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PARAMETRIC AND NON-PARAMETRIC APPROACHES TO EXITS FROM FIXED EXCHANGE RATE REGIMES

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Abstract

When the Bretton-Woods system collapsed in the mid 1970s, almost all countries were pursuing one form of a pegged regime or another. Increasing trade and financial integration forced many countries to move to more flexible regimes. Some countries exited without experiencing major disruption to their economic activity, but the majority did so in the midst of a crisis. At the same period, generally for stabilization purposes, many developing countries were advised to pursue pegged regimes, in which the exchange rate was used as a nominal anchor to enhance the credibility of monetary policy. Moving to more flexible regimes once a certain level of economic stability was reached was the ultimate objective for many programs. Again, some countries managed this transition quite successfully, but the majority faced speculative attacks along the way.

The aim of this study is to determine the conditions under which exits from pegged to flexible regimes are managed in an orderly manner. To do so, this paper proposes a way to merge two methodologies – standard regression analysis and CART analysis on a dataset of 128 countries from 1975 to 2002. The application of CART methodology to economic phenomenon like exiting is quite new. The analysis shows that higher output growth, higher private credit and an overvalued real exchange rate a year before exit, among others, increase the likelihood of exiting in a disorderly way. Following the exit both output and credit collapse and the exchange rate depreciates considerably. The ill-managed financial liberalization and macroeconomic stabilization programs seem to lay the seeds of instability that take the form of boom-bust cycles.

ملخص

عندما انهار نظام بريتون وودز (Bretton-Woods) في منتصف السبعينيات كانت معظم الدول تتبع أحد أشكال أنظمة الربط. وقد دفع التكامل التجاري والمالي المتنامي بالعديد من الدول إلى التحول إلى أنظمة اكثر مرونة. فقد نفذت بعض الدول التحول دون التعرض لاختلال كبير في أنشطتها الاقتصادية، لكن غالبية هذه الدول فعلت ذلك وهي في منتصف الأزمة. وفي نفس الفترة ولأسباب تتعلق بالاستقرار بشكل عام فقد تلقت العديد من الدول النامية نصائح بان تتبع أنظمة ربط يستخدم فيها سعر الصرف كمستقر إسمي لتعزيز مصداقية السياسة النقدية. وبمجرد التوصل إلى مستوي معين من الاستقرار الاقتصادي فإن التحول إلى أنظمة أكثر مرونة يكون الهدف الأخير للعديد من البرامج. وإلى هذا، فقد نجحت بعض الدول إلى حد بعيد في إدارة هذا التحول، لكن واجهت غالبية هذه الدول في هذا الوقت عمليات مضاربة عشوائية على العملة المحلية.

تهدف هذه الدراسة إلى تحديد الشروط التي يتم بموجبها إدارة عمليات التحول من أنظمة الربط إلى الأنظمة المرنة بطريقة منظمة. ولتحقيق ذلك تقترح هذه الدراسة طريقة لدمج منهجيتين وهما تحليل الانحدار المعياري وتحليل CART لمجموعة بيانات من 128 دولة خلال الفترة من 1975 إلى 2002. وتطبيق منهجية CART على ظاهرة اقتصادية مثل التحول يعتبر شيئا جديدا إلى حد ما. ويظهر التحليل أن نمو الإنتاج المرتفع والائتمان الشخصي المرتفع وكذلك سعر الصرف الحقيقي المغالي في تقييمه في العام الذي يسبق هذا التحول (ضمن عوامل أخرى) يزيد من احتمالية التحول بطريقة غير منظمة. ويتبع هذا التحول انهيار في الإنتاج والائتمان وانخفاض كبير في سعر الصرف. ويبدو أن التحرير المالي الذي تنقصه الإدارة الحكيمة وبرامج استقرار الاقتصاد الكلي تضع بذور التقلب وعدم الاستقرار والتي تكون في شكل دورات ازدهار متعسرة.

1. Introduction and Literature Review

Following the demise of Bretton-Woods, trade and financial globalization has taken a fresh start. Intensifying linkages among countries required them to align their economic policies, including exchange rate regime policies, with the new rules brought by the new economic order. In this new era, the attractiveness of fixed regimes (hard or soft) has been on a continuous decline. This was especially confirmed after the dramatic experiences of emerging market countries in the 1990s and early 2000s. The transitions have not, however, been painless. Many countries experienced harsh economic conditions during the move from pegged to flexible regimes. When and how to exit is an extremely important issue given the nature of the economic consequences involved. And this constitutes the main aim of this paper, namely to determine the conditions behind orderly exits.

The issue of exiting from fixed to flexible regimes lies at the junction of two rich bodies of literature: currency crisis and regime choice. The currency crisis literature falls short in accounting for orderly regime transitions. The regime choice literature, on the other hand, does not consider the consequences of this choice. It is within this niche that this study sits.

The empirical literature on exiting was initiated by Eichengreen and Masson (1998). Relying on case study analysis, the authors found that most countries hesitated to leave a peg when things were going "well" and considered the option of exit only when forced to do so, in other words, when it was too late. Building on this study, Asici (2002) and Asici and Wyplosz (2003) employed probit models to determine the conditions behind orderly exits. Their findings were in line with a recent theoretical study by Rebelo and Vegh (2006) which asserted that exits are more likely to be orderly when undertaken in favorable conditions (sound macroeconomics, adequate banking systems and a period of capital inflows). In Asici et al. (2007), an inherent sample selection bias problem was dealt with by employing Heckman Selection Models proposed by Heckman (1979). Interestingly, this study found that the macroeconomic discipline represented by budget and current account balance did not seem to be important in determining the type of exit. The role of capital controls was found to be important: while these made exits less likely, once a country actually exited, they increased the likelihood that it would be orderly. This conclusion contradicted with the common perception.

Other closely related empirical papers can be listed as follows.

Klein and Marion (1997) examined the determinants of de-pegging, which included both realignments within an exchange rate regime and exits to a more flexible regime. They did not distinguish among these two categories, however, nor were they interested in the conditions under which de-pegging was orderly or not. Duttagupta and Otker-Robe (2003) extend the Klein and Marion study by analyzing the conditions that led to orderly exits. They used a multinomial logit procedure to allow for different outcomes: realignments within the same regime, orderly exits to more or to less flexible regimes, and "exchange rate pressure episodes", which may occur within the same exchange rate regime or not.

Masson and Ruge-Murcia (2005) focused entirely on exits by estimating time-varying transition probabilities among three exchange rate regimes (fixed, intermediate and flexible). The authors then tried to explain the estimated probabilities with macroeconomic factors. Agénor (2004) provided a detailed study of three exit episodes, with special emphasis on capital flows. In his study, exits encompassed moves from intermediate regime types to the two extremes of hard pegs or free floats. Detragiache et al. (2005) used multinomial logits to estimate the difference between orderly and disorderly exits, using no exits as the reference situation.

In a recent paper, Aizenman and Glick (2006) studied the empirical and theoretical association between the duration of a pegged regime and the cost incurred upon exiting the regime, where the exchange rate was used as a commitment device. They found that hard pegs, especially arrangements like currency boards, increased the credibility of authorities in tackling inflation by raising the cost of devaluation and regime change. In turn, however, the duration of pegs tended to increase as fragilities built up. Increasing credibility through pegging thus came at a cost, namely the pain following exit.

This paper is a generalization of Asici et al. (2007). Apart from the use of an expanded dataset, the paper makes two additional contributions to the existing literature. Firstly, it introduces a new non-parametric technique, known as Classification and Regression Tree (CART thereafter) analysis to study the issue, alongside standard regression techniques. Secondly, it proposes a way to merge these two approaches.

As a nonparametric technique CART has some superior features over standard methods especially in areas where the relationships amongst variables tend to be nonlinear rather than linear, such as crises. Manasse et al. (2003) used CART to accompany their logit model in predicting sovereign debt crises. Similarly Ghosh and Ghosh (2003) analyzed the role of structural vulnerabilities in currency crises with the help of a classification tree. Kaminsky (2003), on the other hand, emphasized that currency crises could take various types and pinned down the different paths leading to different types of currency crises.

CART allows working with both categorical and continuous dependent variables. When the dependent variable is categorical (binary or multi-level) the tree is called a *classification tree* and when it is continuous the tree is called a *regression tree*. In classification tree analysis the main idea is to find a set of **general** (applicable not only to an individual observation but to as many observations as possible) rules so as to maintain the different types of observations (like for example crisis, tranquil) in separate parts of the tree as **homogenous** (crisis and tranquil observations in separate nodes) as possible. While preserving the main idea, in regression tree analysis, the algorithm tries to find a set of **general** rules so as to maintain similar observations (with respect to the dependent variable) in separate parts of the tree as **close** (close to mean or median value within the node) as possible.

The classification and regression tree algorithms will be explained in detail further along in the text, but before that let us have a quick look at the problem of classification tree analysis with the help of a simple, hypothetical example. Assume that we have 50 observations, 20 Class-A type (namely debt default) and 30 Class-B (namely tranquil). For these observations further assume that we only have two variables (short-term debt to

GDP and inflation rate) to explain the occurrence of debt defaults. Figure 1 illustrates the distribution of these observations on the X-Y plane.

A classification solution that characterizes the Class-type as a function of variables X and Y can be useful in understanding how these variables affect the occurrence of debt defaults.

Figure 2 shows two vertical (x=15 and x=25) and one horizontal axis (y=10), that seem to partition the two class-types into 5 different groups quite successfully.

The obvious questions like where to start partitioning – by using which variable and at what value – become increasingly difficult as the number of variables and observations increases. Classification tree analysis provides automated techniques for exploring these kinds of axis parallel partitions. Figure 3 illustrates a classification tree that corresponds to the partitions shown in Figure 2.

Starting from the top node, algorithm starts to test all possible partitions. Since we have 50 observations and two explanatory variables, the number of candidate splits to be tested is 100. At a glance, it is easy to see that at the beginning the best partition (hence the most powerful among others) can be made by drawing a line at y=10. As a result, we can almost completely separate Class-B observations from Class-A. Observations satisfying Y<10 rule split off to left, and those that do not split to right. For the observations on the left node where we have 4 Class-A and 24 Class-B observations, it is still possible to find a rule to partition observations further. Note that when Y<10 and X>=25, we do not have any Class-A observations left in the right node, hence X<25 can be a perfect rule. Hence, these observations form Group 3.

The algorithm recursively searches for splits to make the groups as pure as possible. With 4 splits (X<15 conditional on X<25 and Y<10, X<25 conditional on Y<10, X<15 conditional on Y<10 and Y<10) we manage to perfectly isolate the observations within Group 1, Group 3 and Group 5. It is theoretically possible to further split Group 2 and Group 4 observations by assigning some further rules, but these splits do not add any information. Note that the class ratio within these nodes is 1-1 or the same number of observation from each class. Partitioning can only make sense if it were to lead to a change in the class ratios. Unfortunately, it is not possible to increase the purity of Group 2 and Group 4 observations by partitioning, since there is no vertical or horizontal line that can isolate one class better than the current partition. In other words, change in improvement by partitioning is zero for all possible splits and this is where the tree growing stops.

Next step is to assign the class of the nodes – default prone or tranquil. It is decided according to the relative frequencies of classes within each node. Note that Class-A (Class-B) observations constitute 40% (60%) of the sample. Hence, the unconditional probability of, say debt default, is 40%. Taking this value as a benchmark, the group with a higher (lower) concentration of Class-A observations is assigned as a default prone (tranquil) node. As a result, Group 2, 4 and 5, where the conditional probability of observing Class-A observation is higher than 40%, are called as default prone nodes and Group 1 and 3 as tranquil.

Classification (and regression) tree algorithms can be evaluated by their accuracy, speed and interpretability. Predictive accuracy on unseen data constitutes the main reference point in comparing the solutions of different approaches. The inherent noise in real-world data may affect the solution and decrease the predictive accuracy of the tree grown. The most common way to deal with this problem is by dividing the sample into two parts. The first part is used to grow the tree and the second part is used to test the accuracy of the rules found. If the rule is found to be inapplicable to the observations in the testing subsample, it will be dismissed from the tree, leading to a smaller tree than that presented in Figure 3. As seen, there is a trade-off between the purity and the applicability of the tree. As the tree size shrinks, rules become more general and applicable, but it comes at the expense of decreasing the purity of the groups. Comparison made over the misclassification rates of different sub-trees can strike a fair balance between purity and applicability. The sub-tree which fares better in placing the testing observations within right groups is chosen as an optimal tree. It will possibly be smaller in size than the maximal tree but its predictive accuracy, when tested with new data, will be higher and hence more robust.

The plan of this paper is as follows. Section II describes the dataset and the sample. The tree growing methodology is explained formally in Section III. Then, in Section IV, I present two models, called as EXIT and DGAPT models, a classification and a regression tree, respectively, and discuss results. Results of parametric analysis and comparison of the two approaches can be found in Section V. In this section I will also propose a way to merge the two approaches and discuss the improvements made. Finally Section VI concludes the paper.

2. Data and Sample

2.1 Exit Definition

In this study I determine the exit (and no-exit) dates by using the regime classification proposed by Reinhart and Rogoff (R&R) (2004). As is well documented now, "fear of floating" and "fear of fixing" prevent countries from announcing their "true" regime, and studies show that officially announced *de jure* regimes do not often match *de facto* regimes observed (see Genberg and Swoboda, 2005). R&R, therefore, uses market-determined/black-market exchange rates to classify regimes on the ground that underlying monetary stance of authorities can best be represented by these rates and not by officially announced ones.

