Agricultural and Rural Finance Markets in Transition

Proceedings of Regional Research Committee NC-1014
St. Louis, Missouri

October 4-5, 2007

Dr. Michael A. Gunderson, Editor

January 2008

Food and Resource Economics
University of Florida
PO Box 110240
Gainesville, Illinois 32611-0240

Commodity Linked Credit: A Risk Management Instrument for the Agrarians in India

Prepared by

Apurba Shee
Pennsylvania State University

Calum Turvey
Cornell University

Abstract

This research analyzes daily commodity spot prices and designs risk contingent structured financial instruments as a means to mitigate business and financial risk by reducing debt obligations depending on the embedded commodity options whose payoffs are linked with commodity price fluctuations. Models are developed for operating loans and farm mortgages. The results show that the distributions with the embedded option have higher probability of greater returns and the embedded option with the repayment contingent on the price fluctuation reduces the downside risk of the return from the investment.

Introduction

The problem of endemic poverty in the agriculture of developing countries is largely attributed to low-return economies of scale with any opportunity for increasing either the scale or size of farm operations constrained by access to credit. On the matter of scale the inability of farmers to access short run operating credit to purchase inputs limits the value of total product that can be achieved. On the matter of size the inability to acquire longer term credit, i.e. a mortgage, constrains farms to seemingly perpetual state of low output livelihoods; a poverty trap. The two reasons that commercial lenders or rural cooperatives are so reserved in their lending to developing agriculture is because these farmers have in limited resources insufficient collateral to support the loan, and second, even if collateral were sufficient, because the business risks arising from adverse price and weather movements is so high relative to scale, that the likelihood of default is almost insurmountable.

The question then is what can be done to resolve this problem in a practical way? This paper offers a very novel and practical solution in the form of commodity-linked credit. Commodity-linked credit are structured financial products that have imbedded options against price movements. We present two formulations in this paper each designed to deal with different problems. On the operating side we evaluate a standard single period operating loan with repayment tied to the price of an underlying commodity. The built-in price protection reduces downside risk to the farmer and simultaneously the risk of default to the lender and this unto itself would increase the supply of credit to agriculture. To manage growth and increase economies of size we evaluate a commodity-linked mortgage. This product offers contingent credit in each year of the mortgage; that is in any year that commodity prices fall below a stated target the principal payment required in that year is reduced. It is important not to confuse these products with schemes that merely postpone payment in times of adversity. The products discussed in this paper remove entirely from present or future liability the indemnified risk. The removal of risk of course comes at a cost, and in this paper the formulas presented solve for the risk adjusted interest rate for the operating and mortgage products.

The formulas we present are unique. Turvey (2007) developed the formulas for weather-linked credit and indeed in agricultural economies that face greater peril from weather risk than price risk the formulas can be as easily applied. We also believe that the formulas can be used in developing micro-loans. Micro-finance institutions have in many regions entered into group-lending activities that provide entrepreneurial and consumption capital. Group lending activity to farmers however is constrained by the commonality of risk across its members; that is if all members are involved in the same or highly correlated production activities then any price fall will impact all of the group members at once. The operating loan discussed in this paper resolves this problem because the commodity linkage will protect all group members equally.

The region we address in this paper is particularly well suited for the type of product we propose. Indian agriculture faces wide commodity price fluctuation which makes the return from investment vulnerable and risks the debt repayment ability of farmers. When farmers face adverse market prices, they frequently receive less revenue and when that occurs they often can not repay the debt they took for the investment. The accumulation of unpaid loans limits their access to new capital, which in turn makes their investment in agriculture vulnerable. To meet their financial obligations farmers are forced to sell fixed assets such as land, trees, jewelries etc. leading to an abysmally poverty trap from which few escape. Sometimes the situation becomes so unbearable that farmers in large numbers commit suicide (Mohanty (2005), Mishra (2007), Jeromi (2007)).

There is also a political will in India that makes our credit products attractive. Government intervention offers some relief with subsidized credit (e.g SGSY ;Swarnajayanti Gram Swarozgar Yojana) with the intent of increasing credit access; however, the subsidized SGSY loan is limited to farmers Below Poverty Line (BPL) leaving with limited or no access a large percentage of the population. To encourage commercial lending the government has been promoting community organization around small saving and credit groups[49] and banks then provide loans to the groups considering the groups as social collateral. This aids lenders in the mitigating information imperfections (adverse selection and moral hazard)[50] (Armendariz and Morduch 2005) but group lending unto itself does not hedge against price risks, especially if all group members are involved in growing the same commodity or commodities that are highly correlated in price. Despite the group lending and peer pressure for the repayment, the business risk (price-fluctuation) can lead to default by the entire group. Consequently, group lending amongst poor farmers is not that common in Indian agriculture and because of the inherent business risks individual lending is heavily rationed. As discussed earlier, commodity-linked credit can be plied by MicroFinance Institutions (MFI) to micro loans of farmer-centric self help groups as well as to individual farmers with only limited access to collateral.

