Reducing Foreign-Exchange Exposure through REDUCIN (Reverse Dual-Currency Indexed-Note)

ABSTRACT
In this paper, we develop a new financial instrument, REDUCIN (Reverse Dual-Currency Indexed-Note), which is a combination of Reverse Dual Currency Note (RDCN) and Indexed Currency Option Note (ICON). Like a RDCN, the REDUCIN pays interest in one currency and the face-value in another. In addition, like an ICON, the face-value paid at maturity is linked to a spot exchange-rate at that point. We also highlight how to value – using desynthesis - a REDUCIN. We show how this instrument protects an exporter against a depreciation in the foreign-currency against her home-currency. We also develop a variation of REDUCIN and show how to desynthesize and value it.

KEYWORDS
Reverse Dual Currency Indexed Note (REDUCIN), Inverse-REDUCIN, Reverse Dual Currency Note, Indexed Currency Option Note (ICON), Financial Innovation, Synthetic Financial Instrument, Valuation through De-synthesis, Foreign-Exchange-Exposure Management

INTRODUCTION

In this paper, we talk about a new financial instrument developed by us. Named REDUCIN (Reverse Dual-Currency Indexed-Note), this instrument is a combination of Reverse Dual Currency Note (RDCN) and Indexed Currency Option Note (ICON). Like the former, REDUCIN pays interest in one currency and the principal in another; like the latter, the maturity-payment is linked to an exchange-rate (or, some other index) at maturity. We show how to desynthsize and value a REDUCIN issued by an exporter to investors in the importer's country where interest is paid in the exporter' currency and the face-value in importer's currency, with the amount of the latter linked to the maturity-date exchange-rate between the two currencies. We also explain how this instrument protects the exporter against a depreciation in the foreign currency with respect to the home currency. We extend our model by developing a variation of REDUCIN and also show how to desynthesize and value it. We also compare the attractiveness of these two instruments from the point of view of the exporter. Section-I describes exchange-rate exposure faced by importers and exporters and the ways they manage it. Section-II highlights the essential features of RDCN, ICON, and other related instruments and then goes on to characterize REDUCIN in detail and shows how this can be desynthesized into a combination of a debt instrument and an option. Section-III delineates the details of valuation of REDUCIN. Section-IV chalks out the characteristics of the variant of REDUCIN that we have developed and elucidates how to value it. Section-V concludes.

I: MANAGING EXCHANGE-RATE EXPOSURE

Exporters and importers face exchange-rate exposure and risk. An exporter gains when the foreign-currency appreciates vis-à-vis her home currency and loses when the opposite happens. To be precise, when the foreign-currency falls against the home-currency, the home-currency value of the export proceeds plummets. There are two broad approaches exporters can follow to manage this exposure risk: reactive and proactive. The *reactive* strategy basically leans upon deciding what fraction of the effect of a change in exchange-rate to pass-through to the customer (the importer). In the two limits, the exporter may pass-through the effect completely to the customer (Complete Pass Through) or price to market (PTM) by absorbing the total shock itself and passing through nothing (Gagnon and Knetter 1995, Gust, Leduc, and Vigfusson 2010, Huang and Brahmasrene, 2010, Knetter 1993). In the former case, the foreign-currency price of the export is increased to a level so that its home-currency value goes back to the earlier level; thus, the exporter's profit-margin per unit remains unchanged, though the price-elastic demand typically falls. In case of PTM, however, the exporter keeps the foreign-currency price of export unchanged, thus reducing her profit-margin; the demand in this case typically remains unchanged, as there has been no change in price. One of the newer concepts also talks about what we like to allude to as "price to quality" (PTQ), meaning that the exporter reduces the quality of export without increasing the price (Auer and Chaney 2009); this follows the works of Mussa and Rosen (1978), which, like the similar work of White (1977), built on Kevin Lancaster's path-breaking product-attributes-model (Lancaster 1971).