R&R defines 13 exchange regime categories ranging from the absence of a domestic currency (dollarization) to a pure free float. R&R also distinguish an additional category – freely falling – corresponding to high inflation and continuing depreciation, within which they rank countries along the previous 13 categories.

Following the logic of Asici et al. (2007), I define a regime as fixed if there is a commitment of authorities (implicit or official) to back the regime. The rationale is that any such commitment stands to be challenged as long as authorities stand ready to honor their commitments. It does not matter whether the band is wide or narrow, horizontal or moving. Accordingly, regimes 1-11 in R&R scale are reduced to a single category which I call fixed and 12-13 to flexible regimes.

Exit is then defined as transitions from regimes 1-11 to 12-13.

I employ 3-year exclusion window for exit and non-exit cases. In order to be a case in the exit sample a minimum of two years of pegging should be followed by at least one year of flexible regime. This is designed to eliminate cases of rapid re-pegging, possibly followed by rapid exit, which I consider as one exit event, the first one. The longer pre-exit period is chosen to ensure that I only deal with cases where the peg has been in place for a substantial period before exit.

No-exit cases are arbitrary in the sense that nothing happens. The chosen procedure is to apply the same three-year exclusion window as in the exit cases. To that effect, for each country, I adopt the following procedure:

- If the country never exits during the sample period, I partition the period in as many three year sub-periods as possible, leaving out what remains at the end. Each of these three-year sub-periods is treated as the no-exit analog of the exit cases, where t = 0 corresponds to the observation two years after the beginning of the sub-period.
- If the country exited once, I start from the exit case and its associated three-year window. From there, I move to the left and to the right to identify as many three-year windows as possible.
- If there are several exit cases, I proceed as above, filling up the periods in between exits and both ends with as many three-year windows as possible. Since there are many ways for filling the periods in between exits, I arbitrarily move leftwards.

There exist different criteria to distinguish orderly exits from disorderly ones. In this study, as in Asici et al. (2007), exit type is determined on the basis of the evolution of the output gap. Exit is called orderly if the change in output gap between t+1 and t-1 is greater than -3 and disorderly otherwise, with t being the year of exit.[1]

$$y_{i,t} = output\_gap_{i,t+1} - output\_gap_{i,t-1}$$

The output gap is computed by de-trending real GDP using the Hodrick-Prescott filter and it is measured as a percentage deviation of real GDP from its trend. Detailed explanation about data, frequency and source are given in the Appendix.

2.2 Sample

The sample is assembled from R&R country chronology dataset which lasts until end-2001. After applying the 3-year window and omitting currency union cases[2], I end up with 566 cases, 59 exit and 507 no-exit observations. Exit observations with dates of exiting are presented in Table 1 below. No-exit observations can be found in the Appendix.

2.3 Explanatory Variables

The issue of exiting from fixed to flexible regimes lies at the junction of two rich bodies of literature; regime choice and currency crisis. Levy-Yeyati et al. (2004) analyzed the

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[1] Moderate depreciation around exit time (between t-6 and t+6, t being exit month), less than 25% more specifically, can also be taken as a criterion to define orderly exits.

[2] Exiting from a currency union is more political than economical in nature, see Edwards and Magendzo (2003) for a discussion.

determinants of regime choice by testing three hypotheses: *Optimum Currency Area* (OCA), *financial integration* and *political crutch*. Countries may opt to have greater exchange rate flexibility with the aim to cope with changing economic conditions. From that perspective exits can be seen as voluntary decisions. OCA theory relates regime choice to economic structure. It predicts that a pegged regime is more desirable with a higher degree of trade integration, but finds it harder to sustain when economy is subject to large real shocks, like terms of trade shock in the absence of price/wage flexibility and labor mobility. The financial view highlights the consequences of financial integration over the regime choice. As financial integration increases, this view predicts a higher occurrence of flexible regimes. Coming to the political view, authors find that fixed regimes are more likely if the country lacks a good institutional track record, but likely if the government is too weak to sustain them (ibid. p:5).

On the other hand, exit decision may be taken involuntarily. Speculative attacks may force governments to adopt more flexible regimes. Currency crisis literature, with its several generations of crisis models, investigates the different sources of vulnerabilities. In the first generation models, the source of vulnerability is the inconsistency between the exchange rate regime and the macroeconomic policies. Symptoms of this inconsistency can be found in real exchange rate overvaluation and current account deficit. Second generation models emphasize domestic economic and political vulnerabilities that may prevent authorities from upholding a fixed regime especially in front of speculative attack. Unemployment and negative output gaps could be taken as important indicators of an upcoming speculative attack. Third generation models, on the other hand, point out financial maturity and currency mismatches as sources of vulnerability. The relevant indicators can be external debt, liquidity of banking sector, and financial depth variables.

Speculative attacks on fixed regimes lie at the heart of voluntary exits as well as involuntary ones. The speculative pressure index is often used in literature to pin down the exact date of these attacks and crises. However, these indices can also be used to detect mounting pressure. A small increase in interest rate against a short-lived speculative attack can be detrimental in the medium-term for its adverse effect over debt dynamics, but it can go undetected under the standard index. One can extract this information by slightly changing the computation of the standard speculative pressure index, which is calculated based on a weighted average of monthly changes in exchange rate, interest rate and international reserves. The standard index takes a value of 1 if the pressure exceeds a specific threshold (often the mean plus 3 standard deviation). As mentioned, I intend to use this measure not only as a *bell* marking the start date of a crisis but also as a sort of *early-warning device*. This can be done by first lowering the threshold and extending the monitoring period of the measure. The binary indicator, *forced,* is computed by using a mean plus one standard deviation threshold and takes a value of 1 when pressure measure exceeds this threshold in any of the 12 months preceding exit.

3. Methodology

In the first part, I present and discuss two models, called EXIT and DGAPT, classification and regression trees respectively, by employing non-parametric CART methodology. In the parametric part I employ probit and Heckman selection models. Note that the parametric part does not aim to give a full account of exiting (see Asici et al. (2007) for a full-fledged parametric analysis) but rather to show how non-parametric CART analysis changes and improves the results obtained from parametric methods.

Before discussing conditions leading to exit and no-exit, let us have a look at CART procedure first.

3.1 CART Procedure

i. Algorithm

The main idea behind CART methodology is to find general rules so as to contain different types of observations (for example crisis, tranquil) within separate groups as pure as possible. It is a recursive process, so that after each separation the groups' heterogeneity decreases. Once it becomes impossible to decrease heterogeneity further, tree growing stops. The branches of this tree (called a maximal tree) show the different paths (set of conditions) leading to different outcomes (such as crisis-zone, tranquil-zone).

Theoretically, at the end of this process, one may reach a tree in which each individual observation is contained in a different node, a perfect-fit situation. Up to this point nothing has been done to prevent idiosyncrasies or exceptions from becoming general rules. The applicability of such tree to a completely new set of observations would be limited since it may contain observation-specific rules which cannot be generalized across cases. Therefore, there should be a way to stop growing at some point before possible exceptions are reigned in. Various ways to improve the robustness of the tree may exist, but CART algorithm does so through testing different-sized sub-trees (all obtained from maximal tree by cutting branches sequentially). In the testing phase the sample is divided into two parts respecting the relative frequencies of different classes. The first part, which constitutes 90% of observations, is used to grow a maximal tree, and the remaining 10% is used to test sub-trees obtained from the original. This process is repeated 10 times so that each observation is used in tree growing and testing phases. The sub-tree containing less exception-induced rules will obviously perform better in placing these test observations into groups where they belong (crisis observation within crisis-prone group and vice versa). The selection of the optimal tree is based on the performance of sub-trees under the testing sample not the full sample. The sub-tree with the least misclassification ratio is chosen as an optimal tree.

As seen, the algorithm involves two opposing segments. The *purity-greedy* segment tends to grow the tree with maximum number of nodes (as many as the number of observations as long as purity increases by splitting). On the other hand, the g*enerality-greedy* segment operates in exactly the opposite spirit by getting rid of individual-observation-specific rules (those cannot be generalized), hence it favors smaller trees. The battle between these two opposing segments yields the tree within which purity and generality is optimized. It is called the optimal tree and by construction it will be robust when applied to completely new datasets.

ii. Option Setting under EXIT and DGAPT Models

Researcher's intervention comes in when setting the options. With a different set of options one can reach slightly different trees. Table 2 below presents the option setting under EXIT and DGAPT models and their likely effect on the structure of optimal tree.

For its relative importance in algorithm and tree growing, splitter selection criterion option is explained in detail.

Under classification tree analysis, we have two classes of observations, exits and no-exits. Because of its emphasis on correct classification of rare class observations, I grow classification trees by using **Entropy** splitting criterion.

Now let us have a look at *how entropy splits nodes*.

In node t we have m different classes (exit, no-exit etc.) with proportions represented by $p(j \mid t)$, where $j = 1,2,\ldots,m$. So that within node t we have $\Sigma\, p(j \mid t) = 1$.

Define a measure $i(t)$, impurity of t, as a nonnegative function of the $p(j \mid t)$ such that

$$i(t) = -\sum_{j=1}^{m} p(j \mid t) * \ln p(j \mid t)$$

Then, CART tries all splitters to split observations in node t into left and right child nodes and compute the goodness of split. The goodness of the split is defined as the decrease in impurity (improvement) and takes the form

$$\Delta i(t)=i(t)-p_L i(t_L)-p_R i(t_R)$$

where p_L and p_R represent probabilities of class j being in left and right child nodes, and $i(t_L)$ and $i(t_R)$ represent the impurity of left and right child nodes, respectively.

After comparing improvement scores for all splits in candidate set which is defined as S, CART chooses the one making the highest improvement (largest decrease in impurity).

$$\Delta i(s^*,t)= \max_{s \in S} \Delta i(s,t)$$

The process above continues to split further cases within left and right child nodes. Splitting stops at node t when change in impurity (Δi) after splitting it into left and right child nodes is found to be 0.

CART enables working with the continuous dependent variable as well. In this case the tree is called a Regression Tree. Splitter selection follows similar logic but since it is not possible anymore to talk about different class of observations but a continuum of them, CART uses different criteria, namely *Least Squares* and *Least Absolute Deviation (LAD).* In growing regression trees I use LAD as a splitting criterion and splitter selection is as follows.

Under the LAD criterion, node impurity is measured by within-node sum of absolute deviation, *AD(t)*, which is defined as

$$AD(t) = \sum_{i=1}^{N_t} \left| y_{it} - \overset{\approx}{y}_t \right| \quad \text{for i=1, 2, ..., } N_t$$

where y_{it} is the individual value of the dependent variable and $\overset{\approx}{y}_t$ is the median of the dependent variable at node t. N_t is the number of observations in node t.

Given the impurity function, $AD(t)$ and splitter s that sends cases to left (t_L) and right (t_R) child nodes, the goodness of a split is measured by the function

$\Delta i(t)=AD(t)-AD(t_L)-AD(t_R)$

where $AD(t_L)$ and $AD(t_R)$ are the sums of absolute deviation in left and right child nodes. Among the candidate set S, the splitter making the maximum improvement (by minimizing absolute deviation of dependent variable within the node), s^*, is chosen as a primary splitter.

$$\Delta i(s^*,t)=\max_{s\in S} \Delta i(s,t)$$

Again this process continues until no further improvement is possible. At the end of this process, we reach the maximal tree. It is not optimal because nothing has been done to check its robustness. This will be done in the testing phase as mentioned above. See Appendix for further details.

4. CART Analysis

4.1 EXIT Model

In this model the dependent variable is a binary EXIT variable, which takes a value of 1 if exit occurs at time t and 0 otherwise.

My strategy consists of two steps: the first step is to identify exit and no-exit prone nodes, and then in the next step I identify orderly and disorderly nodes depending on the output gap criterion.

The choice of dependent variable forces CART to group exiting countries and no-exiting countries under different nodes as pure as possible. Once *exit prone* nodes are identified, one can check whether *orderly* and *disorderly* exits have been concentrated within different nodes. A check is made by comparing the mean output gap change across exit prone nodes.

Before proceeding to the tree analysis, let us have a look at the descriptive statistics of explanatory variables across exiting and no-exiting countries.

4.1.1 Descriptive Statistics: Exit versus No-Exit

Table 3 presents the mean values of explanatory variables across exit and no-exit groups in our sample. The choice of these variables has been done by CART, which orders variables according to their splitting power either as a primary splitter or a surrogate. The variables listed below portray statistically different means across two groups of countries.

A year before exit, exiting countries compared to no-exiting countries have

- an above-trend output growth,
- an overvalued real exchange rate,
- lower openness,
- faced speculative pressure in foreign exchange market more often,
- a more flexible peg,
- lower financial sector development,
- faced more incidence of exits in previous 12 months,
- higher inflation,
- faced higher US interest rates,

- shorter peg duration,
- lower long-term debt,
- lower public debt,
- lower total external debt,
- a higher ratio of short-term debt to total debt,
- capital controls more often,
- a higher current account deficit,
- a more deteriorated budget balance,
- an above-trend real investment and real private credit growth.

However, having statistically different means does not necessarily guarantee representation on the tree. Starting from the top to the bottom node, the variables making the highest improvement are chosen as a primary splitter and others are kept aside as competitors. In parametric methods, on the other hand, it is the marginal effect of a variable that counts when others are held constant at their mean. Hence, the way in which a variable is chosen and represented as an explanatory variable is fundamentally different under parametric methods and CART**.** How do these technical differences affect results?

