E c o n o m i c s B u l l e t i n

A primer on the empirics of original sin

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Abstract

The empirical literature on "original sin" could be misleading. Eichengreen and Hausmann (1999) defined "original sin" as a liability dollarization bias and as a short term maturity bias. This is a source of concern for all emerging borrowers. However, the existing estimators of "original sin" only account for the dollarization bias and ignore the maturity bias. In this paper, we provide a new estimator, accounting for the two accepts of "original sin".

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1. Introduction

It seems obvious that many countries suffer from an inability to borrow long term or in their own currency, even domestically. This is one explanation of the tremendous problem of asset substitution, which is called Financial Dollarization. Here, the nature of the problem is more underdevelopment than time inconsistency. Indeed, this is a constraint rather than a choice. However, the reason why some countries are less financially developed than others is clearly puzzling. So Eichengreen and Hausmann (1999) called this inability "Original Sin".

Original Sin is one of the most famous concepts of the theory of emerging market financing. According to Eichengreen and Hausmann (1999):

> *"This is a situation in which the domestic currency cannot be used to borrow abroad or to borrow long term, even domestically. In the presence of this incompleteness, financial fragility is unavoidable because all domestic investments will have either a currency mismatch (projects that generate pesos[1] will be financed with dollars[2]) or a maturity mismatch (long-term projects will be financed with short-term loans)."*

In the light of this theory, currency and maturity mismatches are two sides of the same coin. Since a firm or a sovereign cannot use its own currency to borrow, except in the short term, if its assets are in domestic currency (and/or long term), the extent of the mismatches will be destabilizing.

To understand the scope of the problem, it is important to have good indicators of the original sin. Even if the definition of original sin accounts for two problems, debt dollarization and short term maturity, the empirical literature on original sin is focused only on the measurement of debt dollarization.

The paper will be organized as follows. Section two describes an alternative indicator of original sin, accounting for dollarization and for short term maturity. An important problem is that the consequences of original sin are often underestimated. In the literature the authors usually express the original sin as an aggregate measure. In section three, we will present a sectoral decomposition and discuss the concept of systemic sin.

2. How to Measure It?

We owe the first attempt to measure the original sin to Eichengreen, Hausmann and Panizza (2005). They made the hypothesis that the original sin may be decomposed in two parts. The first part, debt dollarization, is only on external debt. On domestic debt, the emerging borrowers face only a problem of short termism. Their indicators only account for what the authors called international original sin (i.e. the dollarization problem)[3].

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[1] Hereafter, we will use "peso" instead of domestic currency.
[2] Hereafter, we will use "dollar" instead of foreign currency.
[3] In a separate work, Eichengreen, Hausmann and Panizza (2005) constructed indicators of the domestic original sin. Their measure accounts for the share of short term (or indexed) liabilities on total liabilities on the domestic market. The problem here is that this indicator introduces a threshold effect because in order to measure it, the authors need to define what is short term and what is long term.

Eichengreen, Hausmann and Panizza [hereafter EHP] constructed three estimators. We will present here only two of their measures. They call the first one *OSIN1*, and the second one *OSIN3*:

$$OSIN1_i = 1 - \frac{Securities\ issued\ by\ country\ i\ in\ currency\ i}{Securities\ issued\ by\ country\ i} \quad [1]$$

$$OSIN3_i = Max\left(1 - Index\,,\,0\right) \quad [2]$$

$$\text{with } Index = \frac{Securities\ in\ currency\ i}{Securities\ issued\ by\ country\ i} \quad [3]$$

When the value of *OSIN1* or *OSIN3* approaches unity, we can say that the country suffers from a high original sin. More precisely, when we analyze *OSIN1* we can see that when a country cannot use its own currency to borrow, the ratio will be near 0, and so the indicator will be near 1. However, if a foreign country (or a foreign firm) borrows in the currency of this country, domestic firms (or sovereign) will be able to swap their liabilities with the foreign borrowers.