The *proactive* strategy involves taking an action in advance that reduces or eliminates the adverse effect of the exchange-rate change on the exporter. Diversification (selling different products or in different countries) is one way. Hedging (through forward, futures, option, or swap) is another. Optimal currency composition of debt, borrowing in home and foreign currencies in an appropriate proportion, is also an alternative (Berrospide 2008, Michaux 2011). A more tailor-made – possibly more complex – strategy is to make use of various modes of financial-engineering, whether through structured-products or some other types (Lyuu 2002, Neftci 2008). This research work falls in this last category: financial innovation. We have come up with a new instrument – and its variations too – that allows an exporter to counter the adverse effect of depreciation in the foreign-currency against its home-currency by issuing an instrument called Reducin (Reverse Dual-Currency Indexed-Note). There is a variation of RDCN called the Power-RDCN (Sippel and Ohkoshi, 2002), but it is very complex and, as is evident from the happenings in the Japanese capital market (Jeffrey 2003), is designed more for investment and speculative purposes than for hedging.

II: FEATURES OF REDUCIN

Throughout the article, the exporting country would refer to the same, though unspecified, country, and its currency would be called the home currency (HC hereafter). Similarly would be the case for the importing country, whose currency would be called the foreign-currency (FC hereafter). R_d would represent the interest-rate on domestic or home-currency; it would be the stated rate (in the format of the APR, annual percentage rate) per period, continuously compounded, and the period may or may not be a year. Similarly, R_f would represent the stated interest-rate on foreign-currency. The exchange-rate S (whether S_0, S_T, or S_t) would be the direct (or American) quote, HC per FC. FV would denote the face-value in HC, while FV' would be the face-value in FC. For consistency, we would take FV = FV' x S_0, where 0 denotes the date of issue and, therefore, S_0 is the spot-exchange-rate on the issue date.

In our numerical examples, we would take USA as the exporting country and Eurozone as the importing area. Correspondingly, US$ (denoted as $) would be the home-currency and euro (symbolized as €) would be the foreign-currency. Thus, S would be in $ per €.

Before we describe the features of Reducin, it would be useful to describe some other instruments that we would liken it to or that would indirectly help our analysis. Simplest among them is the pure HC Note, where both interest and face-value (what is also called the par-value or maturity-value) are paid in the home-currency of the issuer.

Pure Home-Currency (HC) Note

Let us now characterize a (pure) HC Note. Because of continuing compounding, the interest payment would be FV x $(e^{Rd} - 1)$ every period, as shown below, where R_d is the per-period stated rate. So, the cash flows would look as follows.

From the end of first period (t=1) till maturity (t=T) in HC: FV x $(e^{Rd} - 1)$

At maturity (face value), in HC: FV

Discounted at a per-period stated-rate of R_d, continuously compounded, the PV (present value) of the cash flows would be equal to FV as shown below.

$$FV \times (e^{Rd} - 1)\, e^{-Rd \times 1} + FV \times (e^{Rd} - 1)\, e^{-Rd \times 2} + \ldots FV \times (e^{Rd} - 1)\, e^{-Rd \times T} + FV\, e^{-Rd \times T} = FV$$

The cash outflow of the issuer would be exactly the opposite, ignoring flotation costs and all that.

Reverse Dual Currency Note (RDCN)

A dual currency note or bond (RDCN or RDCB) gives interest in one currency and the face-value in another. To make a clear distinction, some use the term "reverse" dual-currency-note (RDCN) to denote an instrument that pays interest in the issuer's currency and the face-value in the investor's; we would do the same. Here, the cash flows to the investor look as follows.

From the end of first period (t=1) till maturity (t=T) in HC: $FV \times (e^{Rd} - 1)$

At maturity (face value), in FC (the importer's currency): FV'

Here, FV' is the note's actual face-value (in FC), whereas FV is a notional face-value (in HC) on which the interest-payment (also in HC) is based. To value this, we would need both R_f and R_d. The PV (in HC) then can be expressed as follows:

$$FV \times (e^{Rd} - 1)\, e^{-Rd \times 1} + FV \times (e^{Rd} - 1)\, e^{-Rd \times 2} + \ldots FV \times (e^{Rd} - 1)\, e^{-Rd \times T} + (FV'\, e^{-Rf \times T}) \times S_0.$$

This PV would *not* equal FV or FV'. The PV in FC can be obtained by dividing this value by S_0.

