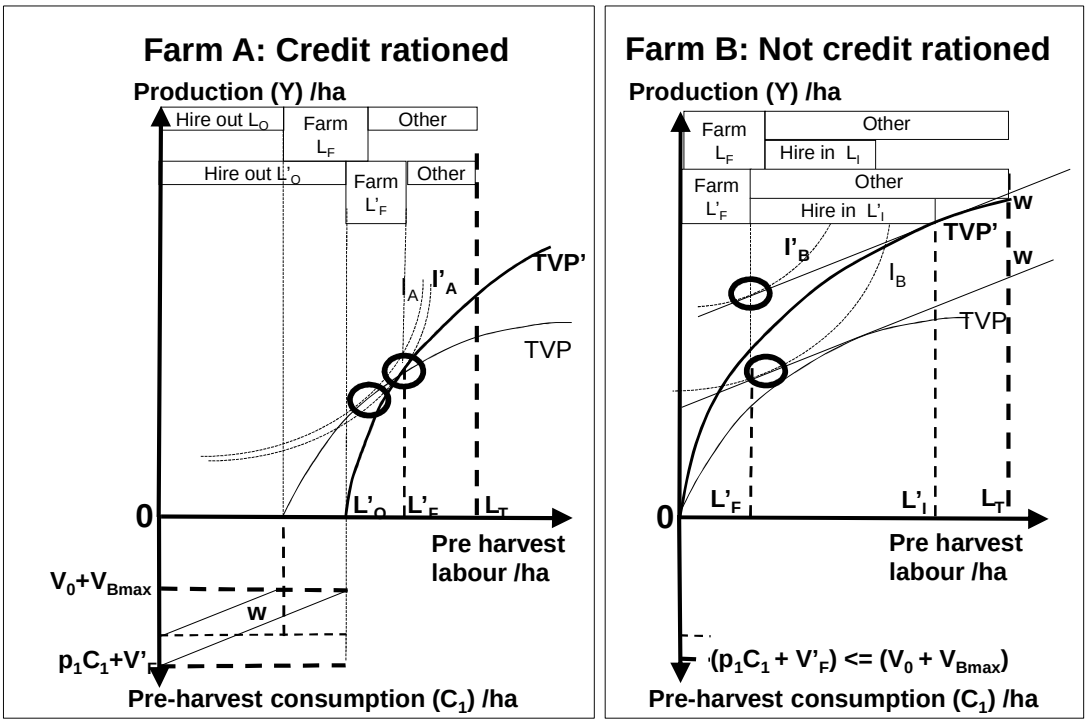

Figure 4 Impacts of new technology requiring seasonal investment, no subsidy

As drawn for household A in figure 4, investment in new technology leads to a lower welfare (tangency with a lower indifference curve $\mathbf{I'_A}$), and the new technology will therefore not be adopted. For household B, however, the new technology allows achievement of a higher indifference curve $\mathbf{I'_B}$ and should therefore be adopted. Increased hired labour demand and higher production should lead to lower output prices and higher local wages (if these markets are to some extent separated from wider markets and if there are sufficient numbers of producers able to adopt the new technology) with subsequent benefits to poorer households unable to adopt the new technology. An important point to

note in this is the way that credit rationing can explain variation between otherwise similar households as regards their technology choices and productivity.

We now investigate the impacts of a subsidy that reduces the seasonal working capital requirements for the new technology. A partial subsidy is assumed that substantially reduces, but does not eliminate, the cost of inputs such as seed or fertiliser. The analysis is shown in figure 5 for farm household A only, since farm household B would invest in the new technology anyway, without a subsidy.