OSIN3 accounts for this possibility. According to EHP, *OSIN3* is better, because "*by capturing the possibility of hedging exchange rate risk, it provides an aggregate measure of currency mismatch*". When a country can fully hedge its position, which is denominated in foreign currencies, it will keep away from the original sin. It is the case when $Index \geq 1$. This is not the situation of emerging countries. For these economies, there are no sufficient possibilities to hedge, and the original sin is highly significant. Finally, when *Index* is very low, *OSIN3* and *OSIN1* report the same values.

Based on the Bank for International Settlements statistics, EHP (2005) calculated the values of these two indicators of original sin for approximately ninety countries. The main financial centers and the Euro zone (since 1999) do not have any original sin. However, if some other developed countries face statistically significant values of original sin, the majority of the developing countries suffer from very high (near to one) values. This is the case of many countries of the Western Hemisphere, Africa and Asia. In comparison, transition economies exhibit relatively smaller values of original sin[4].

Even if these indicators allow the estimation of the original sin for each country and at all times, they suffer from some shortcomings. Firstly, by construction, we have: $OSIN3 \leq OSIN1$. For some countries, the results could be very sensitive to the choice of the estimator. Secondly, the indicators of EHP measure only the share of dollarized liabilities for a particular country, thus neglecting the effect of the original sin on the maturity of loans.

A good indicator should take into account the two aspects of original sin, dollar contracts instead of "pesos" contracts and short duration contracts instead of long duration contracts. There are, in the literature, separate indicators for dollarization ratios and short term maturity. It seems important to construct an aggregate measure to better estimate the original sin. There are interactions between the two aspects of this phenomenon. A "good" estimator has to display the existing statistical interdependence. As we can see in the definition, the original sin is a situation

[4] For more details, see EHP (2005).

of full financial dollarization, of zero dollarization but short duration, or of intermediate levels of dollarization and duration. For the *sinners*, there is a continuum of situations. They can choose to borrow long term, but fully in dollars. They can also choose to borrow in "pesos", but fully short term. Finally, between these two polar cases, they can choose to denominate a part of their debt in "pesos" (short term) and the rest in dollars (longer term).

To build a good indicator of original sin, we have to aggregate two measures. The first one, the dollarization ratio, could be one of the ratios of EHP. The second one must have the property to measure the short duration bias without threshold effects. Firstly, to estimate the extent of the bias for a particular country, we propose a relative measure of average maturity of debt:

$$\overline{M} = \frac{\sum_{\gamma} \rho_{\gamma}\, \gamma}{\sum_{\gamma} \rho_{\gamma}} \qquad [4]$$

where $\overline{M}$ is the average maturity of debt for the country ; ρ_{γ} is the amount of debt issued with a time to maturity equal to γ ; γ stands for the various time to maturity values for which debts were issued[5].

In order to compare the values for a sample of countries, we have to normalize the average maturities between zero and one. Then, we obtain the indicator $\underline{\overline{M}}$. For the country with the highest maturity, we set the value of $\underline{\overline{M}}$ to one. For the other countries, the estimator will exhibit values in the interval $]0,1]$. Now, we can propose a measure for the maturity bias component of the original sin:

$$OSIN_M = 1 - \underline{\overline{M}} \qquad [5]$$

The aggregate original sin ($OSIN_{mc}$) is a function of the dollarization bias $OSIN_C$, measured for example by $OSIN3$, and of the maturity bias $OSIN_M$. Then, we have:

$$OSIN_{mc} = f\,(OSIN_C\ , OSIN_M) \qquad [6]$$

From this general form of our function, we can make some assumptions. We think it is consistent to suppose that the aggregate original sin is approximately equal to one, when one of the two components is equal to unity, even if the other component is very small but not equal to zero. The function below is consistent with this assumption[6]:

$$OSIN_{mc} = OSIN_C^{\,(1-OSIN_M)} \qquad [7]$$

The properties of this indicator are described in the appendix table and figures. When there is no maturity bias (i.e. $OSIN_M$ =0), the aggregate original sin is equal to the same value as the currency component of the original sin. When the maturity bias is positive, the aggregate original

[5] In a time series framework, it is important to see that, for a particular bond, γ will decrease with the time.