The overall objective of this study is to investigate the applicability of price contingent credit as a means of balancing business and financial risks for pulse crops in India. We

[49] A Self Help Group is an informal and socio-economically homogeneous association of 10 to 20 persons, who meet weekly for the business of savings and credit for enhancing the financial security and raising the economic status of its members. It acts not only as a microfinance intermediary but also a platform for sustainable livelihood and women empowerment.
[50] Adverse selection is the lenders inability to assess which borrower is risky and which one is safe. Moral hazard problem in lending is referred to as banker's inability to observe the effort taken or the realization of the return by the borrower.

investigate three types of commodity dominated structured financial products- operating loans, farm mortgages and commodity bonds. The specific objectives are:

i. To investigate historical pattern of price movements for pulses in India. In order to accomplish this objective, we calculate annual volatilities of pulse cash price series in some Indian local wholesale markets.
ii. To determine the range of interest rates that could be charged to risk contingent credit for pulses. To accomplish this goal, we construct model structures of contingent claims such that the repayments of the credit instruments are contingent on the pulse market price variable in India.
iii. To test the effectiveness of commodity credits on the livelihood of a typical household in Sunderpahari, a block in eastern India. To investigate this, we generate the distributions of the portfolio return of the household by simulation.

Commodity-Linked Credit

In this section we present the basic model for commodity linked credit. The principles involved follow from Turvey (2006) who explores a range of commodity-linked bond structures and Turvey (2008) who develops the formulas used here in an application to weather-linked credit. Most medium and small farmers require operating loans for a crop year (around 8 months to 1 year). Farmers take money for the investment on the crop production and generally repay the loan amount by selling their produce after the harvest. Price variation of the commodities directly affects their repayment ability to the banks. The repayment risk can be hedged by structuring the repayment of the operating loan with commodity price fluctuation. The lenders portfolio of an initial operating loan of f amount with embedded commodity option can be written as,

(1) $$B = e^{-rT}[fe^{r^*T} - \psi[\max(0, K - S(t))]]$$

where r is the discount rate, K is strike price, r^* is the interest rate charged on the operating loan which reflect the lender's cost of capital, and $\psi = \frac{f}{K}$. Now, the present value of the operating loan without the commodity can be written as,

(2) $$B_1 = e^{-rT} fe^{(r^{**})T}$$

Therefore, to hedge the price risk with the embedded commodity option, the interest rate charged by the lender (r^*) can be calculated by equating (1) and (2);

(3) $$e^{-rT}[fe^{r^*T} - \psi E[\max(0, K - S(t))]] = e^{-rT} fe^{(r^{**})T},$$

and solving for r^*;

(4) $$r^* = \frac{\ln\left[\frac{\psi E[\max(0, K - S(t))]}{f} + e^{(r^{**})T}\right]}{T}$$

Equation (4) provides the exact formula for calculating the interest rate on an operating loan with payment protection against low commodity prices.

To see how equation (4) works, we determine the interest rate for a non-revolving operating loan for Ranchi bengalgram a pulse crop. From calculations that will be described presently, the price for Ranchi bengalgram has a natural Brownian drift of 11.6% and annualized volatility of 31.5%. Assuming a risk-free discount rate of 5%, a one year at-the-money put option premium priced with a general equilibrium formula with the current cash price of Rs. 2,825 is Rs. 215.43 assuming the market price of risk is 0. Assuming a base interest rate of 12% for conventional loans and an operating loan of Rs.20,000 then $\psi = \frac{f}{K} = \frac{20{,}000}{2825} = 7.08$, and from equation (4) the interest rate on the operating loan

(5) $$r^* = \ln\left[\frac{7.08 \times 215.43}{20{,}000} + e^{.12}\right] = 0.1854 .$$

Hence, the risk adjusted interest rate is 18.54% or a risk premium of 6.54% above the price of a loan without the contingencies. If the cash price of Ranchi bengalgram falls below the strike, Rs. 2,825, the loan repayment obligation also falls. For example, if the commodity price at termination falls to Rs.2542.5, then the payout on the option part is $7.08 \times Max(2825 - 2542.5, 0) = 2000$, and the loan amount repaid after 1 year $20,000 \times e^{0.1854} - 2,000 = 22,075$ Rupees. In comparison the loan without the embedded option would be $20,000 \times e^{.12} = 22,550$ Rupees. What this boils down to is that producers get a protection against the downside price risk. Figure 1 shows the decreasing loan repayment obligation as the prices decrease. The loan repayment without the option is depicted by the horizontal line.