First of all, as long as CART finds a better splitter, some variables may not show up on the tree no matter how they differ across exit and no-exit cases. Differences across means of exit and no-exit cases in the very beginning may vanish within a subgroup of exit and no-exit cases deeper into the tree, which prevents that variable from being represented on the tree. The opposite is also true, a variable may be indistinguishable across exit and no-exit cases in the beginning, but deeper on the tree, depending on the splitters, it may significantly differ across some subset of observations and may become a splitter. Secondly, a variable may show up more than once (with different thresholds) on the tree as long as it continues to be the best splitter. From the top to the last node on the tree, there is a continuous race among variables to be a primary splitter, and races have been run for an ever-decreasing number of observations. In parametric methods, however, variables have been evaluated according to their marginal contributions as others are held constant at their mean value. If we use the same race analogy, there is only one race for all observations in the beginning and that is all. This is the main difference between CART and parametric methods. And it is this multiplicity of race that enables CART to detect non-linearity much more easily and effectively compared to parametric methods.

4.1.2 EXIT Tree

Given the option setting, CART grows a maximal tree with 31 nodes as shown in Figure 4. The maximal tree has a misclassification cost of 4.7% and, as expected, fits the full sample with higher accuracy than any other sub-tree. But as mentioned above, unless verified by testing procedure, this figure is misleading since maximal tree by construction fits idiosyncrasies and noise within the full sample which are unlikely to occur with the same pattern under the test sample. In fact this is the case, when test sample applied to the maximal tree we see that almost 70% of observations have been misclassified. The optimal tree is probably a smaller tree than the maximal one. Checking costs under different sub-trees, from right to left, till the 10-noded tree, the number of misclassified observations decreases and after this point starts to increase again as given by the test sample cost curve in the figure. As a result CART picks the 10-noded tree as an optimal tree. As seen, the optimal tree selection is decided over the test sample cost not the full sample cost. Once the optimal number of node is determined, CART presents that specific tree which has been grown with the full sample. Of course, grown under the full sample, this specific tree will have a lower misclassification cost than its counterpart under the test sample (optimal tree costs under full and test sample, 0.306 vs. 0.512).

The optimal tree grown by CART has 10 nodes. We have 59 exit and 507 no-exit cases in our sample, therefore unconditional probability of exit is around 10% (59/566). Recall that CART automatically labels terminal nodes "exit prone" and "no-exit prone" by comparing conditional exit probabilities in TNs with unconditional exit probability in the top node. That is, TNs with exit probabilities *greater (smaller) than 10%* are labeled as *exit (no-exit) prone*. As a result, *TNs 2, 5, 7, 9 and 10 are labeled as exit prone* and *TNs 1, 3, 4, 6 and 8 as no-exit prone*.[3]

Now let us trace back the routes leading to exit and no-exits.

Table 4 shows the set of conditions leading to 10 different TNs.

Findings can be summarized as follows:

Exit Prone Nodes:

i. Overvaluation of RER increases the likelihood of exiting.

The majority of exits occurred when RER was overvalued. 35 out of 59 exits placed in TNs 9 and 10 experienced overvaluation of RER exceeding 6.1%.

Overvalued RER combined with

- speculative pressure increases conditional probability of exit to 48% (TN10)[4]
- output gap higher than -1% increases the conditional probability of exit to 21% (TN9).[5] In this node, on average, output gap before exit is 4.5%.

In the absence of overvaluation

ii. A higher output gap in the previous year makes exit more likely at present.

Output gap higher than 3.7% combined with

- *speculative pressure* increases conditional probability of exit to 62% (TN7)[6]

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[3] Appendix files containing detailed explanation of CART procedure in growing EXIT tree and will be made available upon request.

[4] Depending on their association value, **surrogates** can serve as a secondary source of information. For TN10, *openness* and *depreciation before* are given as surrogates and low openness (on average 44) and higher depreciation before exit (on average 27%) are features shared by many exits in this node. Note that, average *openness* and *depreciation before* for exit cases in TN9 are 85 and 3.3% respectively.

[5] CART gives c*hange in terms of trade*, *change in total external debt* and *private credit* as surrogates for TN9. Exit cases in TN9 can also be distinguished from cases in TN8 by having negative terms of trade shock of 4.1 and 5.5% increase in total external debt and 58% private credit on average. No-exit cases in TN8, however, saw their terms of trade to improve by 16, 1.7% decrease in their total external debt and had a private credit that is 30% of GDP on average.

[6] *Terms of Trade* and *depreciation before* are two variables given as surrogates and cases in these nodes can also be distinguished by lower Terms of Trade (on average 87) and higher depreciation rates (on average 45%) before exit.

- *openness* that is lower than 65 increases the conditional probability of exit to 23% (TN5).

In the absence of overvaluation and excess output growth,

iii. .Low openness and shallow financial markets under a less rigid fixed regime increase the likelihood of exiting.

Countries with *openness* that is lower than 75%, shallower financial markets (*M2 to GDP* lower than 46%) and less rigid fixed regime (*depreciation before* exit greater than 8%) are more prone to exit. Under these conditions, exit probability reaches 17% in TN2.[7]

No-exit prone nodes:

iv. A lower output gap and higher openness make exiting less likely.

Conditional on *overvaluation of RER* that is lower than 6.1%,

- exit probability is less than 1% on average across TNs 1, 3 and 4 when *output gap* is lower than 3.7%,
- when *output gap* is higher than 3.7%, it is *openness* that saves countries from exiting conditional on no *speculative pressure*. In TN6, exit probability is 0% conditional on no speculative pressure and higher openness (higher than 65).
- Conditional on higher *overvaluation of RER* (greater than 6.1%),
- exit probability is 0% when *output gap* is less than -1% and country did not face *speculative pressure* in the previous 12 months (TN8).

4.2 Orderly versus Disorderly Exit

After identifying different routes leading countries to exit, the next step is to rank these groups of exits depending on output gap change. As mentioned earlier, we expect CART to place orderly and disorderly exits into separate TNs, so that one can identify routes leading to "orderly" and "disorderly" exits. To that end, first of all, I test how significant the difference is between group means (of exit cases) by using mean t-test with unequal variance.

Test results show that it is indeed possible to group TNs into *orderly* and *disorderly* nodes. Across these groups, mean *output gap change* value differs significantly and, expectedly, differences vanish across the same type of nodes. Take for example TN1 and TN2, both are labeled as orderly and there is no statistically significant difference between mean output gap change. Comparing orderly TN2 and disorderly TN10, -6.3% difference is statistically significant at 5% significance level. A second check can be done by comparing *exchange rate depreciation* figures across orderly and disorderly nodes. In fact, the exchange rate portrays different evolutions for two groups of exits. Mean depreciation rate within orderly nodes is only 24%, whereas in disorderly nodes it increases to 81%. This fact also reinforces our observation that majority of countries do exit in the midst of a turbulence which has negative consequences in terms of exchange rate depreciation as well as output growth.

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[7] *Inflation* and *domestic credit* variables are given as surrogate for TN2. Most of the cases placed in TN2 can also be distinguished by having higher inflation rates, on average 14%, and lower domestic credit (on average 40% of GDP) as opposed to no-exit cases placed in TN3, for which the variables took values of 7.2% and 82% respectively.

These findings indicate that most of the cases placed in TN1 and TN2 managed a relatively smooth transition between regimes compared to 47 cases placed in TN5, TN7, TN9 and TN10. And therefore, *I call TN1 and TN2 as orderly nodes and others as disorderly.*

4.3 DGAPT Model

In this section, I would like to analyze the regression tree grown by using a continuous dependent variable, *output gap change* (*dgapt*). CART algorithm tries to group countries with similar evolution of output gap change within same terminal nodes. As in classification tree analysis, CART first grows the maximal tree. Within-node median, minimum and maximum values of dependent variable are calculated for each terminal node. Then in the testing phase, CART tries to place testing sample into the nodes of different sub-trees which have been obtained through pruning the maximal tree. If the observation in the test sample falls outside the boundaries drawn by min and max values of that particular node, it is said to be misclassified.

Coming to DGAPT tree, we find that the optimal tree has 7 nodes with a misclassification cost of 95%. Compared to EXIT model, DGAPT tree did not perform well in classifying observations in the right nodes as evidenced by high misclassification cost. Nevertheless, our tree has revealed interesting points worth mentioning.

First of all, CART started splitting cases by picking binary *exit* variable as a primary splitter in the very top node, showing the importance of an exit event on output gap evolution. Note that for the whole sample output gap change on average takes a value of -0.2%, it is -6% for exit cases and 0.4% for no-exit cases. Secondly, CART grew the tree with variables which unveil an important link between the financial and real sectors. Notably, deviation of private credit, private consumption and investment from their H-P trends were chosen as most important variables, either as a primary splitter or a surrogate. In other words, these variables have the most power in explaining the change in output gap and I will return to this issue further into this section.

As in EXIT model, we can determine the type of nodes depending on the mean output gap change. From the table below we see that only TN4 with a mean output gap change of -0.7% is deserved to be called an *orderly* node. Accordingly, TN5, TN6 and TN7 are assigned as *disorderly* nodes. Median depreciation rates also support this distinction. It is 23% in TN4 as opposed to 56% across TN5-TN7.

Before exploring the routes on the tree let us have a look at what descriptive statistics tell us about the cases gathered in orderly and disorderly nodes. Table 8 shows the mean difference of explanatory variables across orderly and disorderly nodes under each model.

The exit cases in our orderly TN4 can be distinguished from other exits in disorderly TNs by having

- a lower output gap,
- lower depreciation (hence more rigid pegged regime),
- lower inflation,
- bigger improvement in trade balance,

- a higher current account balance,
- a lower private consumption gap around trend growth,
- a lower gross capital formation gap around trend growth,
- a lower private credit gap around trend growth,
- lower private credit growth
- a higher public debt before exit.
- Also, exits in orderly node TN4 occurred when US interest rate was lower.

Coming to our DGAPT tree, the table below shows the route information of 4 nodes where exit cases have been gathered.

As seen, the most powerful variable distinguishing orderly exits from disorderly ones is *private consumption gap* (deviation of real private consumption from its H-P trend).

i. Above-trend consumption and investment growth lead to disorderly exits.

Countries with *real private consumption deviation* lower than 1.9% are likely to exit in an orderly fashion (TN4). *Deviation of investment* from long-term trend, *current account* and *trade balance* are variables given as surrogates for TN4. And orderly exits in TN4 can also be distinguished by having *lower deviation of investment, higher improvement in current account* compared to disorderly exits in TN5.

ii. A more liquid banking system can soften negative consequences of disorderly exits on output gap.

Although most of the exits in TN6 and TN7 are of the disorderly type, countries in TN7 experienced a less dramatic change in their output gap (-6.5% vs. -16.8% on average where difference is significantly different from zero). And *banks' liquid reserves to asset ratio* is the variable that makes the difference. Countries with a more liquid banking system (TN7) have done relatively well in curbing the transmission of volatility from consumption and investment to the output.

Checking the grouping of cases in different TNs, we see that exits in TN7 are those occurred during *Balance of Payment* type crises of the 80s. *Inflation*, *exports to imports ratio and domestic credit private sector* are variables given as surrogates for the parent node preceding TN6 and TN7. That is, exits in TN6 have lower inflation, higher exports to imports ratio and higher domestic credit compared to cases in TN7. It is also interesting to see that many of the *Asian Crises* countries have been placed in TN6 within which banking sector fragility is present as pointed out by the primary splitter.

4.4 Combined Analysis of EXIT and DGAPT models

41 out of 59 (70%) exits have been classified as orderly and disorderly (6 orderly and 35 disorderly exits) by both models. *Mean differences* between orderly and disorderly groups are given in the table below under the column COMBINED. Once we restrict our analysis to these cases we see that, orderly exits occurred when there is:

- lower overvaluation,
- a lower output gap,
- lower openness,
- a more rigidly pegged regime,

- lower foreign direct investment,
- a higher improvement in trade balance,
- a higher current account balance,
- lower short-term to total debt,
- lower private credit, consumption and investment gap around long-term trend and,
- lower private credit growth a year before exit.

Significantly higher *output gap*, *higher credit*, *consumption* and *investment growth* coupled with significant *overvaluation of RER* before exit are the most important characteristics of most countries placed in disorderly nodes under both models. **All of these variables have taken a sharp turn to the opposite direction in the year following exit.** Credit, investment and consumption fell below long-term trend growth, output collapsed and RER depreciated dramatically.

4.4.1 What do splitter thresholds tell?

Our EXIT tree reveals that overvaluation is the most important characteristic of disorderly exits. For the sample of countries and time period under consideration, the threshold is found to be 6.1%. Countries with RER overvaluation exceeding this threshold, first of all, are more prone to exit (with 76% probability vs. 34% if overvaluation is not present) and secondly, if they do exit it is more likely to be disorderly (with 70% probability). Overvaluation of RER also increases the odds of an occurrence of speculative attack. 48% of cases with RER exceeding this threshold experienced a speculative pressure in their foreign exchange market and 83% of them exited in a disorderly fashion. Speculative pressure (attack) does not force countries to exit instantly. A country may successfully contain it by increasing interest rates and spending its foreign exchange reserves. But it is not without costs. Short-term tranquility is bought more often at the expense of middle-term vulnerabilities. For example, interest rate defense can easily put the viability of peg into question due to the increased roll-over cost of the sovereign debt.