[6] The only problem is when $OSIN_C$ equals 0. In this case when $OSIN_M$ equals 1, we cannot estimate the indicator. However, by construction $OSIN_M$ could be near but never equal to 1.

sin is always higher than $OSIN_C$. Then, we know that $OSIN_{mc} \geq OSIN_C$. Therefore, we can underline that the maturity bias implies an exacerbation of the original sin. However, as it can be seen in the appendix table, when there is no dollarization bias (i.e. $OSIN_C = 0$), the indicator does not report any original sin, even for large maturity biases.

Our definition of the indicator allows for an important change in the interpretation of the results. It could be possible that a country with less dollarization (reported as *less sinner* by EHP) faces a higher aggregate original sin. In other words, a sovereign can use substitutes like short term pesos contracts, but this does not change the way he "sins". This result is consistent with the definition of the original sin. To reinforce that, we can add that for a lender, dollarization contracts or short term contracts will also be good substitutes, for example, to protect his investment from dilution.

To conclude on this point, we have to note that our measure is a relative one. The maximal value of our indicator (one) corresponds to various situations symbolizing a full exposition to the original sin (theoretically, there is a continuum of cases). Values less than one imply a partial redemption from the original sin. This redemption is full when this value is zero, when a country borrows long term and in "pesos".

However, with our indicator, we can only make evaluations on the extent of the aggregate original sin. Then, a second question deserves an answer: what is the cost of the exposition to this risk?

3. A Disaggregation by Sectors

We will now consider a decomposition of the original sin by sectors. We provide the components of the original sin that are likely to cause a systemic risk. In our view, the latter depends on several factors, which we will describe.

We suppose that the domestic economy is made up of three sectors: the firms (F), the public sector (P) and the banks (B). We decompose the global original sin into the original sin of each sector of the economy. Formally, we have:

$$OSIN_j = \sum_i \theta_j^i OSIN_j^i \quad \text{with} \quad \sum_i \theta_j^i = 1 \qquad [8]$$

θ_j^i represents the share of the debt of the sector i in the total debt of the country j.

$$\theta_j^i = \frac{Debt\ in\ sector\ i\ of\ country\ j}{Total\ debt\ of\ country\ j} \qquad [9]$$

$OSIN_j$ is the aggregate original sin in country j. $OSIN_j^i$ represents the original sin in sector i of country j.

The sector of firms can be disaggregated in two sub-sectors: non-tradables (NT), and tradables (T). Therefore, we can also write:

$$OSIN_j^F = \beta_j^{NT} OSIN_j^{NT} + \beta_j^T OSIN_j^T \qquad with \quad \beta_j^{NT} + \beta_j^T = 1 \qquad [10]$$

The size of a country can be estimated by the degree of openness. The large country has a small degree of openness and therefore has an important non-tradable sector. Conversely, the tradable sector is generally large in a small and very open economy. Then, we have:

$$\begin{cases} \beta^{T}_{Small} \geq \beta^{T}_{Large} \\ \quad and \\ \beta^{NT}_{Small} \leq \beta^{NT}_{Large} \end{cases} \quad [11]$$

Moreover, there is a negative correlation between the size of the country and the original sin. The larger is the country the weaker is the original sin and vice-versa. This assumption is checked by EHP (2005). In their survey, the country size is measured by the GDP, the domestic credit or the total trade.

$$OSIN_{Large} \leq OSIN_{Small} \quad [12]$$

Substituting [10] in [8], we have:

$$OSIN_j = \theta^F_j (\beta^{NT}_j OSIN^{NT}_j + \beta^T_j OSIN^T_j) + \theta^B_j OSIN^B_j + \theta^P_j OSIN^P_j \quad [13]$$

We consider α^i the share of the unhedged original sin of the sector i. This share depends on several variables such as the maturity and the currency mismatches, but also on the interaction between sectors that can likely influence the share of the original sin having systemic implications. Moreover, we can say that the linearity of the relation is more guaranteed when the α^i_j is merely influenced by the currency mismatches. In this case the general form of α is:

$$\alpha = 1 - \frac{Assets\ issued\ in\ foreign\ currency}{Liabilities\ issued\ in\ foreign\ currency} \quad [14]$$