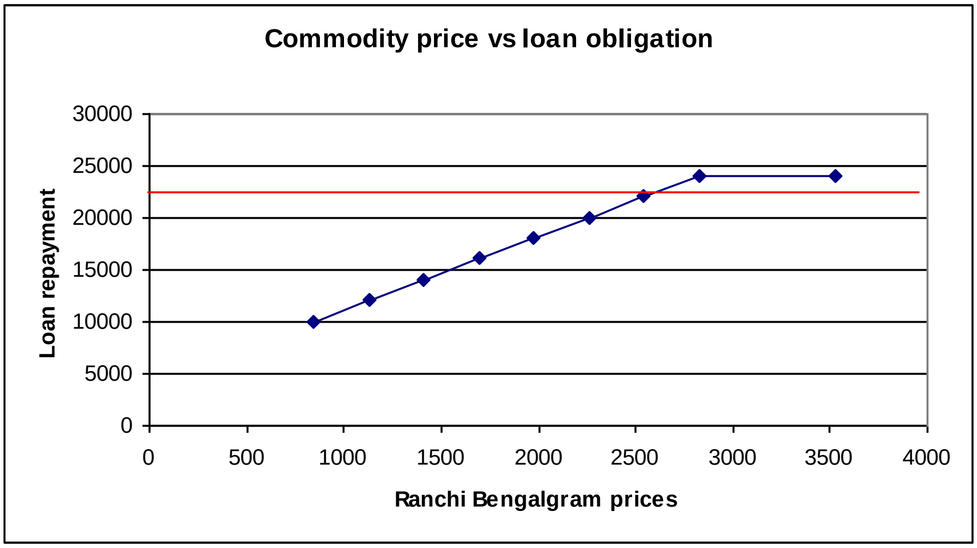

Figure 3.1: Commodity price and the loan obligations with options

Farm mortgage

A farm mortgage is one of the established ways for a farm owner to get a loan from a financial institution. In this case the farmer has to keep the farm as collateral for the borrowed money with the provision that if the loan is not repaid the lender has the right to the borrower's farm. Mathematically an annuity formula for a T year mortgage of the total loan amount F can be written as;

(6) $$A(i) = F\left[\frac{1-(1+i)^{-T}}{i}\right]^{-1},$$

where $A(i)$ is the amortization of the lump-sum amount F into T smaller cash flows. Now applying $\psi = \frac{A(i)}{K}$, the value of the mortgage with an embedded commodity option is as follows;

(7) $$B = \frac{A(i^*)}{r}(1-e^{-rT}) - \left(\frac{A(i)}{K}\right)E[\max(0, K - S(t))]\frac{(1-e^{-rT})}{r}$$

If r is the discount rate applied to the present value of the amortization without any option then the value of the mortgage to the lender is:

(8) $$B_1 = \frac{A(i)}{r}(1-e^{-rT})$$

Now to completely hedge the amortization repayment against commodity output price risk, the mortgage rate (i^*) can be calculated by equating (7) and (8) to obtain

(9) $$\frac{1-(1+i^*)^{-T}}{i^*} = \left[\frac{1-(1+i)^{-T}}{i}\right]\left[1+\frac{E[\max(0, K - S(t))]}{K}\right]^{-1} ,$$

which can be solved using an iterative process.

Suppose a farmer wants to raise Rs (INR) 150,000 for investment in bengalgram cultivation by mortgaging the property for ten years. The amortization for Rs. 150,000 of 10-year mortgage at 12% base interest rate is Rs. 26,547.62 per year. The embedded a-the-money option as calculated previously is 215.43. Solving equation (9) we get i^* =14% which is 2% higher than the base interest rate of 12% and when applied to the farm mortgage, yields an amortization of Rs.28,572.04 per year. If we suppose in a particular time the price of Ranchi Bengalgram is 2,542.5, then the repayment in that year would be $28,572.04 - \frac{26,547.62}{2,825}[\max(2,825 - 2,542.5), 0]$ or Rs. 25,917.28 which is less than the base amortization value. Figure 2 depicts the decreasing amortization payments with the fall in commodity prices where horizontal line represent the amortization payment without the option[51].