Second the most important characteristic of disorderly exit is the growing output gap above long-term trend. CART algorithm gives this threshold 3.7%. Some 60% of the cases with output gap exceeding this threshold cannot sustain the peg and exit within the next 12 months, and 85% of them do so in a disorderly fashion. Note that these cases experience an output boom, a year before exit, at a magnitude of 7.7% on average. Such a big output gap cannot easily be sustained, especially when the economy is subject to real shocks like terms of trade shocks or rapid increases in external debt.

Moreover, it is interesting to note that all these output boomers are relatively less open (with trade accounting for less than 65% of GDP). It indicates that output boom is a result of the over-expansion in the non-tradable sector, such as construction. Countries which are more open (higher than 65%), in contrast, are more likely to sustain the peg better despite the output boom exceeding 3.7%.

Our DGAPT tree reveals that exiting alone is a disruptive event regardless of its type. Note that the CART algorithm picked the binary variable EXIT as the top splitter when output is considered. And among the exiting cases, a relatively smooth exit seems to be only possible when real private consumption is on its trend growth rate. Booming consumption expenditures (CART puts the threshold at 7.8%) is the main driving factor behind the booming output and this consumption expenditure go mainly to the non-tradable sector.

Despite the occurrence of consumption and the accompanying output boom, countries with a more liquid banking sector better manage to keep their output growth on-trend. If the ratio of liquid reserves to assets is greater than 22%, the disruptive effects of exiting can be kept limited. Comparing the 6th and 7th terminal nodes we see that mean output gap change is almost two-fold lower in former than in latter group (-16.8 vs. -6.5%).

What are the dynamics behind such an excessive volatility in the economy? In the following section I will try to answer this question.

4.4.2 Boom-Bust Cycles behind Disorderly Exits

There is a strong link between financial development and growth. A wide body of literature claims that it is financial development that stimulates economic growth, in other words, causality runs from former to latter (see Levine (1997) for an early survey of literature). Keeping this in mind, it becomes natural to seek the roots of output volatility in developments taking place in the financial side of the economy.

Two strands of the literature, *financial liberalization* and *macroeconomic stabilization,* cite lending booms as one of the most important factors behind currency and banking crises. Now let us see to what extent stylized facts can explain the volatility behind disorderly exits in our sample. In other words, the question becomes: is it less painful to exit during the pre-liberalization period than during the post-liberalization period? And secondly, what are the chances of stabilizing the economy without incurring output and exchange rate collapse in the medium-term?

i. Financial Liberalization and Volatility:

Studies on financial liberalization established that countries with liberalized financial markets grow faster. By decreasing the cost of funding, liberalization increases the amount of credit invested and as more investment projects are undertaken, risk diversification through financial markets becomes easier, which in turn stimulates further investment. The other side of the coin, however, is the increased occurrence of crises following financial liberalization. Crisis literature highlights the detrimental effect of excessive credit growth in countries where liberalization has been undertaken inadequately and left unchecked, see for example Demirguc-Kunt and Detragiache (1998) and Kaminsky and Schmukler (2002), Wyplosz (2002). In their study Tornell and Westermann (2002), went further by investigating the effect of lending booms preceding twin crises. They found that lending booms coincided with overvaluation of RER and the fast growth of the non-tradables (N) sector compared to the tradables (T) sector. Their analysis shows that '…co-movements are generated by the interaction of two characteristics of financing typical of middle income countries: risky currency mismatch and asymmetric financing opportunities across the N and T-sectors.'

Poorly regulated financial liberalization may lead to a lending boom following a surge in capital inflow that boosts domestic investment and consumption. Implicit or explicit bail-out guarantees, inadequate monitoring of new projects, among others, play crucial roles in feeding lending booms through credit channels, or financial accelerators as mentioned in Bernanke et al. (1999) and Aghion et al. (2004). Asset price increases during a boom increases borrowers' net worth which facilitates new lending. Increased demand for assets push asset prices even higher, a bubble which bursts as bust period sets in.

Is it possible to say that disorderly exits occur mainly in the post-liberalization period triggered by a lending boom that follows? What is the distribution of exits vis a vis liberalization dates?

Bekeart, Harvey and Lundblad (2005) provides the most extensive dataset on financial liberalization dates. They pin down the date as the date of first American Depository Receipt issuance.[8] In our original dataset we have 59 exits, but we have data on financial liberalization dates for only 51 of them. Checking the dates, I found that **more than half of the exits** have taken place **before financial liberalization** (57%, 29 out of 51). In line with the literature, which predicts a higher probability of crises in the post-liberalization period, 86% of exits (19 from 22) which occurred during post-liberalization period were placed in one of the disorderly nodes under our EXIT model.[9]

ii. Macroeconomic Stabilization Programs and Volatility

Countries adopting fixed exchange rate regimes might have various reasons to do so. Macroeconomic stabilization is one of them. The use of the exchange rate as a nominal anchor to stabilize chronic inflation constituted the main instrument in exchange-rate-based stabilization (ERBS) programs, which have been widely used especially by Latin American countries.

However, macroeconomic stabilization programs are often criticized on the grounds that they often lead to excess volatility within the economy. For example, less-than-perfectly-credible exchange rate stabilization programs may trigger a consumption boom as agents increase their demand for consumption or investment goods when they are "cheap", in other words, before the possible collapse of the currency. The economic consequences of stabilization programs using exchange rate or monetary aggregates as nominal anchors have been widely studied in the literature, see for example Calvo and Vegh (1999), Tornell and Westermann (2002), Hamann et al. (2005) and Ranciere et al. (2005). One stylized fact that emerged from country experiences is that economies often go into a "boom-bust cycle", a boom period often terminated by crises and an eventual recession. Overvaluation of RER, unavoidable consequence of having a peg in an economy where the upward pressure of high inflation cannot be offset by an increase in productivity, plays a pivotal role in this outcome. Hamann et al. (2005) listed stabilization programs implemented during the 1960-2001 period. They defined a stabilization episode as a period of substantial decline in inflation from a relatively high and persistent level which lasts at least 24 months. Then, stabilization is said to start at time T if significant decline in inflation begins in that month and does not revert back for at least 11 consecutive months.[10]

Checking our sample we found that 9 exit cases represent an exit from stabilization programs which have been identified by the abovementioned study, 8 exits from ERBS

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[8] See Bekeart et al. (2005) for country chronologies.

[9] Under DGAPT model, this figure becomes 77% (17 out of 22 exits in the post-liberalization period).

[10] For more information on episode determination and a list of programs with historical records see Hamann et al. (2005).

program and 1 from money based.[11] 8 out of 9 exits from stabilization programs have been placed in disorderly nodes by both EXIT and DGAPT models, verifying the criticisms mentioned above. In general, output boom is accompanied by real exchange rate overvaluation and many of them face speculative pressure ahead of exit. For these cases, on average, the output gap a year before exit reached 5.9% above trend followed by a contraction of -3.5% with a depreciation of 121% following the exit year. Note that for other exits, these values are 4.4%, -1.9% and 64% respectively.[12]

Regarding output volatility, on the stage set by financial liberalization and macroeconomic stabilization program, private credit plays an important role. In the next section I will investigate the link between private credit and output growth.

4.4.3 Credit and Output Boom

In theory, credit can grow as a result of financial deepening (trend), normal cyclical upturns or excessive cyclical movements (called credit booms). As mentioned earlier, a credit boom plays an important role in the making of most crises episodes. Recognizing the fact that most of the exits have taken place in the midst of a crisis raises questions on the role credit plays. Excessive credit growth may be the factor behind the unsustainable rise of output gap a year before exit and it is what I would like to investigate in this section.

WEO (2004) analyzes the credit expansion episodes in 28 emerging market countries between 1970 and 2002. It finds that cyclical upturn in economic activity is associated with credit booms followed by a deep contraction in output and private absorption. Price of non-tradables increases relative to tradables during a credit boom and then subsequently falls. Banks expand credit (mostly to N-sector) which is financed mainly by increased external borrowing. The ratio of debt to equity in the N-sector rises faster and is higher than that in the T-sector, reflecting the liability dollarization phenomenon.

Noting the fact that credit can grow faster than GDP as an economy develops – a process named financial deepening – the study makes a distinction between episodes of *rapid credit growth* and *excessive credit growth (credit booms).* A c*redit boom* episode is identified as an episode of credit expansion exceeding the standard deviation of that country's credit fluctuations around trend by a factor of 1.75. Real private credit (private credit deflated by CPI) is detrended by H-P filter, and since by construction the mean of fluctuations around the trend is expected to be zero, using a threshold with 1.75 standard deviation, observing credit booms are a 5% probability event.

An episode of *rapid credit growth*, on the other hand, is identified based on the evolution of real credit growth in years preceding credit booms. For 28 emerging market economies, the study establishes that the median rate of real credit growth preceding credit booms is 17%, and episodes with an average exceeding this threshold of real credit growth over three years are labeled as rapid credit growth.

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[11] Exchange rate based stabilization programs with their starting dates are as follows: Argentina December 1978, Brazil July 1994, Chile February 1978, Ecuador September 1993, Iceland March 1984, Mexico September 1988, Turkey December 1999, Uruguay October 1978. Money based stabilization program Malawi January 1995. See Hamann et al. (2005) and Calvo and Vegh (1999).

[12] Mean of output gap at t+1 and depreciation rate across exits from stabilization programs and other exits are statistically different at 10% significance level.

Following the same methodology for 133 countries between 1970 and 2004, I detected 116 episodes of credit boom. The median rate of real credit growth preceding credit boom episodes is found to be 12.5%. Using this threshold, I identify 232 episodes of rapid credit growth. Some 73 of these episodes end in a credit boom whereas the rest (159 episodes) represent normal cyclical movements of credit. After identifying the peak year of a credit boom and rapid credit growth episodes, I check how these peak years are distributed around exit year. Most of the credit boomers saw their credit peak at the year of exit, t=0. Countries with rapid credit growth episode, again, saw their credit growth peak mostly at t=0 and some at t-1, or a year before exit. In the event study analysis, this timing issue is important for expositional purposes. For that reason, I group countries (for instance, boomers having a peak during the exit year) so as to have a clearer view of the evolution of some selected variables around exit year. We have 59 exits in our sample with 11 placed in orderly and 48 in disorderly nodes.[13] The most reasonable distribution of episodes across exits placed in these nodes is as follows:

Group 1: Credit Booms associated with disorderly exits.

10 exits in disorderly nodes have been preceded by a credit boom episode with a peak taking place at t=0, exit year.

Group 2: Rapid Credit Growth associated with disorderly exits.

12 exits in disorderly nodes have been preceded by a rapid credit growth episode with a peak at either t-1 or t=0.

Group 3: Disorderly exits without Boom or Credit Growth.

16 exits in disorderly nodes have experienced neither credit boom nor rapid credit growth episodes between t-4 and t=0.

Group 4: Orderly exits without Boom or Credit Growth.

9 exits in orderly nodes have experienced neither credit boom nor rapid credit growth episodes between t-2 and t=0.

List of exits under these groups are found in Table A.I.2 in Appendix 3.

The **co-movement** of *credit* with *output*, *consumption* and *investment* for exit cases in Group 1 is highly visible in the first column of Figure 7. The same holds true for Group 2 cases which experienced rapid credit growth, yet with smaller amplitudes for cycles. Note that all of the exits in these groups have been placed in one of the disorderly nodes. For both groups, event study analysis indicates that it may be **excessive credit expansion** (either in the form of a credit boom or in rapid credit growth) which leads to output boom through higher private investment and consumption expenditures.

In Group 3, none of the countries experienced a credit boom or credit expansion episode around the exit year. Private credit, consumption and investment gaps are hardly different from zero. The change in output gap is relatively small compared to Group 1 and 2 but it is still -4.5% on average and that is why they have been classified as disorderly. **The link between credit and output is missing for these cases.** Note that only 5 of the 16 cases

[13] Note that for the sake of brevity, here I made groupings based on EXIT model's results.

had liberalized financial markets before exiting, which is perfectly in line with our argument above – on the disruptive short-term effect of liberalization.

What are the sources of volatility in the output then? Speculative pressure is one. Ten out of 16 exits in this group have faced a speculative pressure ahead of exit. Russia's 1998 and Brazil's 1999 exits can be explained by contagion. And, debt problems are apparent behind Ecuador's 1982, Colombia's 1983 exits. What is clear here is that credit growth was not behind the collapse of output for this group of countries.

Group 4 involves exits placed in orderly nodes. Evolution of variables around trend is flat and cannot be distinguished from the zero line. None of the countries experienced a credit boom nor rapid credit expansion episodes. One interesting observation is that 8 out of 9 orderly exits have been managed during the pre-financial liberalization period. And capital controls were intensively at their disposal (except Japan's 1977 exit) by the time of exit.

4.5 Results of Non-parametric Part

Our results show that, overvaluation and an unsustainably high output gap fuelled by real private credit and real consumption growths are the most important characteristics of disorderly exits from a fixed regime. As argued by Eichengreen and Masson (1998), it is better to exit early rather than late – before abovementioned vulnerabilities take their toll on the peg. Our results indicate that the sources of these vulnerabilities can be found and understood within the framework of ill-managed financial liberalization and macroeconomic stabilization.