Therefore, we define the systemic exposure of the country j ($SSIN_j$) by:

$$SSIN_j = \theta^F_j (\beta^{NT}_j \alpha^{NT}_j OSIN^{NT}_j + \beta^T_j \alpha^T_j OSIN^T_j) + \theta^P_j \alpha^P_j OSIN^P_j + \theta^B_j \alpha^B_j OSIN^B_j \quad [15]$$

We can say that the original sin can lead up to a systemic crisis. Indeed, the systemic effect of the original sin depends on three factors:

- The extent of the original sin in each sector;
- The extent of sectoral balance sheet mismatches (imbalances);
- The relative importance of each sector in the economy.

The extent of the sectoral original sin

The higher the sectoral original sin, the larger is its systemic effect. However, we can notice that it is not obvious that the crisis will begin in the sector more intensely exposed to the original sin. Indeed, the cost of original sin can be different from one sector to another. If a sector is barely exposed to the original sin but, in the same time, significantly unhedged, the costs can be substantial. In such a case, even a small shock will be able to trigger a crisis, and the interaction with other sectors will probably produce a systemic crisis.

The extent of the balance sheet mismatches

After the Asian crisis, several authors argued that the crisis could have been anticipated, if the consolidated balance sheet of the countries had been examined more closely. The analysis in terms of flows is always important, but it must be accompanied by an assessment of the stocks. According to Allen and al. (2002), in order to avoid the crises or to react more effectively when they occur, it is fundamental to preserve the equilibrium of the balance sheets. Firstly, the original sin can precipitate serious financial problems related to maturity mismatches even if the exchange rate is stable. Secondly, the instability of the exchange rate will lead to disturbing currency mismatches between assets and liabilities.

The currency mismatch occurs when the liabilities of the borrower are denominated in foreign currency and his assets in national currency. After a devaluation, the borrower cannot refund this debt due to the increase in his debt burden, in national currency. Referring to the credit and balance sheet channels, Aghion and al. (2001) and Bacchetta (2000) show that monetary policy becomes increasingly complex when the firms have a significant share of their debt in foreign currency. Indeed, the fall of interest rate can have expansionist effects expressed by the existence of a credit channel. Conversely, if we refer to the balance sheet channel, the devaluation/depreciation caused by the reduction of the interest rate can be contractionary. The countries subjected to the original sin and which have a net foreign debt, such as the case of the majority of the emerging market economies, experience currency mismatches. These imbalances explain the variability of the domestic production, the volatility of the capital flows and the restrictive nature of monetary policies.

There is a **maturity mismatch** when long run assets are backed with short run liabilities. This reinforces the probability of default of the borrowers (they will be unable to repay their debts at maturity).

Allen and al. (2002) provide a balance sheet approach to the financial crisis. These authors suggest that it is essential, in order to avoid and/or to solve the crises, to examine the consolidated balance sheet. In other words, it is necessary to compare the foreign debts that the public sector, the banks and the firms have and their external assets (in particular the international reserves). On the other hand, it is also very important to check up closely the balance sheets of all sectors. The sectoral imbalances, which may not appear in the consolidated balance sheet, can nevertheless trigger a financial crisis. The assessment of the consolidated balance sheet of the country and those of the whole sectors will make it possible to detect the existing weaknesses and to correct them before the default. Therefore, we can avoid financial difficulties and consequently the probability of a systemic crisis becomes very small.

We can conclude from equation [15] that the value of α_j^i is higher if the mismatches of a sector are larger. In other words, a significant maturity mismatch and a sizeable currency mismatch have considerable systemic implications. The systemic effects will depend as well from the relative size of each sector and the imbalances of the key sectors of the economy.

Relative importance of each sector in the economy

The debt in one sector can be an asset for another sector. If a sector displays some difficulties to honour its debt service, the liquidity of the other sectors will be altered. Moreover, if the sector in crisis is a key sector or its size is relatively important to the economy, the panic will hit all the sectors in interaction with it. Hence, a vicious circle could be generated and probably the sectoral crisis will be transformed into a systemic crisis.