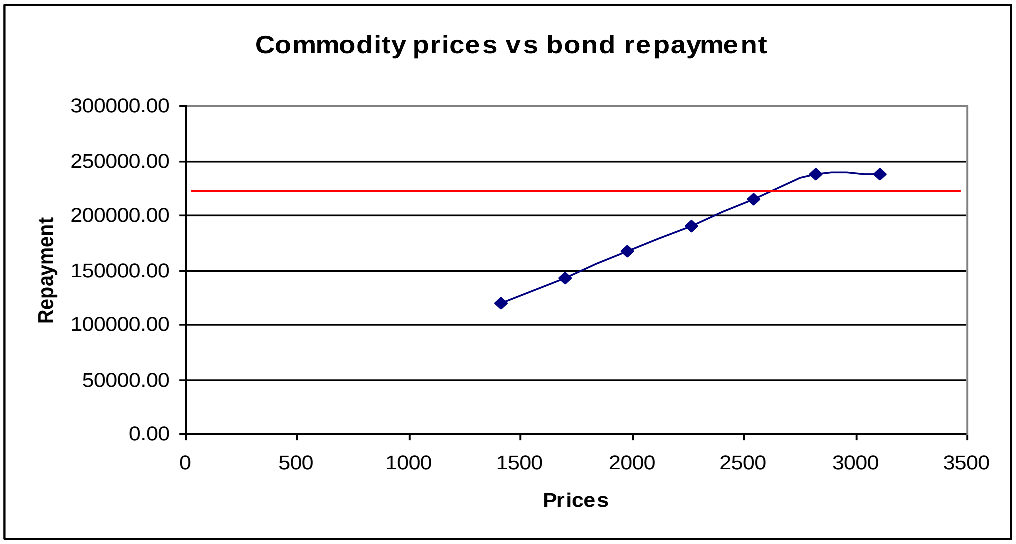

Figure 5.1: Commodity prices with bond repayment

Background area and local wholesale market price data

The study focuses on a block called Sundarpahari in the Godda district of Eastern India, which is home to indigenous Santhal and Paharia tribes. The Santhals live in the plain

[51] An alternative which we do not present in this paper is a commodity-linked bond. with the entire periodic cash flow requirement for coupon payment and sinking fund;

$$B = \frac{c}{r}(1-e^{-rT}) + Fe^{-rT} - \left(\frac{c+\frac{F}{T}}{K} \right) E[Max(0, K - S(t))] \frac{1-e^{-rT}}{r},$$

where the bond yield rate r =discount rate.

area and cultivate rice, maize and different types of pulses such as Bengalgram (Cicer aritinum L.), Masur(Lentil), field pea, lathyrus (khesari) and rajmas during rabi season and Arhar(Cajanus cajan), Greengram (Vigna radiate), horse gram, Cowpea (Vigna unguiculata) during kharif[52] season. The paharias reside on the hilltops and practice shifting cultivation on the slopes and produce Cowpeas, Arhar, maize, and pearl millets.

The motivation for examining different pulses crop in this paper is that farmers who produce pulses in significant portions require credit for pulse cultivation. In the absence of access to commercial lending most of the Santhal and Paharia family borrow money from the local moneylenders. In the months of July and August people take loans ranging from Rs 500 to Rs 10,000 for the labor intensive pulses cultivation[53]. These loans are in the form of seeds, rice and cash from local money lenders. The loans are normally repaid by December-January and the interest charged by moneylenders is 50 to 100%. However, it is often the case that low harvest prices lead to loan default. In this process of indebtedness, many families resort to distress sale of fixed assets huge live trees of Mango, Jackfruit, Mahua etc. at low prices. Many families lose their land to the money lenders. The lack of formal lending has been a major impediment to economic growth in the region. Despite efforts through government and non government initiatives to develop formal lending activities, lender concerns about price variation still constrain capital.