Indexed Currency Option Note (ICON)

An ICON, developed by bankers Trust in 1985, is somewhat like a pure HC-Note, but links its interest, FV, or both to an exchange-rate. We would consider the one that links only its FV to an exchange-rate. Typically, it sets a ceiling and a floor. If the actual exchange-rate at maturity is above the ceiling, it pays nothing, whereas, if it is below floor, it pays 100% of the FV. If the exchange-rate lies between the two limits, it pays a proportion of FV defined according to a pre-set rule. Thus, the cash-flows to the investor are as follows.

From the end of first period (t=1) till maturity (t=T) in HC: FV x $(e^{Rd} – 1)$

At maturity (face value), in HC: *As follows (the manager sets an M):*

$$\begin{cases} S_T < S_0: FV \\ S_T > MS_0: 0 \end{cases}$$

$S_0 < S_T < MS_0$: FV $(MS_0 - S_T)/(MS_0 - S_0)$

Reverse Dual-Currency Indexed-Note (REDUCIN)

Our innovative instrument, Reverse Dual-Currency Indexed-Note (Reducin), is a combination of RDCN and ICON. It pays interest in one currency and the face-value in another and links the maturity payment to an exchange-rate (or another index). We design that – as in the case of RDCN - the interest would be in the issuer's currency (usually HC) and the face-value in the investors' (usually FC). Though the stated face-value is in FC, the notional face-value, the one which is used in computing the annual interest-payment, is in HC. Anyway, how much actually is paid at maturity depends on the maturity-date exchange-rate, S_T. This dependence may be modeled in a plethora of ways. We choose a very simple form for the maturity payment: max{FV', FV' x (S_0/S_T)}. The cash-flows to the Reducin investor would then look something like the following.

From the end of first period (t=1) till maturity (t=T) in HC: FV x $(e^{Rd} – 1)$

At maturity (a multiple of the stated face value), in FC: max{FV', FV' (S_0 / S_T)}

III: VALUING A REDUCIN

As we see above, the Reducin investor receives more than FV' if $S_T < S_0$. As the maturity-payment is FV' or more, there is a built-in option for the holder, which investors would find attractive and willing to pay a premium for. As we would show now, the investor here has a long position in an RDCN plus a long position in a foreign-exchange (FX hereafter) put, while the issuer has a short position in a HC-Note and a short position in a FX Call.

Investor Perspective

Reducin's maturity-payment can be broken-down (de-synthesized) as follows: max{FV', FV'(S_0/S_T)} = FV' + max [0, FV' {(S_0 - S_T) / S_T)}]. That can be re-stated more clearly as FV' + FV' max [0, {(S_0 - S_T) / S_T)}]. Thus, we can now restate the cash-flows to Reducin holder as follows.

From the end of first period (t=1) till maturity (t=T) in HC:	FV x (e^{Rd} – 1)
At maturity (face value):	FV'
	+
	FV' max [0, {(S_0 - S_T) / S_T)}]

The first two lines combine to form exactly an RDCN, while the part after the "+" sign resembles FV' times the payoff from a European put-like option (with an exercise-price of S_0). Thus, as we had claimed earlier, Reducin is a combination of an RDCN and a put-like option. In fact, if we convert the option's FC cash-flow into HC by multiplying it by S_T, we would get FV' max {0, {(S_0 - S_T), which is precisely FV' times the HC payoff from a European FX Put. So, if we divide this HC value of this put by S_0, we would get the FC value of the put to the US investor.

Issuer Perspective

An exporter loses when FC falls against HC (that is, when S_t falls or, put another way, $S_T < S_0$). So, she would like to pay less when $S_T < S_0$ and more when $S_T > S_0$. But, she would be willing to issue this instrument. The trick: what matters to the exporter is the HC outflow, not the FC outflow. Though the FC payment to the investor (at maturity) is higher when $S_T < S_0$, the HC-payment is fixed. To see this, let us compute the HC cash out-flow of the issuer towards face-value payment at maturity by multiplying the FC-payment by the spot exchange-rate at that point, which would be S_T. Thus, the issuer's maturity-payment becomes FV' S_T if $S_T > S_0$ and FV' S_0 if $S_T < S_0$. Here, FV' S_0 is a fixed amount, whereas FV' S_T is greater than FV' S_0. So, as desired, the exporter's HC outflows are less when $S_T < S_0$.