Our results also suggest that less rigid pegs are more likely to exit compared to hard pegs. In a way this points out the credibility and stability enhancing features of hard pegs, as put by the hollowing out hypothesis *a la* Fischer (2001).

Optimum Currency Area literature argues that countries with high degrees of integration (more open) are more likely to have pegged regimes, since stable rates enhance the welfare gains derived from trade. See, for example Levy-Yeyati et al. (2006). Verifying the theory, we found that countries with less trade openness are more likely to exit. Having higher openness, on the other hand, increases the vulnerability of countries to external shocks, notably to shocks to Terms of Trade. In our EXIT tree, we found that, among the countries with higher openness, countries facing *Terms of Trade shock* are more likely to exit (see TN7 and TN9 for example).

Following the Asian crises in 1997, the structure of the financial sector gained importance among scholars. The size of currency, maturity mismatches and the liquidity of the banking sector are extremely important variables, among those variables found necessary to understand the dynamics of third generation currency crises, see for example Chang and Velasco (2000) and Levy-Yeyati et al. (2006). In this paper, I used *Banks' Liquid Reserves to Assets Ratio* as an indicator for the health of the banking sector, since more refined data, say on liability dollarization, was not available for the majority of countries in our sample. Yet, our finding supports the theory. In our DGAPT tree, we found that countries with a banking sector having high reserves to assets ratio have experienced relatively less painful post-exit realization of output, thanks to the decreased amplitude of the output cycle (see TN7). The s*peculative pressure index,* which was constructed so as to detect the pressure in the year to exit, can be used as a proxy indicating the size of the vulnerability caused by currency and maturity mismatches. Countries with sizable currency and maturity mismatches are expected to be more vulnerable to changes in the nominal exchange rate and interest rate. Expectedly, almost all of the exits which were followed by a period of speculative pressure were of disorderly types, showing the importance of these vulnerabilities which carry the potential of triggering a crisis when conditions turned unfavorable.

5. Parametric Methods and Comparison

How can we make use of our findings from CART analysis within standard methods? That is, is there a way to merge these two methodologies? We can see that CART trees split the sample into groups within which different vulnerabilities emerge, and indicate threshold values beyond which these vulnerabilities become effective. The effects of explanatory variables are expected to be different under different groups, for example when RER is overvalued and when it is not. There might be several ways to incorporate CART into regression analysis, but here I would like to propose a specific one. Namely, one can run several regressions with the full sample and also with each and every terminal node on the tree. Results can be compared across different terminal nodes and that of the full sample.

Of course the number of thresholds that can be accounted for depends on the sample size. Small number of exits, unfortunately, do not allow for considering more than one threshold in this study. Therefore, I will only use the first threshold given by our EXIT tree, namely RER overvaluation of 6.136%.

Recall that our EXIT tree started to split cases on the basis of overvaluation at the very top node. Cases with overvalued RER (greater than 6.136%) go to the right branch and others to the left. All of the terminal nodes on the right branch are of the disorderly type. Overvaluation of RER seems to be a very important factor.

Table 9 shows the probit estimation results when a binary EXIT variable is used as a dependent variable. After running the regression for the whole sample (note that among 650 observations, 224 of them have been dropped due to missing observations), I run the same model for the right (left) branch of our EXIT tree where overvaluation is greater (smaller) than 6.136%. The aim is to check how marginal effects of coefficients change once we restrict the sample to a small group of observations. Note that there are 85 (341) observations left after the exclusion of cases with lower (greater) overvaluation. The ratios of marginal effects of coefficients (evaluated at means) are given in the last 3 columns.

Changes in the marginal effects of some variables are immense. Take for example, *forced* (speculative pressure dummy) which is found to increase the likelihood of exiting over the whole sample. But **its effect is multiplied (by more than 2 folds)** when *overvaluation of RER* is present. And it is found to be insignificant when overvaluation is not an issue. The same is also true for the variable measuring *incidence of exit* in the preceding 12 months. Again, its effect is multiplied by more than 5 folds for countries having an overvalued RER. For the cases on the left branch where overvaluation is not present, this variable has a positive yet relatively small impact on exiting. US interest rate which has often been used to account for push-pull sources of capital flows (see Calvo et al. 1996, Hausmann and Rojaz-Suarez 1996) is found to significantly increase the likelihood of exit as expected. But surprisingly, once we restricted our sample to cases with overvalued RER, contrary to our expectations it lost its significance with a bigger marginal effect. Expectedly, it is less effective when overvaluation is not present.

Domestic credit to private sector has different impacts on exiting within two subsamples. When overvaluation is present, it significantly increases the likelihood of exiting, but in the absence of overvaluation its effect changes direction (the higher the credit the lower is the likelihood of exiting), but it becomes insignificant. This finding shows the importance of threshold effects. Note that within the full sample the mean of domestic credit to private sector is 46% of GDP; it is 41% for cases with overvaluation and 48% for cases without overvaluation. Overvaluation of RER increases the vulnerability of countries to an increase in domestic credit. The same increase does not have the same effect in countries without an overvaluation problem.

As our EXIT tree portrayed, *output gap* and *openness* are the most important splitters in the left branch of the tree when overvaluation is not present. This is also confirmed by our regression for the respective subsample (left branch). They are found to be significant in the regression run for the left branch observations but not for the right branch observations.

Coming to the Heckman selection model estimates, results are given in Table 10. The same regression is run for the full sample and for the cases with and without overvaluation (equation 11).[14] Let us start with the full sample results.

Facing speculative pressure, having a higher output gap, an overvalued RER, less openness, more incidences of exits, a less rigid pegged regime and a higher consumption gap above trend increases the likelihood of exiting (Selection equations of regressions 1 and 7). Once these factors were accounted for, a higher output gap and a longer duration of pegging significantly deteriorates the output following exit (main equations of regressions 1 and 3). Private investment, as opposed to private consumption, eases the exit by contributing positively to output growth. This shows the importance of how the area credit expansion is channeled. All others being equal, private consumption above trend decreases the output gap following exit (main equations of regressions 5 and 7).

As in probit results, *overvaluation threshold* has considerable effects on Heckman results. In addition to changes in marginal effects (not reported here), some coefficients change their signs and others lose significance under different samples.

Take the main equations of regressions 3 and 4 for example. Leaving other differences aside, *FDI to GDP* is found to be significant for the full sample but is not so when overvaluation is present. Budget balance is another variable, the effect of which differs when we take into account overvaluation. Higher *budget balance* decreases *output gap change* following exit when overvaluation is present, although it is not significant within the full sample. *Duration* of pegging is significant and negatively contributes to exiting in

[14] Unfortunately, insufficient sample size and lack of independence of the two equations (see Asici et al. 2007 for a discussion of statistical properties of Heckman selection models) limit the use of some subsample regressions presented in Table 10. Hence, discussion in the text makes use of regressions number 1-5, 7, 9 and 10.

an orderly way within the full sample, but its effect is nil on the right branch of the tree (Main equation of 1-5, 7 and 9). Coming to the role capital controls play during exit, I verified our early conclusion in Asici et al. (2007) that capital controls ease the pain during exiting by significantly contributing to the output gap. Yet its effect becomes insignificant when we limit our analysis to the right branch where overvaluation is present (main equations of regressions 9 and 10).

These exercises show the importance of threshold effects (non-linearities) in analyzing events where combined effects of fragilities are responsible in the making of events like exiting, crises etc. They also show that the conventional strength of parametric methods can be dramatically improved by employing non-parametric CART methodology. This can be seen from the changes in coefficient estimates in terms of both magnitude and sign, when the full sample is split in line with the thresholds given by CART. Note that sample size prevented us to account for more than 1 threshold. With a larger sample size one can further refine the conclusions by running the same regressions for a smaller group of countries, for each terminal node at the limit for example. Under regression framework, it is theoretically possible to compute marginal effects at some values other than sample means. However, practically these exact values are unknown to a researcher. CART analysis shows where to look, how and at what value non-linearities have emerged. In short, it would not be wrong to claim that both approaches are complementary to each other, rather than substitutes.

6. Conclusions

As of August 2006, IMF's de facto regime classification revealed that among 187 countries, 111 have been pursuing one form or another of a fixed regime (ranging from currency board to crawling peg). Secondly, of 132 countries covered in this paper, Harvey et al. (2005) dataset reveals that 65 were still expected to take steps towards liberalization by end-2005. When and how to exit is still an important question, given the fact that the most disruptive exits have occurred during the post-liberalization period. The challenges confronting developing countries with fixed regimes are obvious.

Overvaluation of RER, a higher output gap above trend fuelled mostly by a private consumption boom, and facing speculative pressure before exit are the most common characteristics of disorderly exits from fixed regimes. The sources of these fragilities can be found within the context of an immature financial liberalization and poorly constructed macroeconomic stabilization programs. As vulnerabilities set in, a small decrease in Terms of Trade or an increase in external debt can easily put the viability of the peg in question, and more often than not, the exit occurs in a disorderly fashion. Having a less rigid fixed regime may limit overvaluation of RER, but it is still not enough to save countries from exiting in a disorderly fashion. Our EXIT tree revealed that in the absence of overvaluation, output gap is the most important condition separating disorderly exits from orderly ones. A closer look at countries hints that countries with a more rigidly fixed regime have done relatively better in keeping their output on trend following exit.

For the majority of disorderly exits, close co-movement of private credit with consumption, investment and output before exit is clearly observed. It continues to hold in the period following the exit, but in opposite direction. As credit lines dry up, consumption and investment fall, leading to an output collapse. One interesting point is that, it is not rapid credit growth per se that is important, but rather the activity for which it has been used – consumption or investment. If the credit expansion is used to finance private consumption, this makes exits more painful as our regression results show. In contrast, credit expansion which is used to finance private investment helps countries to sustain their output growth on-trend, all other factors being equal. Our DGAPT tree shows that this conclusion holds when there isn't a consumption and investment boom at the same time. That is, a private investment boom coupled with a consumption boom, can make exits more painful

Our analysis also shows the importance of the timing of financial liberalization. Almost all countries in orderly nodes have exited before liberalization took place. And all of them had capital controls at work. We did not detect any major deviation of RER nor an output gap from their long-term trend in the magnitudes those disorderly exits experienced. Increased financing opportunities following liberalization, if not adequately monitored, carries a potential of creating an unsustainable economic boom and paves the way to the eventual bust period. Therefore, without loss of generality we can conclude that countries would do better by having exchange rate flexibility before taking liberalization steps.

Inadequately managed financial liberalization is not the only source of volatility, however. Stabilization programs have also been accused of creating boom-bust cycles in domestic economies. Irrespective of liberalization, almost all the countries in our sample, whose stabilization episodes ended by exiting the peg, have done so in a disorderly fashion. Countries should keep in mind that poorly-constructed stabilization plans may become a cause for bigger instability in the future.

As financial globalization keeps integrating countries into the world financial system, we are observing fewer occurrences of financial crises compared to the 1990s. This is the result of two developments the first being favorable external conditions – namely lax monetary stance in world financial centers – and high commodity prices. Both are permitting developing countries to sustain high levels of growth. Secondly, especially after the Asian crises, international financial institutions have put more emphasis on the health and regulation of the domestic financial sector. Prudent banking standards and regulations help countries to better cope with the negative consequences of capital outflows. Favorable external conditions should not be expected to continue forever, however. The current patch of strong growth can be sustained in the long-run by taking steps to contain sources of vulnerabilities while markets are calm. As mentioned, adequate regulation and supervision of financial sector is one of them. The existence of shocks, like Terms of Trade collapse, constitutes another source of vulnerability. In that respect, countries should be encouraged to diversify their production mix beyond primary products so as to contain the disastrous effects of price slumps in world markets.

Coming to the comparison of the two approaches, we see that the conventional strengths of parametric methods can be dramatically enhanced by non-parametric methods, especially when analyzing discontinuous events like crises, or abandoning the peg. The standard regression framework is not totally appropriate for measuring the combined effects of variables. Disregarding the existence of non-linearities may lead to the dismissal of important variables from the analysis and lead to wrong or incomplete conclusions. Non-parametric methods are good at uncovering these kinds of non-linearities and would guide researchers where to look and more importantly indicate threshold values beyond which such non-linearities become effective. In that sense the two approaches should not be seen as substitutes but rather as complimentary.