Volatility in Pulse Crop Prices

Commodity price data was downloaded from the Agricultural Marketing Information System Network (AGMARKNET) (http://www.agmarknet.nic.in), a central sector scheme of

[52] There are two major cropping seasons in India, namely, Kharif and Rabi. The Kharif season is during the south-west monsoon (July-October). During this season, agricultural activities take place both in rain-fed areas and irrigated areas. The Rabi season is during the winter months, when agricultural activities take place only in the irrigated areas.
[53] This is based on survey data collected by senior author in 2003-2004 during in Sundarpahari

Directorate of Marketing and Inspection (DMI), Department of Agriculture & Cooperation, Ministry of Agriculture, India and compiled into a historical time series of daily commodity cash prices. Summary of observations and sample sizes of daily modal cash prices of pulse (a leguminous commercial crop) commodities namely Masurdal, Arhar, Greengram dal, Turdal, Bengalgram, Bengalgram dal, and Cowpea are provided in Table 1 with their respective local wholesale markets. The Cowpea does not have a local wholesale market, more generally selling in the south and west Indian markets. Therefore, the study analyzes some wholesale markets for Cowpea like Koppal and Gadag in Karnataka, Jhunjhunu in Rajastan, and Lalitpur in UP. Prices in these markets can influence the return of the farmers of the outlined area.

The data are summarized Table 2. Prices are represented by Rs (INR) per quintal (100 kg). Prices have high variances (standard deviations) within the period, the highest standard deviation being 641.5 for Ranchi Bengalgram dal, 520.2 for Sahebgang Greengram dal, and 472 for Chaibasa Greengram dal. The data show that except for Sahebganj Masur and Ranchi Masur, all commodities in the respective markets enjoy annual price gains over the study period with the average annual gain being 16.3%. The largest annual price increases are Koppal Cowpea, Jhunjhunu Cowpea, Hazaribagh Bengalgram dal, and Chaibasa Greengram dal at 48.8%, 45.5%, 43% and 40.1% respectively. Sahebganj Masur and Ranchi Masur show the annual price decline of 1.6% and 4.7% respectively. The most volatile pulse is Gadag Cowpea at 191% followed by Koppal Cowpea at 114.9%, Hazaribagh Bengalgram at 75.4%, Chaibasa Greengram dal at 62.5% and Hazaribagh Bengalgram dal at 58.2%. Volatility of 14% for Bhagalpur Arhar is the least volatile while Bhagalpur Masurdal has the second lowest volatility of 17.8%. On an average the annual volatility of all the combination is 46%.

Table 1: Summary of observations and sample size

Commodity	Market	Observation		Sample size
		From	To	
Masur	Sahebganj	9/26/2005	12/31/2006	327
Arhar	Sahebganj	9/26/2005	12/31/2006	347
Greengram dal	Sahebganj	11/1/2005	12/31/2006	243
Masur dal	Dhanbad	4/8/2003	12/27/2006	332
Tur dal	Dhanbad	10/6/2004	12/31/2006	261
Masur dal	Ranchi	2/1/2004	12/30/2006	620
Tur dal	Ranchi	2/1/2004	12/30/2006	618
Bengalgram	Ranchi	5/2/2002	12/30/2006	1029
Bengalgram dal	Ranchi	2/1/2004	12/30/2006	616
Masur dal	Jamshedpur	7/29/2002	12/30/2006	353
Arhar	Jamshedpur	7/26/2002	12/30/2005	350
Bengalgram dal	Jamshedpur	7/26/2002	12/26/2005	361
Bengalgram	Hazaribagh	5/12/2003	12/28/2006	482
Bengalgram dal	Hazaribagh	1/21/2004	12/22/2006	340
Masurdal	Bokaro	12/15/2003	12/27/2006	420
Masurdal	Chaibasa	11/28/2002	11/14/2006	612
Arhar	Chaibasa	11/28/2002	11/14/2006	612
Bengalgram	Chaibasa	12/27/2003	11/14/2006	293
Bengalgram dal	Chaibasa	11/28/2002	11/14/2006	610
Greengram dal	Chaibasa	10/8/2005	11/14/2006	288
Masurdal	Bhagalpur	6/5/2003	5/3/2006	720

Arhar	Bhagalpur	6/5/2003	5/3/2006	758
Bengalgram dal	Bhagalpur	6/5/2003	5/3/2006	705
Cowpea	Koppal	5/2/2003	12/28/2006	278
Cowpea	Gadag	5/2/2002	12/18/2006	639
Cowpea	Jhunjhunu	10/11/2003	12/30/2006	438
Cowpea	Lalitpur	12/20/2002	12/30/2006	525

Table 2: Sample statistics of commodity market prices, annualized geometric growth rates and volatilities