Now, we can restate the HC maturity-payment by the issuer as follows: max (FV' S_0, FV' S_T). That can be desynthesized as follows: FV' S_0 + max {0, FV' (S_T - S_0)}. That may also be rewritten as FV' S_0 + FV' max {0, (S_T - S_0)}. Since FV' S_0 = FV, the issuer's HC cash outflows from a Reducin would be as follows.

From the end of first period (t=1) till maturity (t=T):	FV x (e^{Rd} – 1)
At maturity (face value):	FV
	+
	FV' max {0, (S_T - S_0)}

The first two lines (the part preceding the "+" sign) combine to exactly form the cash flows from a pure HC-Note, while the part after the "+" sign is FV' times the payoff from a European FX

Call. Since these are outflows for the issuer, from her perspective, the Reducin is like a short position in a HC-Note and a short position in a FX Call.

The Two Sides

Juxtaposing the two above perspectives we see that, if we express the Reducin value from both perspectives in HC, the following equality would emerge, which we would also numerically prove later: Value of Reducin = Value of RDCN + (FV' x Value of FX Put) = Value of HC Note + (FV' x Value of FX Call).

Hedging with Reducin

As we saw above, if $S_T < S_0$, then the HC maturity-payment of the issuer – say, the exporter – is fixed at FV' S_0, which equals FV. If, however, $S_T > S_0$, then the HC maturity-payment increases to FV' S_T. So, if the exporter is worried that FC may depreciate against HC – which hurts him – he would like to issue Reducin. If the investors are also expecting that FC would depreciate, they would like the embedded put option that the Reducin contains and would be willing to pay a premium for it, which the exporter would like. If S_T actually turns out to be lower than S_0, the exporter pays the fixed, known amount of FV towards maturity-payment; the premium then partially or fully offsets the reduction in the DC-value of the export proceeds due to the fallen FC. If, on the other hand, S_T actually turns out to be higher than S_0, the exporter's HC maturity-payment becomes higher than FV; but the increase is offset by the increase in the DC-value of the export proceeds due to the appreciated FC.

Numerical Example:

We would take the values of the different variables as follows. The HC and FC interest-rates and the spot exchange-rate are taken quite close to their actual levels for three-year treasuries around early March 2011. The choice of T was arbitrary, while the choice of FV and corresponding FV' does not matter much anyway.

$R_d = 1.00\%$

$R_f = 2.50\%$

$S_0 = 1.25$

FV = \$1,000

FV' = €800 (= 1,000 / 1.25)

T = 3

The cash-flows from the pure HC-Note would then look as follows.

From the end of first period (t=1) till maturity (t=3) in \$: \$10

At maturity (face value), in \$: \$1,000

Discounted under continuous compounding at an APR of 1.00%, it gives a PV of \$1,000, as shown below; this should also be its price.

$10\ e^{-1\% \times 1} + 10\ e^{-1\% \times 2} + 10\ e^{-1\% \times 3} + 1{,}000\ e^{-1\% \times 3} = 1{,}000$

The cash-flows from an RDCN would be as follows.

From the end of first period (t=1) till maturity (t=3) in \$: \$10

At maturity (face value), in €: €800

The PV (in \$) of the RDCN can be shown to be \$957 as follows. (Its € PV would be €1,197.)

$10\ e^{-1\%\ x\ 1} + 10\ e^{-1\%\ x\ 2} + 10\ e^{-1\%\ x\ 3} + (800\ e^{-2.5\%\ x\ 3}\ x\ 1.25) = 957$

As one may notice, at this initial stage, we are not adding any risk-premium (RP) to the discount-rate for discounting cash-flows in a foreign currency. We would later incorporate the RP.

Cash-flows from an ICON issued by a US exporter to US investors – all payments being in $ - would look as follows.