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Figure 1: The Distribution of Class-A and Class-B Observations

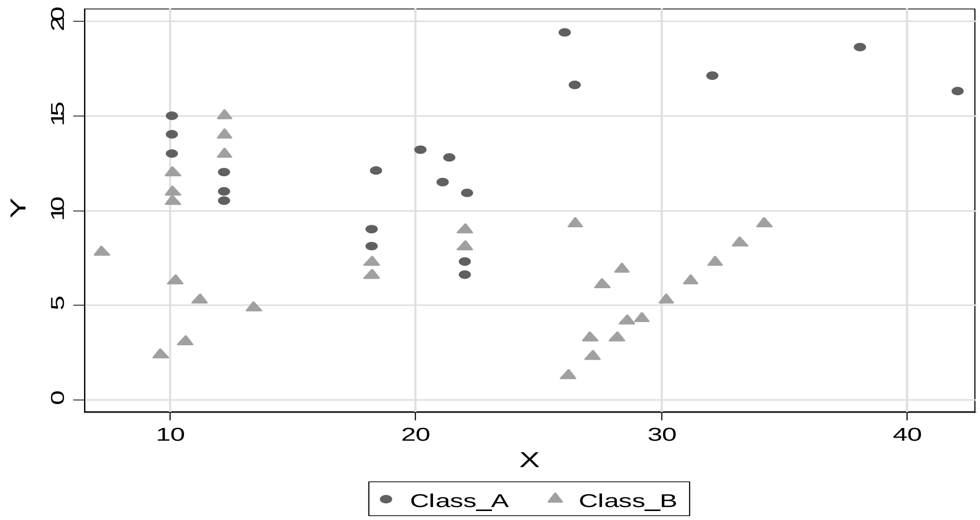


Figure 2: The Partitioning into Groups

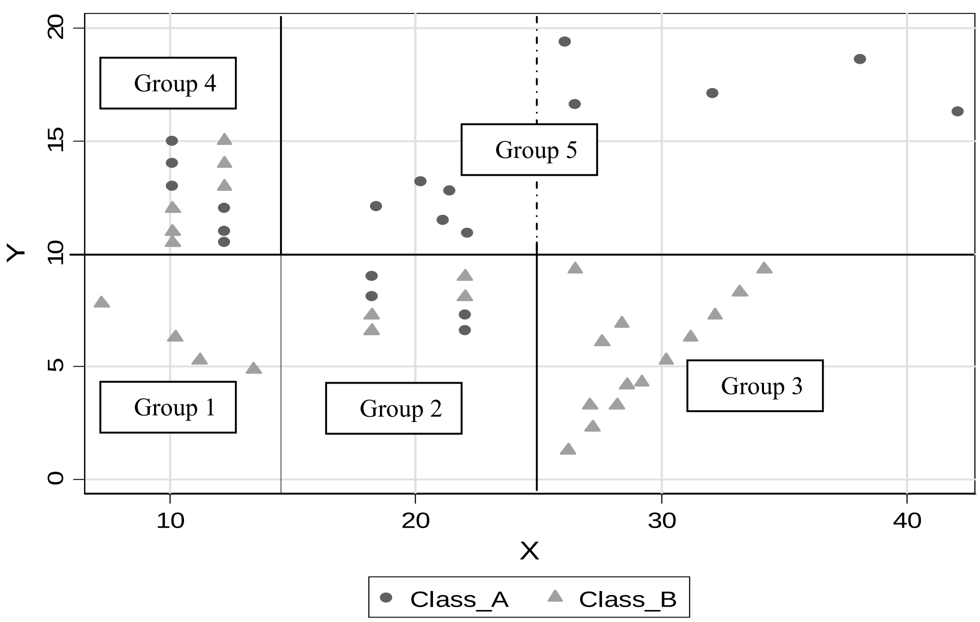


Figure 3: The Classification Tree

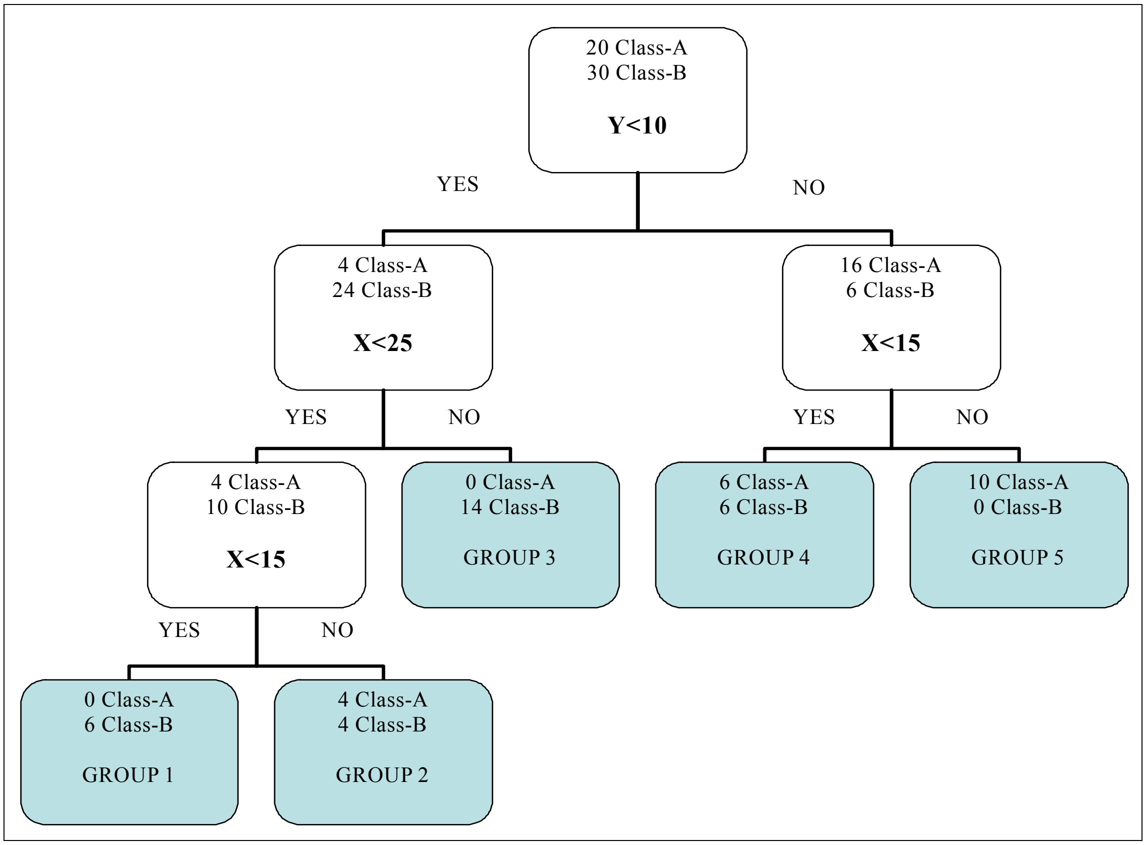


Figure 4: Misclassification Cost under Full and Test Samples

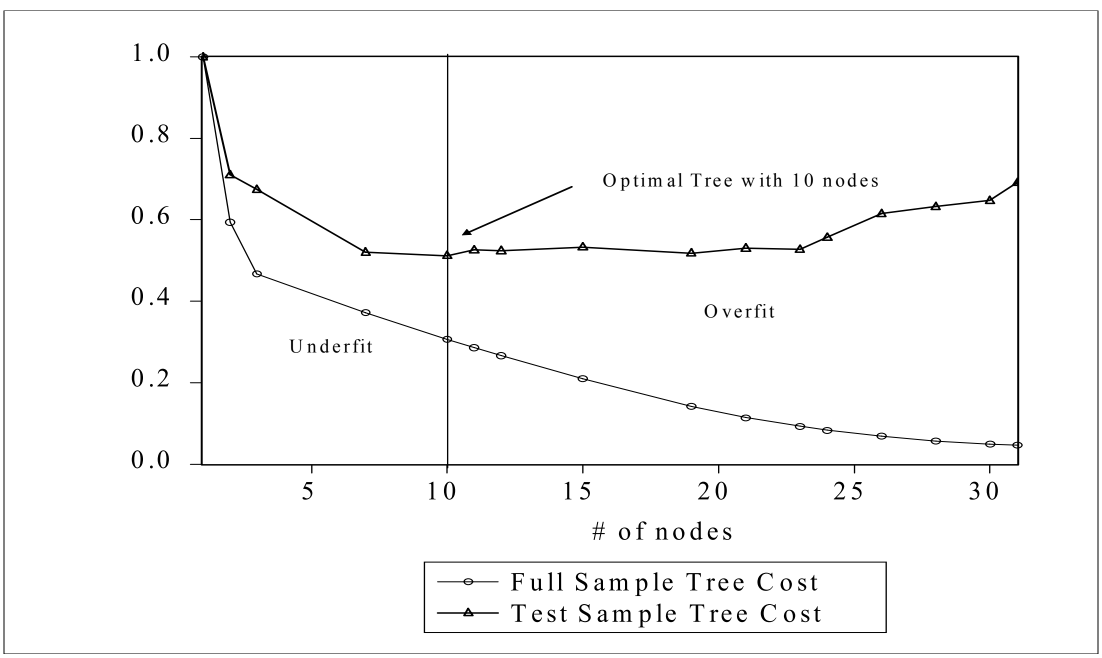
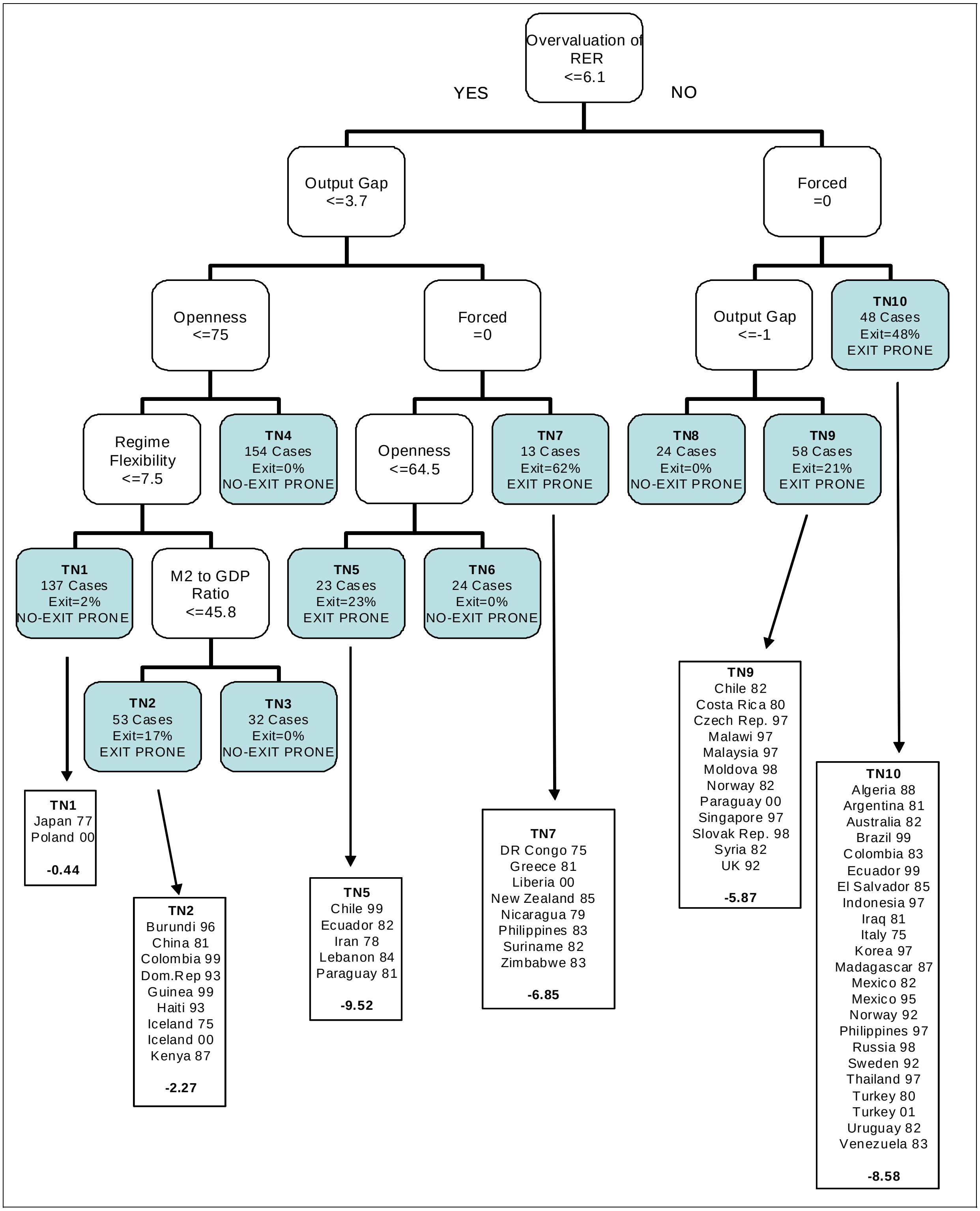


Figure 5: EXIT Model Tree



Note: Figures below country lists represent the mean output gap change within the nodes.