Commodity	Market	Mean	Variance	Standard deviation	Maximum	Minimum	Annual Geometric mean	Annualize volatility
Masur	Sahebganj	2478.13	45487.00	213.277	2850	2050	-0.016	0.243
Arhar	Sahebganj	3041.90	55345.22	235.256	3500	2400	0.0202	0.389
Greengram dal	Sahebganj	3959.47	270571.20	520.165	4800	3050	0.383	0.5108
Masur dal	Dhanbad	2475.66	25151.44	158.592	2800	2025	0.118	0.393
Tur dal	Dhanbad	2984.70	28293.08	168.205	3250	2550	0.032	0.395
Masur dal	Ranchi	2331.18	16002.00	126.499	2700	2000	-0.047	0.228
Tur dal	Ranchi	2801.87	21244.30	145.754	3200	2400	0.007	0.208
Bengalgram	Ranchi	1988.31	190790.09	436.795	3425	1550	0.116	0.315
Bengalgram dal	Ranchi	2523.37	411485.85	641.472	4225	1700	0.254	0.334
Masur dal	Jamshedpur	2206.17	28438.08	168.636	2700	1900	0.075	0.503
Arhar	Jamshedpur	2466.76	56790.19	238.307	2933	2100	0.076	0.359
Bengalgram dal	Jamshedpur	1989.12	29288.72	171.139	2350	1600	0.045	0.413
Bengalgram	Hazaribagh	2129.24	77224.93	277.894	3590	1700	0.219	0.754
Bengalgram dal	Hazaribagh	2268.84	84195.33	290.164	3410	1800	0.43	0.582
Masurdal	Bokaro	2588.63	32639.35	180.664	2930	2050	0.008	0.271

Masurdal	Chaibasa	2317.99	28782.04	169.653	2800	1900	0.083	0.267
Arhar	Chaibasa	2709.40	20796.33	144.209	3000	2400	0.054	0.236
Bengalgram	Chaibasa	2367.92	139407.29	373.373	3200	1900	0.401	0.448
Bengalgram dal	Chaibasa	2588.53	204723.11	452.463	4200	1950	0.238	0.368
Greengram dal	Chaibasa	3934.91	222739.94	471.953	4800	2700	0.401	0.625
Masurdal	Bhagalpur	2367.38	60957.14	246.895	2950	1900	0.152	0.178
Arhar	Bhagalpur	2944.95	45810.20	214.033	3450	2600	0.09	0.14
Bengalgram dal	Bhagalpur	2109.90	90186.42	300.311	3200	1750	0.126	0.373
Cowpea	Koppal	1400.05	121378.83	348.395	2260	700	0.488	1.149
Cowpea	Gadag	1488.81	131823.08	363.074	2450	601	0.14	1.91
Cowpea	Jhunjhunu	1309.70	169849.16	412.128	2100	809	0.455	0.387
Cowpea	Lalitpur	1084.70	17843.95	133.581	1530	840	0.058	0.315
Average							0.163	0.46

Summary of Results

Table 3 summarizes the actuarial interest rates that would be charged to the risk contingent operating loan and mortgage instruments. All pulse market combinations were found to be consistent with geometric Brownian motion by the scaled variance ratio test (Turvey 2007). At the money option premiums were calculated using a general equilibrium formula assuming market price of risk was zero. The base interest rate was assumed to be 12%. Interest rates charged by the instruments are proportional to the volatilities of the cash commodities. It can be seen from the table that for the commodities with higher volatilities the interest rate charged by the contingent credits are higher denoting higher compensation for the lender for taking extra risk. For example, Koppal cowpea has the highest volatility of 115% and the interest rates charged by an operating loan and mortgage are 34.61% and 18.64% which are much greater than the base interest rate of 12%. Therefore the risk premiums for the credit instruments are 22.61% and 6.64% respectively. Bhagalpur arhar has the lowest volatility (14%) and the interest rates charged by the credit instruments were 13.92% and 12.53% respectively with risk premiums of 1.92%, and 0.53%.

Table 3: Interest rates of the instruments with commodity market combinations

Sl no	Commodity	Market	Drift	Volatility	Put premium	1 Yr Operating loan loan=Rs.20,000	10 Yrs Mortgage loan=Rs.150,000
1	Masur	Sahebganj	-0.016	0.243	237.611	20.416	14.372
2	Arhar	Sahebganj	0.0202	0.389	402.181	23.6	15.298
3	Masur dal	Dhanbad	0.118	0.393	251.616	20.891	14.509
4	Tur dal	Dhanbad	0.032	0.395	409.121	23.417	15.245
5	Masur dal	Ranchi	-0.047	0.228	240.229	21.144	14.582
6	Tur dal	Ranchi	0.007	0.208	208.371	18.504	13.823
7	Bengalgram	Ranchi	0.116	0.315	215.432	18.544	13.834
8	Bengalgram dal	Ranchi	0.254	0.334	168.234	16.006	13.115
9	Arhar	Jamshedpur	0.076	0.359	289.969	21.018	14.547
10	Bengalgram dal	Jamshedpur	0.045	0.413	324.867	23.565	15.288
11	Bengalgram dal	Hazaribagh	0.43	0.582	305.473	19.645	14.152
12	Masurdal	Bokaro	0.008	0.271	271.706	20.429	14.375
13	Masurdal	Chaibasa	0.083	0.267	186.979	17.96	13.668