From the end of first period (t=1) till maturity (t=T) in HC: $10

At maturity (face value), in HC: *As follows (the manager sets an M):*

$$\begin{cases} S_T < S_0: \$1{,}000 \\ S_T > MS_0: 0 \end{cases}$$

$S_0 < S_T < MS_0$: $1{,}000\ (MS_0 - S_T)/(MS_0 - S_0)$

If M is chosen to be 1.60 (and S_0 is given to be 1.25), we obtain that the note gives $1,000 x (2.00 - S_T) / 0.75 when the maturity-date exchange-rate is within 1.25 and 2.00. So, if S_T becomes 1.20, full $1,000 is paid as maturity-value, whereas, if it becomes 2.01, nothing is paid. If, however, S_T becomes 1.55 (which is within the range), the ICON pays $600 and, if 1.70, then, $400.

Cash-flows from a Reducin would be as follows.

From the end of first period (t=1) till maturity (t=3) in $: $10

At maturity (face value), in €: max {€800, €800 (S_0 / S_T)}

As we have already seen earlier, from the investor perspective, this Reducin would be equal to a long position in an RDCN and a long position in the FX Put, while, from the issuer perspective, it would be equivalent to a short position in a pure HC-Note and a short position in a FX Call. Let us compare their values in the same currency, say, $.

We have already derived the value of the pure HC-Note to be $1,000 and the value the RDCN to be $957. That leaves us with the task of valuing the FX Call and the FX Put at an exercise price (denoted as X) equal to S_0, thus implying that X = 1.25. For this, we need the volatility (we would denote it as σ).

We collected weekly $/€ exchange rate from http://www.oanda.com/currency/historical-rates/ for the last five years, from 19 March 2006 to 20 March 2011. Using the 262 data-points obtained, we computed the annual standard-deviation, σ, following the standard methodology that uses log-price-relatives, as shown below (Hull 2011). Here, S_t is the exchange-rate on week t, T is the total number of data-points we have, and N 52 (number of weeks per year).

$$\sigma = \sqrt{\left\langle \left[\frac{\sum_{t=2}^{t=T} \left\{ \ln\left(\frac{S_t}{S_{t-1}} \right) \right\}^2}{(T-2)} \right] - \left[\frac{\left\{ \sum_{t=2}^{t=T} \ln\left(\frac{S_t}{S_{t-1}} \right) \right\}^2}{(T-1)(T-2)} \right] \right\rangle N}$$

That yielded a σ of 8.70%. To verify this, we plan to obtain volatility figures from daily data and also through other methods like GARCH and the average implied-volatility from foreign-exchange options. Anyway, in this case, any set of numbers would yield the same result, as we have closed-form valuation models without any need for numerical analysis.

Using Black-Scholes model with σ = 8.70%, along with other data given above, we obtained the values of the above-cited FX Call and FX Put (per €) to be, respectively, $0.048 and $0.101. The $ values of Reducin from the investor and issuer perspective can now be computed as shown below and, as desired, they match.

Investor: Value of RDCN + (800 x Value of FX Put) = $957 + $81 = $1,038

Issuer: Value of HC-Note + (800 x Value of FX Call) = $1,000 + $38 = $1,038.

IV: FEATURES AND VALUATION OF A VARIATION OF REDUCIN

Typically, many indexed instruments give the investor a call option on the index. It is true of, say, SPIN (S&P Indexed Note), whose valuation has been dealt with in detail by Chen and Sears (1990), wherein the investor received an excess over the stated face-value of the S&P 500 index at maturity exceeded its level at the time of issue. Similarly, the payoff from a Power-RDCN, which has been discussed above, is higher if the exchange-rate appreciates in favor of the investor. In keeping with this trend, we came up with a variation of Reducin where the maturity-payment is max{FV', FV' x (S_T/S_0)}. Since this is the opposite of Reducin – paying the investor FV' when $S_T < S_0$ and more when $S_T > S_0$, we call it Inverse-Reducin or, in short, IREDUCIN (Ireducin hereafter). As before, let us analyze this instrument from both the investor and the issuer perspectives.