Conclusion

We showed that the nascent empirical literature on the so-called "original sin" could be misleading. The existing measures, of EHP, take into account only the dollarization problem, ignoring the maturity problem, and underestimating the true extent of the phenomenon. In our view, this problem could lead to a bias in the results of econometric estimations (the case of the missing apple).

The literature on the original sin hypothesis is still burgeoning. For the moment, we do not know if original sin is more a symptom or more a cause of the crisis problem in the emerging markets. The original sin is probably the seventh major puzzle in international macroeconomics[7], and for the moment it is still a conundrum.

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[7] This is here a reference to Obstfeld and Rogoff, "the six major puzzles in international macroeconomics".

Appendix

Table 1:

A simulation on $OSIN_{mc}$

$OSIN_M$ / $OSIN_C$	0	0,01	0,1	0,3	0,5	0,7	0,9	0,99
0	0	0	0	0	0	0	0	0
0,01	0,01	0,010	0,016	0,040	0,100	0,251	0,631	0,955
0,1	0,1	0,102	0,126	0,200	0,316	0,501	0,794	0,977
0,3	0,3	0,304	0,338	0,431	0,548	0,697	0,887	0,988
0,5	0,5	0,503	0,536	0,616	0,707	0,812	0,933	0,993
0,7	0,7	0,703	0,725	0,779	0,837	0,899	0,965	0,996
0,9	0,9	0,901	0,910	0,929	0,949	0,969	0,990	0,999
0,99	0,99	0,990	0,991	0,993	0,995	0,997	0,999	≅1
1	1	1	1	1	1	1	1	1

Notes:

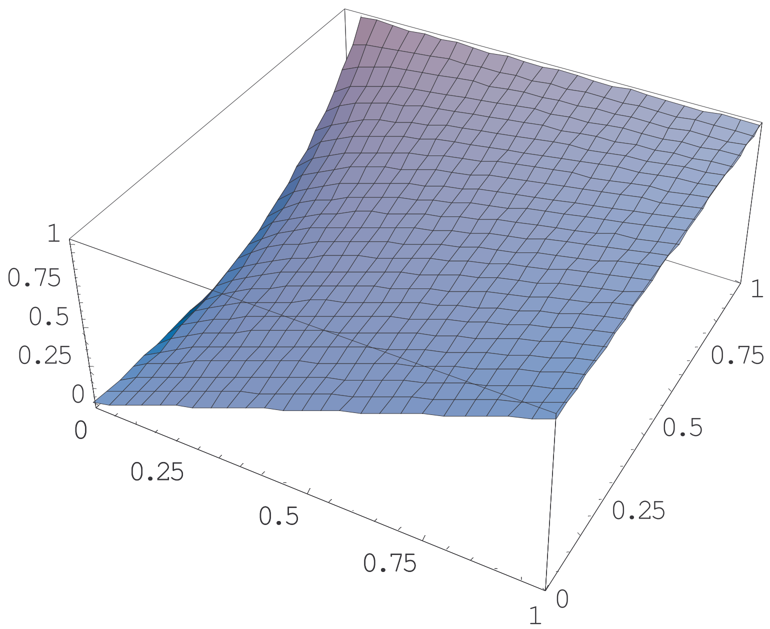
- We can verify here that $OSIN_{mc} \geq OSIN_C$

- By construction, our indicator is equal to $OSIN_C$ (i.e. $OSIN_3$) when the value of the latter is 0 or 1, or when the value of $OSIN_M$ is 0.