14	Arhar	Chaibasa	0.054	0.236	203.467	17.841	13.634
15	Bengalgram	Chaibasa	0.401	0.448	166.304	16.506	13.253
16	Bengalgram dal	Chaibasa	0.238	0.368	256.294	17.27	13.472
17	Greengram dal	Chaibasa	0.401	0.625	512.614	21.425	14.662
18	Masurdal	Bhagalpur	0.152	0.178	58.709	13.749	12.484
19	Arhar	Bhagalpur	0.09	0.14	75.458	13.921	12.532
20	Bengalgram dal	Bhagalpur	0.126	0.373	274.602	20.064	14.27
21	Cowpea	Koppal	0.488	1.149	646.579	34.613	18.642
22	Cowpea	Lalitpur	0.058	0.315	121.279	20.192	14.307

Conclusion

To investigate the applicability of price contingent credits as a means of mitigating business and financial risks for pulse farmers in India we provide an overview of local Indian wholesale markets for pulse commodity, how volatile is the daily commodity prices, how loan instruments can be designed contingent on the daily price variation to mitigate business and financial risk associated with agriculture and finally, we present a real life case of a farm household showing the operating loan instrument reducing the downside risk of the return from the farm investment.

The key findings are as follows. Objective (1) investigates historical pattern of price movements for pulses in India and finds that the wholesale cash prices of pulse commodities are highly volatile with average volatility being 46%. Objective (2) determines the range of interest rate that would be charged to risk contingent credits for Indian pulses and finds that interest rate charged to operating loans and mortgages and coupon rate to commodity bonds are higher than the interest rate charged by a normal loan and increase with the volatility of a commodity prices. It also finds that repayment obligations reduce with a fall in pulse prices. Objective (3) test the effectiveness of commodity credits on the livelihood of a representative household and finds that the distributions of the portfolio returns of the household have higher probability of a greater return and effectively reduces downside commodity price risks.

Implications of this research are as follows. Contingent credits can effectively reduce the downside commodity price risk, and as a result of our analyses we recommend the instruments as a means of mitigating price risks faced by Indian farmers. Although, the interest rates charged by the instruments are higher than that charged by a normal loan, the loan repayment obligations reduces with a fall in commodity price. For extremely volatile commodities, the interest rates charged by the instruments can be very high and could deter farmers from using the instruments. For those commodities, a government interest rate subsidy could be beneficial if the crops are socially or economically significant..

The innovative credit instruments, as this research suggests, can reduce the risk of return and credit risk and propel the rural credit market, nevertheless, it is also important to see how the communities and the local financial institutions respond to these kinds of risk management credit instruments. Therefore, incorporating their responses would help to decide on the strike prices and other criterion to design the instruments. Moreover, this paper deals only with commodity price risk, however, the other frontier issues like crop failure, weather and other hazards should be mitigated for the development of agriculture and rural credit market in developing economies. As a further scope of research, the model for the contingent claim debt instruments with the commodity market price series that are mean reverting in nature should be studied. Some adaptive models would be useful to design credit instruments for those kinds of markets. In addition to pulses, the price behavior of other commercial crops such as vegetables, cottons etc. needs to be studied in the context of managing business and financial risk.

References and Bibliography

Alan J. Marcus, and David M. Modest. (1986). The valuation of a random number of put options: An application to agricultural price supports. Journal of Financial and Quantitative Analysis, vol21, no1, March

Anderson, R.W., Gilbert, C.L., and Powell, A. (1989). Securitization and Commodity Contingency in International Lending. American Journal of Agricultural Economics, 71(1989): 523-30.

Armendariz, Beatriz and Morduch, Jonathan (2005). The Economics of Microfinance. The MIT Press.