Investor Perspective

Ireducin's maturity-payment can be broken-down (de-synthesized) as follows: max{FV', FV'(S_T/S_0)} = FV' + max [0, FV' {($S_T - S_0$) / S_0)}]. That can be re-stated more clearly as FV' +

(FV' / S_0) max $\{0, (S_T – S_0)\}$. Thus, we can now restate the cash-flows to Ireducin holder as follows.

From the end of first period (t=1) till maturity (t=T) in HC: FV x $(e^{Rd} – 1)$

At maturity (face value): FV'

+

(FV' / S_0) max $\{0, (S_T – S_0)\}$

The first two lines combine to form exactly an RDCN, while the part after the "+" sign resembles (FV' / S_0) times the payoff from a European call option (with an exercise-price of S_0). Thus, like Reducin, Ireducin is also a combination of an RDCN and a FX option, except that the FX option here is the call option. Moreover, since this option's cash-flows are in FC terms, it should be multiplied by S_0 to get its HC value, thus becoming FV' max $\{0, (S_T – S_0)\}$.

Issuer Perspective

Let us compute the HC cash out-flow of the issuer towards face-value payment at maturity by multiplying the FC-payment by S_T. This yields max$\{$ FV' S_T, FV' $(S_T)^2/S_0\}$. Thus, the Ireducin issuer pays FV' S_T if $S_T < S_0$ and FV' $(S_T)^2/S_0$ if $S_T > S_0$. Here, FV' $S_T <$ FV' S_0 and FV' $(S_T)^2/S_0 >$ FV' S_0 . So, again, as desired, the exporter's HC outflows are less when $S_T < S_0$ and more when $S_T > S_0$.

Now, with a little juggling around, we can restate the HC maturity-payment by the issuer as follows: FV' S_0 – FV' max $\{0, (S_0 – S_T)\}$ + FV' max$\{0, (S_T^2 - S_0^2) / S_0\}$. Since FV' S_0 = FV, the issuer's HC cash outflows from a Ireducin would be as follows.

From the end of first period (t=1) till maturity (t=T): FV x $(e^{Rd} – 1)$

At maturity (face value): FV

+

FV' $\max\{0, (S_T^2 - S_0^2) / S_0\}$

-

FV' $\max\{0, (S_0 – S_T)$.

The first two lines (the part preceding the "+" sign) combine to exactly form the cash flows from a pure HC-Note, while the part after the "+" sign is FV' times the payoff from a European FX Call-like option and the next part after the "-" sign is FV' times the payoff exactly from a FX Put. Since these are outflows for the issuer, from his perspective, the Ireducin is like a short position in a HC-Note plus a short position in a FX Call-like option minus a long position in the FX Put. Thus, neither from the issuer's perspective nor from the investor's is the Ireducin as simple to value as Reducin, which, at least from the issuer's perspective, is simply a combination of a pure HC note and a pure FX Call option.

Numerical Analysis

We already have given the values of RDCN and the relevant FX Call. Using them, we get the HC value of Ireducin from the investor's perspective as equal to \$957 + \$38 = \$995. Using the same set of numbers again, we get that, from the issuer's perspective, the value of the pure HC Note is \$1,000 and the value of the FX Put is \$81. We also have to have the following equality satisfied by the HC values:

Value of RDCN + Value of FX Call = Value of HC Note – Value of FX Put + Value of FX Call-Like option => \$957 + \$38 = \$1,000 - \$81 + Value of FX Call-Like Option.

This yields the value of the FX Call-Like Option to be (\$957 + \$38) – (\$1,000 - \$81) = \$76.

The call-like FX option here is not easy to value and we have to resort to Binomial Tree Approach and Monte Carlo Simulation for that. Before we proceed, however, we require an estimate of volatility. We already have an estimate from the historical weekly data. Further, as we stated earlier, we plan to estimate volatility also using other approaches, as it would be an important number for the numerical analysis. For the time being, however, we would continue to use the 8.70% figure obtained earlier. It is comforting to note here that Boyle and Turnbull (1989) argue that "for plausible parameter values, the value of a capped option is relatively insensitive to the value of the volatility parameter".