Properties of the $OSIN_{mc}$ indicator

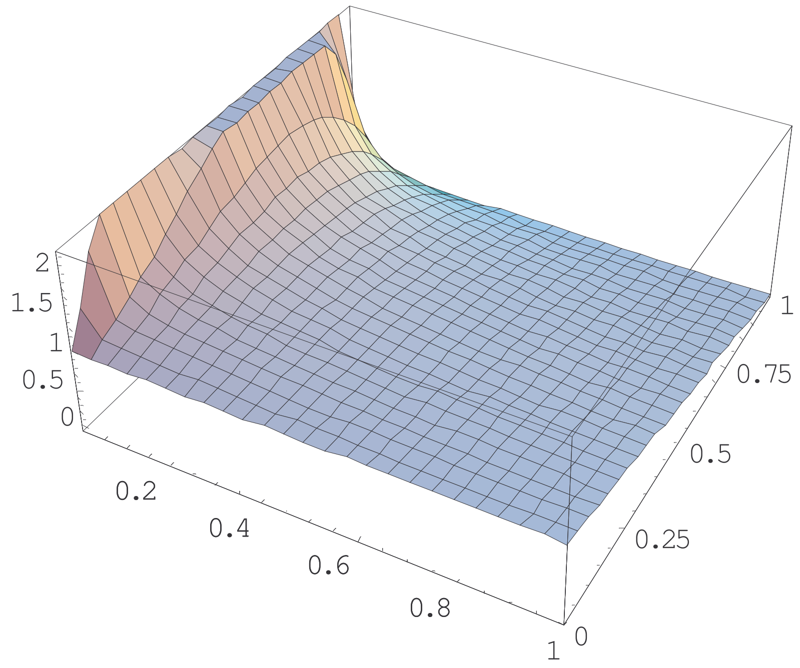
1) The Global Original Sin Function:

$$f(OSIN_C, OSIN_M) = OSIN_C^{(1-OSIN_M)}$$



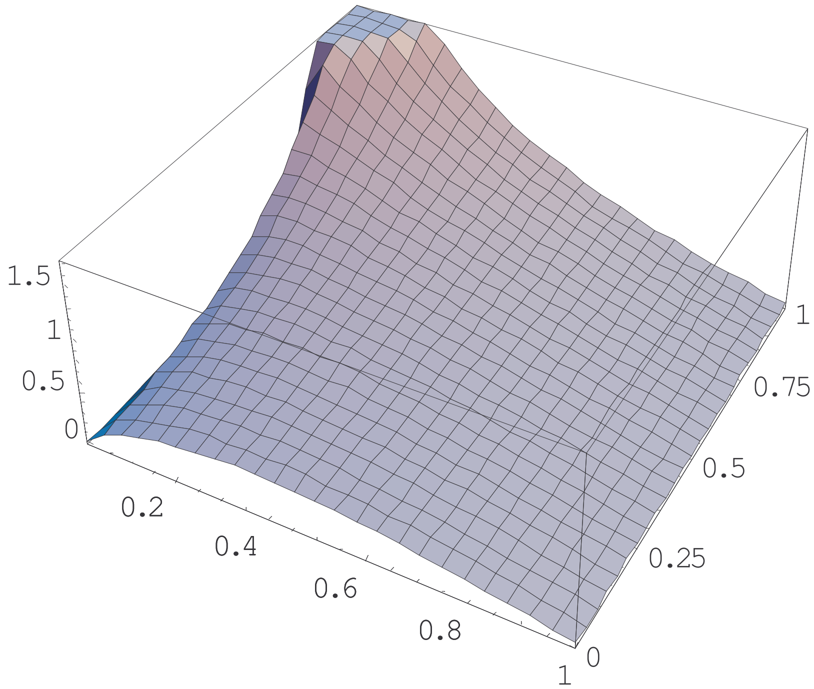
2) The First derivative function vis-à-vis $OSIN_C$:

$$D[f(OSIN_C, OSIN_M), OSIN_C] = OSIN_C^{-OSIN_M}(1 - OSIN_M)$$



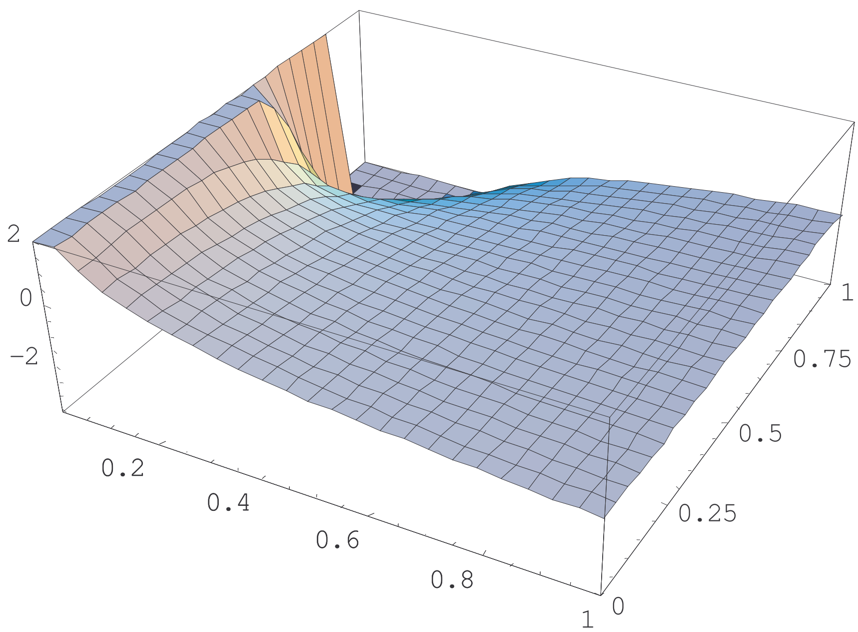
3) The First Derivative vis-à-vis $OSIN_M$:

$$D[f(OSIN_C, OSIN_M), OSIN_M] = OSIN_C^{(1-OSIN_M)} Log(OSIN_C)$$



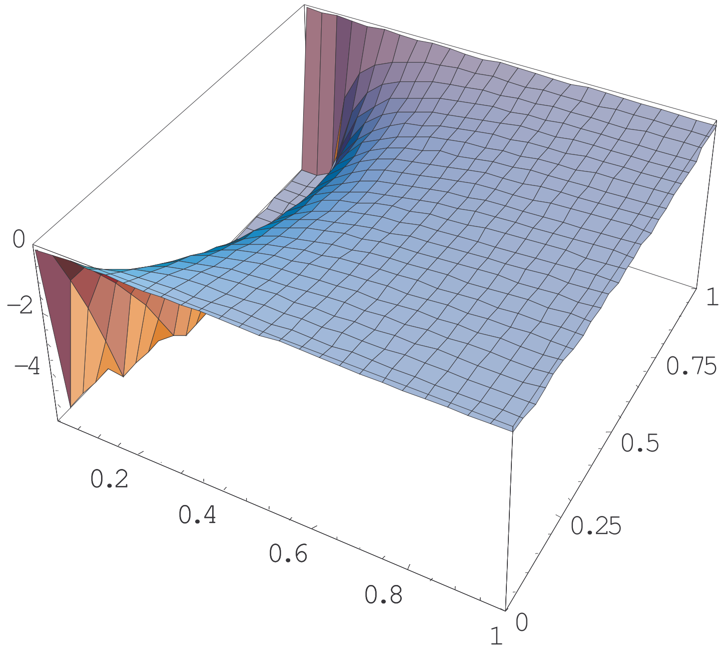
4) The First Derivative Vis-à-vis $OSIN_C$ and $OSIN_M$:

$$D[f(OSIN_C, OSIN_M), OSIN_C, OSIN_M] = -OSIN_C^{-OSIN_M} - OSIN_C^{-OSIN_M}(1 - OSIN_M)Log(OSIN_C)$$



5) The Second Derivative vis-à-vis $OSIN_C$:

$$D[D[f(OSIN_C, OSIN_M), OSIN_C], OSIN_C] = -OSIN_C^{-1-OSIN_M}(1 - OSIN_M)OSIN_M$$



6) The Second Derivative vis-à-vis $OSIN_M$:

$$D[D[f(OSIN_C, OSIN_M), OSIN_M], OSIN_M] = -OSIN_C^{1-OSIN_M} Log(OSIN_C)^2$$