Figure 6: DGAPT Model

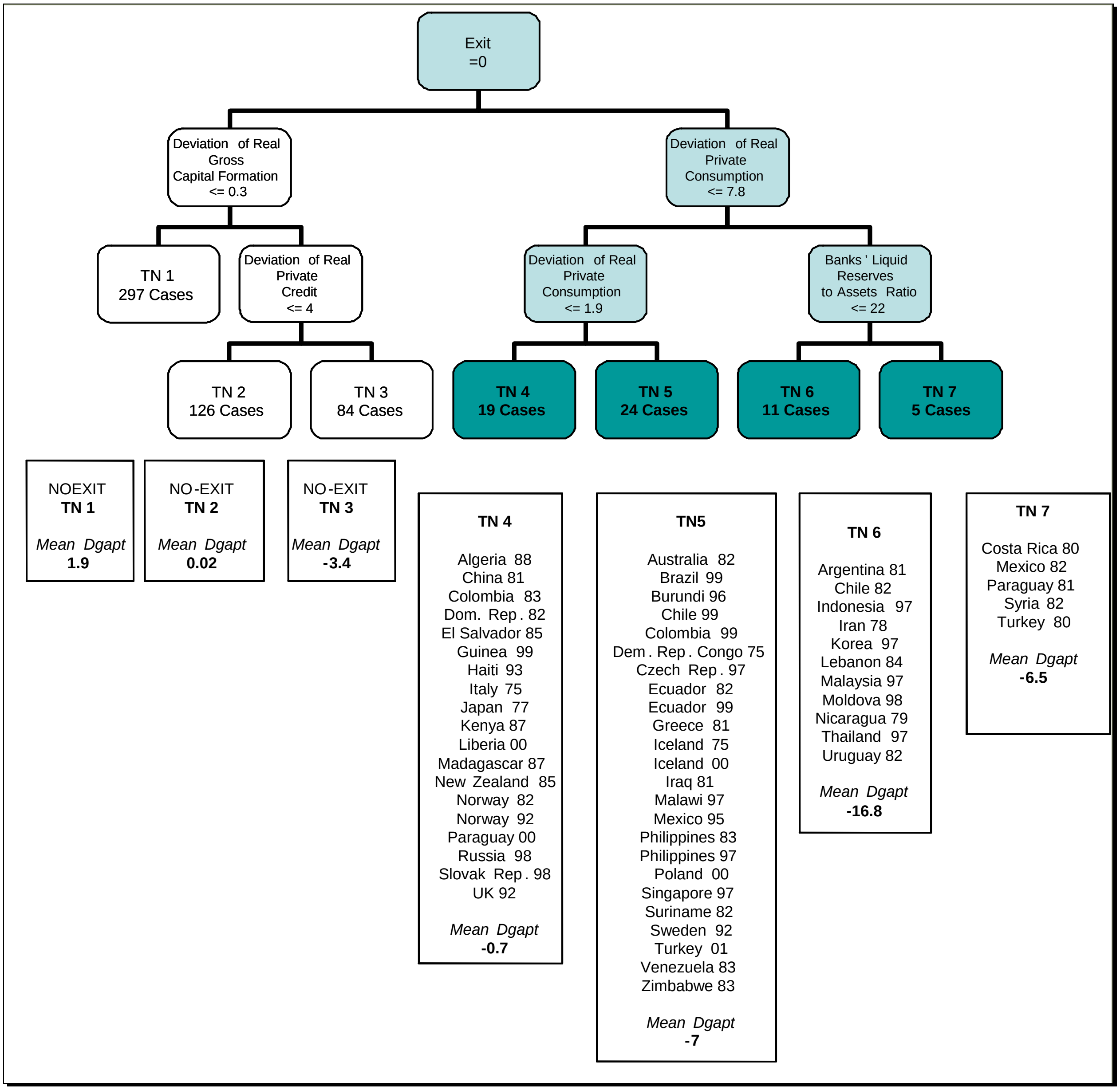


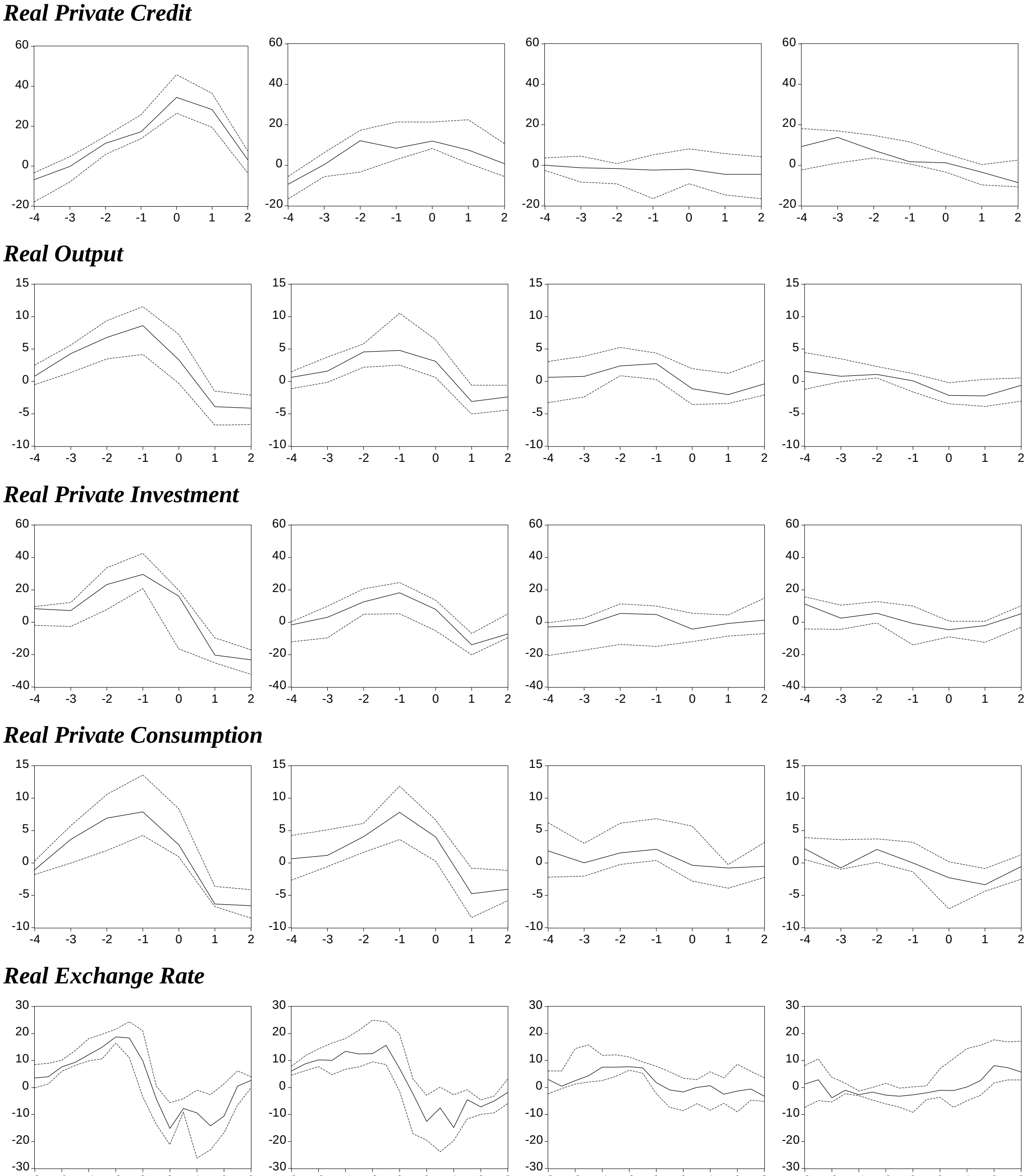
Figure 7: EXIT Model: Selected Variables around Exit Time

(% deviation from H-P trend)

Bold line : Median **Dashed lines** : Upper and lower quartiles

DISORDERLY TNs | ORDERLY TNs

1. Credit Boom *2. Rapid Credit Gr.* *3. No Boom/Gr.* *4. No Boom/Gr.*



Note: The upper (lower) quartile is the smallest (largest) value of the highest (lowest) 25 percent of all observations in each year (quarter for real exchange rate series). Orderly nodes under EXIT model are TN1 and TN2, disorderly nodes are TN3, TN5, TN7, TN9 and TN10.

Table 1: Exit Observations

Country	Time	Country	Time
Algeria	1988m1	Liberia	2000m12
Argentina	1981m3	Madagascar	1987m6
Australia	1982m8	Malawi	1997m7
Brazil	1999m2	Malaysia	1997m8
Burundi	1996m5	Mexico	1982m2
Chile	1982m6	Mexico	1995m1
Chile	1999m9	Moldova	1998m8
China	1981m3	New Zealand	1985m3
Colombia	1983m5	Nicaragua	1979m4
Colombia	1999m10	Norway	1982m8
Democratic Rep. of Congo	1975m1	Norway	1992m12
Costa Rica	1980m10	Paraguay	1981m9
Czech Republic	1997M6	Paraguay	2000m12
Dominican Republic	1982m9	Philippines	1983m10
Ecuador	1982m3	Philippines	1997m7
Ecuador	1999m2	Poland	2000m4
El Salvador	1985m9	Russia	1998m9
Greece	1981m7	Singapore	1997m7
Guinea	1999m11	Slovak Republic	1998m10
Haiti	1993m5	Suriname	1982m5
Iceland	1975m8	Sweden	1992m12
Iceland	2000m10	Syria	1982m6
Indonesia	1997m8	Thailand	1997m7
Iran	1978m11	Turkey	1980m1
Iraq	1981m1	Turkey	2001m2
Italy	1975m10	United Kingdom	1992m9
Japan	1977m2	Uruguay	1982m11
Kenya	1987m1	Venezuela	1983m3
Korea	1997m12	Zimbabwe	1983m7
Lebanon	1984m3		

Source: Reinhart Rogoff (2004).

Table 2: Option Setting and Sensitivity

Option	EXIT Model	DGAPT Model	Default Setting	Sensitivity
Splitting Criterion	Entropy	Least Absolute Deviation	Gini and Least Squares	Low
Parent Node Size	10	10	10	Low
Child Node Size	1	3	1	Low
Missigness Penalty	1.8	1	No penalty	High (conditional)
Best Tree	Minimum cost tree	Minimum cost tree	Minimum cost tree	Low
Misclassification Cost	All classes count equally	All classes count equally	All classes count equally	High

Table 3: Descriptive Statistics: Exit vs. No-Exit

	No-Exit		Exit	
Variable	***Obs.***	**Mean**	***Obs.***	**Mean**
Output Gap Change	465	0.4	55	-6***
Overvaluation	435	-0.04	54	8.6***
Output Gap	465	-0.11	55	3.7***
Openness	445	77	55	55***
Speculative Pressure dummy	395	0.13	53	0.6***
Regime Flexibility	377	5	51	25***
Trade Balance	452	-4.49	55	-4.76
M2 to GDP	393	51.8	53	40.3***
M3 to GDP	399	51.7	53	40.8***
Liquid Liabilities	373	50.94	50	42.94**
Incidence of Exits	481	0.0346	56	0.04**
Inflation	443	8.88	56	14.21**
Change in US interest rate	481	-0.04	56	-0.04
US Interest rate	481	6.56	56	7.39*
Terms of Trade	434	103.86	56	105.88
Duration of Peg	481	140	56	117**
Foreign Direct Investment	456	1.68	55	1.43
Long-term Debt	267	48.35	41	36.3***
Public Debt	267	45.32	49	31***
Change in Trade Balance	450	0.11	55	-0.45
Short-term Debt to Total Debt	270	13.06	41	21.6***
Bank's Liquid Reserves to Assets	437	12.49	55	13.64
Capital Controls	453	0.68	59	0.78*
Trade Concentration Index	341	0.28	48	0.3
Current Account Balance	457	-2.7	56	-5.4***
Domestic Credit	419	55.94	49	50.01
Domestic Credit to Private Sector	437	46.4	55	43.02
Total External Debt	267	57.67	41	46.7**
Budget Balance	425	-3.26	52	-3.39
Change in Budget Balance	399	0.07	50	-0.9***
Real Private Consumption Gap	429	-0.3	50	1.8
Real Gross Capital Formation Gap	437	-0.9	53	11***
Real Private Credit Gap	423	-4	52	7***
Private Consumption	455	64.3	55	65.4
Gross Capital Formation	452	23.9	55	24.5
Real Private Consumption Growth	427	3.8	51	1
Real Gross Capital For. Growth	432	6.9	54	3.3
Real Private Credit Growth	434	8.5	54	6.2

Table 4: Terminal Node Information for EXIT Model

TN No	Route	Surrogates	# of Cases	# of Exit	Conditional Exit Probability
1	Overvaluation<=6.1; Output Gap<=3.7; Openness<=75; Regime Flexibility<=7.5	Lower duration and lower com. price index compared to TN2 and TN3	137	2	2%
2	Overvaluation<=6.1; Output Gap<=3.7; Openness<=75; Regime Flexibility>7.5;M2 to GDP<=45.8	Higher inflation and lower dom. credit compared to TN3	53	9	17%
3	Overvaluation<=6.1; Output Gap<=3.7; Openness<=75; Regime Flexibility>7.5; M2 to GDP>45.8		32	0	0%
4	Overvaluation<=6.1; Output Gap<=3.7; Openness>75		154	0	0%
5	Overvaluation<=6.1; Output Gap>3.7; Forced=0; Openness<=64.5	Lower public and long-term debt to GDP compared to TN6	23	5	22%
6	Overvaluation<=6.1; Output Gap>3.7; Forced=0; Openness>64.5		24	0	0%
7	Overvaluation<=6.1; Output Gap>3.7; Forced=1	Lower TOT and higher depreciation compared to TN5 and TN6	13	8	62%
8	Overvaluation>6.1; Forced=0; Output Gap<=-1		24	0	0%
9	Overvaluation>6.1; Forced=0; Output Gap>-1	Bigger decrease in TOT, higher increase in external debt, higher private credit compared to TN8	58	12	21%
10	Overvaluation>6.1; Forced=1	Lower openness and higher depreciation before exit compared to TN9	48	23	48%
Memorandum Items			**Total** 566	**Exit** 59	**Uncond. Probability** 10.4%

Table 5: Mean Difference t-Test of Output Gap Change: EXIT Model

Exit Probability		2 %	17 %	0 %	0 %	23 %	0 %	62 %	0 %	5 %	48 %
	Node	TN1	TN2	TN3	TN4	TN5	TN6	TN7	TN8	TN9	TN10
2 %	TN1										
17 %	TN2	-1.8									
0 %	TN3										
0 %	TN4										
23 %	TN5	-9.1**	-7.3**								
0 %	TN6										
62 %	TN7	-6.4*	-4.6*			2.7					
0 %	TN8										
21%	TN9	-5.5*	-3.6*			3.6		1			
48 %	TN10	-8.1**	-6.3**			0.9		-1.7		-2.7	

Note: Figures show the mean difference between nodes (row node minus column node).
*** indicates statistically different means at 1% significance level, ** at 5% and * at 10%.