For Binomial Tree Approach, we decided to take step-sizes of 0.75 year, so that we would have four (3.0 / 0.75) steps for the tree-year options, ending up with 16 (2^4) steps at the maturity. We require u, d, and p. Given step-size (Δt) of 0.75 year and σ = 8.70%, we obtain that $u = e^{s\sqrt{\Delta t}} = e^{8.70\%\sqrt{0.75}} = 1.0783$ and $d = e^{-s\sqrt{\Delta t}} = e^{-8.70\%\sqrt{0.75}} = 0.9274$. Moreover, also given that R_d = 1.00% and R_f = 2.50%, we get that

$$p = \frac{e^{(R_d - R_f)\Delta t} - d}{u - d} = \frac{e^{(1.00\% - 2.50\%)\,0.75} - 0.9274}{1.0783 - 0.9274} = 0.3928.$$

That gives rise to the following binomial-tree (Figure 1). The bold value following every number gives us the value of the option at that node. Since this is a European option, the last column (T=3) is the only one where the investor can exercise the option. So, at each of the previous dates (0, 1, and 2), the bold italic value gives the present-value of the cash-flows from the option at the next period. Working backwards, we get the value of the call-like option to be \$0.0958. Multiplied by FV’ of 800, it yields a total value of the call-like option to be \$76.64, which is very close to its theoretical value. Of course, we plan to do sensitivity analysis to find out how well the binomial-tree approach does when the parameters are varied.

Figure-1

t=0	t=0.75y	t=1.50y	t=2.25y	t=3.00y
				1.6896
				1.0339
			1.5670	1.4533
		1.4533	*0.6764*	0.4396
		0.3778	1.3478	1.4533
			0.1776	0.4396
				1.2500
				0.0000
	1.3478			
	0.1948			1.4533
				0.4396
			1.3478	1.2500
		1.2500	*0.1776*	0.0000
		0.0717	1.1593	1.2500
1.2500			*0.0000*	0.0000
				1.0751
				0.0000
				1.4533
				0.4396
			1.3478	1.2500
0.0958		1.2500	*0.1776*	0.0000
		0.0717	1.1593	1.2500
			0.0000	0.0000
				1.0751
				0.0000
	1.1593			
	0.0290			1.2500
				0.0000
			1.1593	1.0751
		1.0751	*0.0000*	0.0000
		0.0000	0.9971	1.0751
			0.0000	0.0000
				0.9247
				0.0000

For the Monte Carlo approach also, we took step-sizes of 0.75 year. We started with the given S_0 of 1.25 and generated random S_1, S_2, S_3, and S_4 using the following diffusion process describing the change in the exchange-rate (ΔS) from its level S at any point of time within an interval of Δt (which is taken to be 0.75, as stated earlier).

$$\Delta S_{t,\, t+\Delta t} = \mu\, S_t\, \Delta t + \sigma\, S_t \sqrt{\Delta t}\ \varepsilon$$

Here, μ is equal to R_d - R_f = -1.50%, σ = 8.70%, and ε is a randomly generated number that has standard-normal distribution. We generate four consecutive ΔS and compute the four St as follows: $S_{0.75} = S_0 + \Delta S$, $S_{1.50} = S_1 + \Delta S$, $S_{2.25} = S_{1.50} + \Delta S$, $S_3 = S_{2.25} + \Delta S$.

Then we get the value of the option as follows:

$$FV' \max\left[0, \left(\frac{S_T^2 - S_0^2}{S_0}\right)\right] = 800 \max\left[0, \left(\frac{S_3^2 - 1.25^2}{1.25}\right)\right]$$

We repeat this process 100 times and check the average value of the FX call-like option. Numerous iterations give a value hovering between \$70 and \$80. But, as in the case of the binomial-tree approach, sensitivity of the Monte Carlo approach to the parameter-values is a task that remains to be done. Besides, it would be nice to bring in more complex, but appropriate, modeling of the exchange-rate process as has been suggested by many authors (Doffou and Hillard 2001, Ingersoll 1997).