Atta-Mensah, J. (2004). Commodity-linked bonds: A potential Means for Less-Developed Countries to Raise Foreign Capital. Bank of Canada Working Paper 2004-20, June 2004

Black, F. and M. Scholes (1973). The Pricing of Options and Corporate Liabilities. Journal of Political Economy 81:637-659

B. B. Mandelbrot. (1997) Fractals and Scaling in Finance. Springer

Buraschi, A. and Jackwerth, J. (2001). The price of a smile: Hedging and spinning in options markets. Review of Financial Studies 14(2) 495-527

Cox, J. C. and Ross, S. A. (1976). The valuation of option for alternative stochastic processes. Journal of Financial Economics 3: 145-66

Eduardo S. Schwartz. (1982). The pricing of commodity-linked bonds. Journal of Finance, 37, 525-539.Heath, D., Jarrow, R., & Morton, A. (1992). Bond pricing and the term structure of interest rates: A new methodology for contingent claims valuation. Econometrica, 60, 77-105.

Hull, J. C. (2006). Options, Futures, and Other Derivatives, Sixth Edition, Prentice-Hall

Jeromi, P. D. (2007). Farmers' Indebtedness and Suicides: Impact of Agricultural Trade Liberalization in Kerala. Economic and Political Weekly, vol. XL11, No. 31 pp.3241-3247.

Jin, Y., and Turvey, C.G. (2002). Hedging financial and business risks in agriculture with commodity-linked loans. Agricultural Finance Review, 62(1), 41-57.

J. E. Ingersoll. (1982). The pricing of commodity-linked bonds: Discussion. Journal of Finance, 37, 540-541.

Lo, A. W. and A. C. MacKinlay. (1999). A Non-Random Walk Down Wall Street. Princeton Press, Princeton, New Jersey

Longstaff, F. A. (1995). Option pricing and the Martingale restriction. Review of Financial Studies Vol 8 No-4: 1091-1124

Maureen O'Hara. (1984). Commodity bonds and consumption risks. Journal of Finance,39,193-206

Mishra, Srijit. (2007). Risk, Farmers' Suicides and Agrarian Crisis in India: Is There a Way Out? Indira Gandhi Institute od Development Research, Mumbai, WP-2007-014

Miura, R., and Yamauchi, H. (1998). The pricing formula for commodity-linked bonds with stochastic convenience yields and default risk. Asia-Pacific Financial Markets, 5, 129-158.

Mohanty, B.B. (2005). 'We are like the living dead': Farmer suicides in Maharastra, Western India. Journal of Peasant Studies, 32(2), 243-76

Myers, R. J. (1992). Incomplete markets and commodity-linked finance in developing countries. World Bank Research Observer, 79(12), 79-94.

Nerlove, Marc. (May, 1958). Adaptive Expectations and Cobweb Phenomena, Quarterly Journal of Economics, 72:227-240

Panos Varangis and Don Larson (1996). Dealing with Commodity Price Uncertainty. World Bank Policy Research Working Paper 1667.

Peter Carr. (1987). A note on the pricing of commodity-linked bonds. Journal of Finance, 42, 1071-1076.

Rajan, R. (1988). Pricing commodity bonds using binomial option pricing. The World Bank, Policy Research Working Paper Series: 136.

Robert J. Myers, & Stanley R. Thompson. (1989). Optimal portfolios of external debt in developing countries: The potential role of commodity-linked bonds. American Journal of Agricultural Economics, 71(2), 517-522.

Todd E. Petzel. (1989). Financial risk management needs of developing countries: Discussion. American Journal of Agricultural Economics, May, 1989.

Tomek, W. G. and Robinson K. L. Agricultural Product Prices. Second Edition, Cornell University Press,

Turvey, C. G. (2006). Managing Food Industry Business and Financial Risks with Commodity-Linked Credit Instruments. Agribusiness, Vol. 22(4) 523-545

Turvey, C.G., Komar Sridar (2006). Martingale Restrictions and the Implied Market Price of Risk. Canadian Journal of Agricultural Economics, 54 (2006) 379-399

Turvey, C. G. (2007). A note on scaled variance ratio estimation of the Hurst exponent with application to agricultural commodity prices. Physica A, 377 (2007) 155-165

Turvey, C. G., Stokes, J. (2007) Market Structure and the Value of Agricultural Contingent Claims. Forthcoming Canadian Journal of Agricultural Economics

Turvey, C. G., Chantarat, Sommarat (2006). Weather-Linked Bonds. Paper presented at NCIOIU annual meeting, Washington DC, October 2006

Marketing Research and Information Network (AGMARKNET), Ministry of Agriculture pulses database. http://agmarknet.nic.in/dirpulses.asp