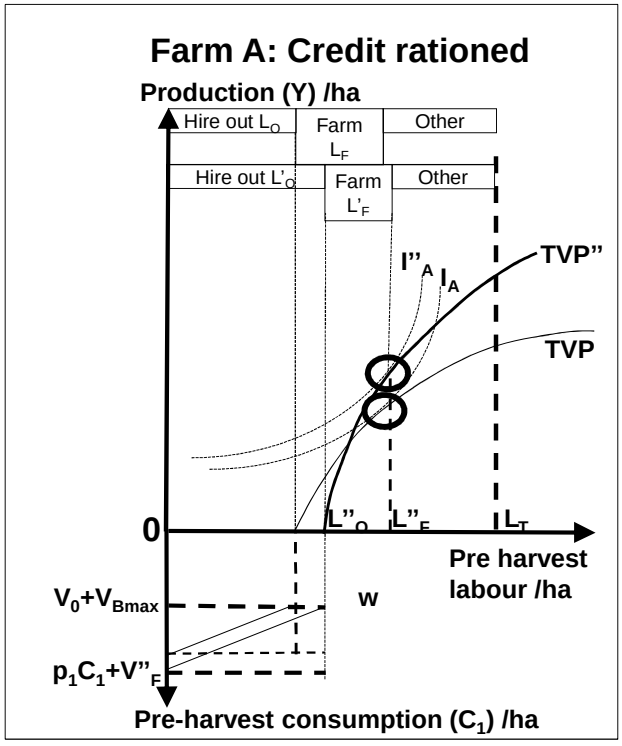

Figure 5 Impacts of new technology requiring seasonal investment, with subsidy

The subsidy leads to a reduction in seasonal working capital needed for farm input purchase with the new technology and hence less hiring out of labour with a smaller rightward movement of the TVP curve (compare L'_O and TVP' in figure 4 with L''_O and TVP'' in figure 5). The result is that with the subsidy the new technology allows farm household A to achieve higher production and a higher indifference curve (I''_A) and hence welfare than they would without adopting the new technology. This result depends upon the size and nature of the subsidy and the characteristics of the new technology and its impact on land and labour productivity. If the subsidy is rationed and targeted, then subsidy

recipients may also be able to sell some of their subsidised inputs, increasing their seasonal working capital and allowing them to invest their retained inputs without the need for any increased hiring out of labour. The likelihood of changes in labour and produce demand and supply should again lead to lower output prices and higher local wages benefiting poorer households, if these markets are to some extent separated from wider markets. However as compared with the unsubsidised situation, price and wage changes could be more marked if there are large numbers of subsidy beneficiaries, as output and labour market effects should be greater[14].

The analysis presented here is consistent with results from modelling and from preliminary analysis of field surveys investigating the impacts on different household types in different areas of the 2005/6 to 2008/9 large scale agricultural input subsidy programme in Malawi (School of Oriental and African Studies et al. (2008), Dorward and Chirwa (2009)). It also supports emerging arguments regarding the importance of the role of subsidies in promoting the affordability of inputs rather than just their profitability, which has in the past been the dominant focus of most discussions on the role of agricultural input subsidies (Dorward (2009)).

7. Conclusions

The stylised findings presented in this paper show that representing the credit rationing effects of seasonal finance market failures in theoretical and empirical farm household models can lead to important differences in our understanding of the impacts of different changes on poor rural people and of the markets in which they participate (or fail to participate). The extent and importance of these difficulties will depend upon the extent and nature of seasonal finance constraints affecting rural people in different areas, the numbers of people affected, and the particular interactions of labour and produce markets with utility and production functions. There are a number of further issues not addressed in the simple graphical analysis presented here, but amenable to quantitative analysis, such as the impacts of inter and intra-seasonal wage and price variation, and of different crop and crop technology options.

[14] Output price effects may also be dampened somewhat if the profit effect increases staple food consumption (as in equation 1) but wage effects may also be heightened if increased real incomes increase demand for non-tradable goods and services. Falling output prices and rising wages should themselves also lead to positive impacts on poorer households' welfare in subsequent seasons (as discussed earlier) and thus raise the possibility of a virtuous circle of growth.

The approach developed in this paper for representing seasonal finance market failures in farm household models suggests that there are no pressing methodological reasons for the widespread failure to examine seasonal finance constraints on poor farm households' behaviour and welfare in standard farm household analysis. We then must ask why seasonal finance market failures are so often overlooked in empirical models.

Two basic reasons may be postulated, first that many (most) analysts have not considered them sufficiently important, and second that data sets have not contained the variables needed for estimation of such models. Since analysts have an important role in specifying the variables included in data sets, analysts' lack of interest in seasonal finance constraints would appear to be the major reason for the absence of models allowing for these constraints. If this is a self perpetuating blind spot then analysts must first recognise it and then adjust their data collection, modelling and analysis activities to allow for these constraints as a standard part of farm household analysis, not only in models specifically investigating seasonal credit.

Inclusions of seasonal finance constraints in more accessible graphical representations of farm household models may be one approach to addressing analysts' lack of attention to these constraints in standard empirical models, if analysis of such representations can demonstrate the importance of these constraints as critical for understanding poor rural people's behaviour and welfare. The examples presented do indeed demonstrate this importance. Analysts, teachers and students in rural development economics should therefore recognise that simpler models without explicit representation of seasonal finance constraints should not be adopted as the norm. They should only be adopted as a special case of the general model in those situations where households' initial working capital (for finance and production) and/or their access to financial markets do not significantly or unduly distort farm household behaviour and outcomes from what would prevail with improved access to functional financial markets. This cannot be taken as the norm, particularly where analysis is concerned with the welfare and behaviour of poorer households.

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Acknowledgements

An earlier version of this paper was presented at the Future Agricultures Conference 'Seasonality Revisited', Brighton, July 2009. I am grateful to participants at that conference, particularly to Rachel Sabates-Wheeler and Stephen Devereux, and subsequently to anonymous reviewers for helpful comments on this paper. Any errors that remain are of course my responsibility.