V: CONCLUSION

In this paper we develop a new instrument, Reducin (Reverse Dual Currency Note), which is like a combination of a Indexed Currency Option Note (ICON) and Reverse Dual Currency Note (RDCN). We show that the Reducin can have a clear-cut value as the sum of the value of a single-currency debt and a foreign-exchange put option which should also equal the value of the more esoteric RDCN and a foreign-exchange call option. We also show how the exporter can use Reducin to hedge proactively against depreciation in the foreign-currency, which indeed hurts her. We also develop an alternative to Reducin, called Inverse-Reducin or Ireducin, but show that it is not as simple to value as the Reducin is.

REFERNCES

Auer, Raphael and Chaney, Thomas (2009): "Exchange Rate Pass-Through in a Competitive Model of Pricing-to-Market", *Journal of Money, Credit and Banking*, Vol. 41: 1 (Supplement: February 2009), 151-175.

Berrospide, Jose M (2008): "Exchange Rates, Optimal Debt Composition, and Hedging in Small Open Economies", *FEDS Working Paper* No 2008-18, Available at SSRN: http://ssrn.com/abstract=1327145.

Boyle, Phelim P and Turnbull, Stuart M (1989): "Pricing and Hedging Capped Options", *Journal of Futures Market*, Vol: 9(1), 41-54.

Chen, KC and Sears, R Stephen (1990): "Pricing the SPIN", *Financial Management*, Vol: 19(2), 36-47.

Click, Reid W and Coval, Joshua D (2002): *The Theory and Practice of International Financial Management*, Prentice hall: USA.

Doffou, Ako and Hilliard, Jimmy E (2001): "Pricing Currency Options Under Stochastic Interest Rates And Jump-Diffusion Processes", *Journal of Financial Research*, Vol: 24(4), 565-585.

Gagnon, Joseph E and Knetter, Michael M (1995): "Markup Adjustment and Exchange Rate Fluctuations: Evidence from Panel Data on Automobile Exports", *Journal of International Money and Finance*, Vol: 14(2), 289-310.

Gust, Christopher, Leduc, Sylvain, and Vigfusson, Robert (2010): "Trade Integration, Competition, and the Decline in Exchange-Rate Pass-Through", *Journal of Monetary Economics*, Vol: 57, 309-324.

Huang, Jui-Chi and Brahmasrene, Tantatape (2010): "Hedging On U.S. Export Pricing: An Exchange Rate Pass-Through Analysis", *International Journal of Economics and Finance*, Vol: 2(3), 134-142.

Hull, John C (2011): *Options, Futures, and Other Derivatives*, Pearson Education: USA

Ingersoll, Jonathan E, Jr (1997): "Valuing Foreign Exchange Rate Derivatives with a Bounded Exchange Process", *Review of Derivatives Research*, Vol: 1, 159–181.

Jeffery, Christopher (2003): “The Problem with Power-Reverse Duals”, *Risk Magazine*, Vol: 16(10), 20-22.

Knetter, Michael M (1993): “International Comparisons of Pricing-to-Market Behavior”, *American Economic Review*, Vol: 83(3), 473-486.

Lancaster, Kevin (1971): *Consumer Demand: A New Approach*, Columbia University Press: USA.

Lyuu, Yuh-Dauh (2002): *Financial Engineering and Computation: Principles, Mathematics, and Algorithms*, Cambridge University Press: USA.

Marshall, JF and Bansal, V (1992): *Financial Engineering: A Complete Guide to Financial Innovation*, New York Institute of Finance: New York, USA.

Michaux, Michael (2010): “Pass-Through, Exposure, and the Currency Composition of Debt”, Presented at *American Finance Association Meetings* at Denver, USA in 2011, Available at SSRN: http://ssrn.com/abstract=1509779.

Mussa, Michael and Rosen, Sherwin (1978): “Monopoly and Product Quality”, *Journal of Economic Theory*, Vol: 18, 301–317.

Neftci, Salih N (2008): *Principles of Financial Engineering*, Academic Press: USA.

Sippel, Jason and Ohkoshi, Shoichi (2002): “All Power to the PRDC Notes”, *Risk Magazine*, Vol: 15(11), S31-S33.

White, Lawrence (1977): “Market Structure and Product Varieties”, *American Economic Review*, Vol: 67(2), 179-182.