Table 6: Mean Difference t-test of Output Gap Change: DGAPT Model

Terminal Node	TN4	TN5	TN6	TN7
TN4				
TN5	-6.3***			
TN6	-16.2***	-9.8***		
TN7	-5.8***	0.6	10.4***	

Note: Figures show the mean difference between nodes (row node minus column node).
*** indicates statistically different means at 1% significance level.

Table 7: Terminal Node Information for DGAPT Model[15]

TN No	Route	Surrogates	Output Gap Change: Cases	Mean	Median	Min/Max
4	Deviation of Real Private Consumption <=1.9	Higher improvement in current account balance and lower deviation of investment compared to TN5	19	-0.7	-0.9	-6.9/8.7
5	1.9 < Deviation of Real Private Consumption <=7.8		24	-7	-5.2	-54.7/1.5
6	Deviation of Real Private Consumption >7.8; Banks' Liquid Reserves to Assets <=22	Higher exports to imports, lower inflation and higher domestic credit to private sector compared to TN7	10	-16.8	-17.5	-22.9/ -10.8
7	Deviation of Real Private Consumption >7.8; Banks' Liquid Reserves to Assets >22		5	-6.5	-5.9	-10.7/-4
Memorandum Items						
Top Node		**Exit=1**	58	-6.6	-5	-54.7/8.7
		Exit=0	487	0.55	0.5	-21.5/47.5

[15] Table shows information on nodes containing exit cases only. Terminal nodes 1-3 contain no-exit cases.

Table 8: Descriptive Statistics: Orderly vs. Disorderly Nodes under Models

	Models		
Variable	**EXIT†**	**DGAPT**	**COMBINED**
Output Gap Change	5.7***	8.8***	9.4***
Overvaluation	-16***	-5.3	-17.6**
Output Gap	-5.4***	-4.4**	-7***
Openness	-19.2**	-15.4	-31**
Speculative Pressure dummy	-0.6***	0.04	-0.32
Regime Flexibility	-0.7	-12.8*	-15*
Trade Balance	-1.1	2.4	1.8
M2 to GDP	-4.3	6.4	3.2
M3 to GDP	-3.7	5.7	5.1
Liquid Liabilities	-2.1	12.6	13.5
Incidence of Exits	-0.01	-0.01	-0.01
Inflation	-1.2	-6.6*	-6.9*
Change in US interest rate	-0.05	-0.12	-0.18
US Interest rate	-1.4	-1.5*	-1.3
Terms of Trade	-5	-5	-6.8
Duration of Peg	32	-11	21
Foreign Direct Investment	-0.8	-0.8	-1.6***
Long-term Debt	13.7	24.3	17.7
Public Debt	14.7	25.7*	23
Change in Trade Balance	0.7	2.2**	2.2*
Short-term Debt to Total Debt	-10**	-6.4	-10.5*
Bank's Liquid Reserves to Assets	4.7	4.4	15.1
Capital Controls	0.27***	0.25***	0.34***
Trade Concentration Index	0	0.03	0
Current Account Balance	1.4	2.5*	3.4*
Domestic Credit	-5.4	7.5	3.5
Domestic Credit to Private Sector	-3.3	0.6	-0.5
Total External Debt	5.3	41.3	17
Budget Balance	0.05	-1.2	-1.1
Change in Budget Balance	0.8	0.3	0.7
Real Private Consumption Gap	-0.5	-19.1*	-10.7***
Real Gross Capital Formation Gap	-15.2**	-14*	-24.7**
Real Private Credit Gap	-3.6	-9.7**	-9.6***
Private Consumption	7	4.3	9.5
Gross Capital Formation	-2.1	-2.7	-2.9
Real Private Consumption Growth	2.5	-15.7	-1.3
Real Gross Capital Form. Growth	-9.4	-3.4	-13.7
Real Private Credit Growth	-4.2	-5.3*	-7.9*

† ORDERLY nodes' mean **minus** DISORDERLY nodes' mean in EXIT, DGAPT. COMBINED contains cases which are classified as same by both models Mean difference t-test with null hypothesis of equal mean;
*** significant at 1%, ** 5%; * 10%.

Table 9: Probit Estimates

	Full Sample (I)	Overvaluation >=6.136♣ (II)	Overvaluation <6.136♥ (III)	Marginal Effects Ratios		
Variables	EXIT	EXIT	EXIT	II/I	III/I	III/II
Forced	0.887	1.299	0.438	2.82	0.26	0.09
	*(3.98)****	*(2.85)****	*-1.48*			
Output Gap	0.097	0.012	0.099	0.36	0.61	1.70
	*(3.72)****	*-0.29*	*(3.14)****			
Overvaluation	0.036	0.106	-0.011	8.18	-0.18	-0.02
	*(3.07)****	*(2.81)****	*-0.57*			
Openness	-0.008	-0.005	-0.01	1.77	0.79	0.45
	*(1.97)***	*-0.69*	*(2.03)***			
Exit Incidence	6.675	12.128	7.697	5.02	0.68	0.14
	*(3.53)****	*(2.92)****	*(3.13)****			
Dep. Before	0.015	0.017	0.011	3.03	0.46	0.15
	*(2.22)***	*-1.24*	*-1.23*			
Dom. Cr. to Prv. Sector	0.002	0.023	-0.006	25.82	-1.37	-0.05
	-0.65	*(2.88)****	*-0.8*			
Change in US interest rate	0.549	0.296	0.602	14.91	0.65	0.04
	*(1.87)**	*-0.52*	*(1.70)**			
Observations	426	85	341			
Adjusted R^2	0.34	0.49	0.25			

Robust z statistics in parentheses. *significant at 10%;
** significant at 5%;
*** significant at 1%; constant not reported. ♣Right branch of EXIT tree. ♥ Left branch of EXIT tree

Table 10: Heckman Selection Model Estimates

Main Equation Change in Output Gap	1 All Sample	2 Right Branch♣	3 All Sample	4 Right Branch	5 All Sample	6 Right Branch	7 All Sample	8 Right Branch	9 All Sample	10 Right Branch	11 Left Branch
Output Gap	-1.015***	-1.070***	-0.972***	-1.044***	-1.195***	-0.726**	-0.799***	-0.640**	-0.92***	-1.04***	-0.698***
	[8.96]	[7.80]	[8.31]	[9.01]	[7.48]	[2.55]	[4.56]	[2.29]	[7.51]	[9.82]	[3.02]
Duration	-0.010*	0.000	-0.012*	0.001	-0.012*	-0.006	-0.012*	-0.010	-0.012**	-0.002	-0.008
	[1.65]	[0.02]	[1.85]	[0.18]	[1.96]	[0.72]	[1.77]	[1.11]	[2.03]	[0.31]	[0.76]
FDI	0.430	0.023	0.577*	0.677	0.120	-0.160	0.230	-0.123	0.58**	1.05**	0.334
	[1.53]	[0.03]	[1.91]	[1.13]	[0.36]	[0.24]	[0.72]	[0.19]	[1.98]	[2.06]	[0.98]
Overvaluation	0.048	0.015	0.026	0.023	0.016	-0.015	0.018	-0.007	0.031	0.045	0.161*
	[1.09]	[0.17]	[0.59]	[0.28]	[0.35]	[0.17]	[0.38]	[0.09]	[1.00]	[0.49]	[1.92]
Dom. Cr. To Prv. Sec.	-0.020	-0.019	-0.014	-0.006							
	[1.37]	[0.89]	[0.96]	[0.33]							
Budget Balance			0.032	-0.331**					-0.11	-0.517***	0.143
			[0.21]	[2.07]					[0.84]	[3.72]	[0.77]
Private Invest. Gap					0.080*	-0.081					
					[1.92]	[1.15]					
Private Cons. Gap							-0.279*	-0.417*			
							[1.87]	[1.81]			
Capital Control									3.01**	1.71	5.490**
									[2.56]	[1.62]	[2.10]
Selection Equation Exit dummy											
Forced	0.738***	1.225***	0.829***	1.182**	0.667***	1.364***	0.619**	1.284***	0.849***	1.342***	0.481
	[3.17]	[2.64]	[3.30]	[2.37]	[2.68]	[2.97]	[2.38]	[2.72]	[3.32]	[2.82]	[1.37]
Output Gap	0.094***	0.016	0.118***	0.021	0.096***	0.034	0.024	0.024	0.125***	0.056	0.145***
	[3.93]	[0.28]	[4.35]	[0.36]	[2.76]	[0.50]	[0.61]	[0.34]	[4.52]	[1.07]	[4.21]
Overvaluation	0.036***	0.109***	0.031**	0.098**	0.040***	0.092**	0.048***	0.095**	0.031**	0.079**	-0.011
	[3.19]	[2.79]	[2.55]	[2.31]	[3.35]	[2.41]	[3.68]	[2.47]	[2.41]	[2.06]	[0.48]
Openness	-0.007**	-0.005	-0.008**	-0.003	-0.006	0.003	-0.005	0.002	-0.007*	0.004	-0.013**
	[2.08]	[0.60]	[2.19]	[0.30]	[1.59]	[0.47]	[1.33]	[0.31]	[1.77]	[0.60]	[2.09]
Incidence of Exits	4.884**	11.151**	5.255**	11.102**	5.309**	9.846**	5.452**	10.313**	5.119**	7.933*	5.585
	[2.17]	[2.42]	[2.20]	[2.22]	[2.25]	[2.15]	[2.21]	[2.24]	[2.07]	[1.79]	[1.60]
Regime Flexibility	0.020***	0.018	0.020***	0.019	0.024***	0.021	0.025***	0.020	0.019***	0.011	0.020**
	[3.18]	[1.17]	[3.09]	[1.14]	[3.29]	[1.40]	[3.17]	[1.35]	[2.95]	[0.78]	[2.41]
Dom. Cr. To Prv. Sec.	0.002	0.022***	0.004	0.025***							
	[0.77]	[2.65]	[1.24]	[2.71]							
Budget Balance			0.039	0.027					0.043	0.049	0.032
			[1.49]	[0.48]					[1.59]	[0.94]	[0.89]
Private Invest. Gap					-0.005	0.002					
					[0.53]	[0.09]					
Private Cons. Gap							0.068**	0.025			
							[2.25]	[0.47]			
Capital Control									0.054	-0.460	0.416
									[0.19]	[0.88]	[0.99]
Observations	428	86	396	80	399	78	391	77	369	76	292
Uncensored obs.	376	58	348	55	352	53	345	51	324	53	271
Censored Obs.	52	28	48	25	47	25	46	26	45	24	21
Wald Chi²	121.3	92.1	107.6	114.3	108.8	70.3	128.5	98.2	126.5	150.1	71.48
Rho	0.56	0.85	0.58	1	0.53	0.49	0.47	0.22	0.47	0.94	0.339
Mill's Ratio	2.070**	2.798**	2.080**	2.811***	1.935**	1.554	1.673*	0.673	1.529*	2.15**	0.963
	[2.28]	[2.36]	[2.33]	[2.88]	[2.19]	[1.23]	[1.82]	[0.48]	[1.79]	[2.39]	[0.72]

Absolute value of z statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

♣ Right (Left) Branch of EXIT tree contains observations with overvaluation greater (smaller) than 6.136%.

Tables and Figures Appendix

Table A1: No-Exit Observations

Algeria (1979,1982,1985,1997,2000)	Honduras (1976,1979,1982,1985,1988, 1993,1996, 1999)	Morocco (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)
Argentina (1981)	Hong Kong (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	Nepal (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)
Armenia (1997, 2000)	Hungary (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	Netherlands (1976,1979,1982,1985,1988, 1991,1994, 1997)
Australia (1976, 1979)	Iceland (1985, 1988, 1991, 1994, 1997)	New Zealand (1976,1979,1982)
Austria (1976,1979,1982,1985,1988, 1991,1994, 1997)	India (1976,1982,1985,1988, 1991,1994, 1997, 2000)	Nicaragua (1976, 1994, 1997, 2000)
Azerbaijan (1998, 2001)	Indonesia (1976,1979,1982,1985,1988, 1991,1994)	Norway (1976,1979,1989)
Belgium (1979,1982,1985,1988, 1991,1994, 1997)	Iraq (1975, 1978)	Pakistan (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000,)
Bolivia (1989, 1992,1995, 1998, 2001)	Ireland (1976,1979,1982,1985,1988, 1991,1994, 1997)	Panama (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000,)
Bosnia-Herzegovina (1996, 1999)	Israel (1988, 1991,1994, 1997, 2000)	Paraguay (1975, 1978, 1988, 1991, 1994, 1997, 2000)
Botswana (1977, 1980, 1983, 1986, 1989, 1992,1995, 1998, 2001)	Italy (1985,1988, 1991,1995, 1998)	Peru (1998, 2001)
Bulgaria (1999)	Jamaica (1976,1981,1984,1987,1995, 1998, 2001)	Philippines (1977,1980, 1988, 1991, 1994)
Burundi (1975,1978, 1981, 1984, 1987, 1990, 1993, 1999)	Jordan (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	Poland (1997)
Canada (1976, 1979, 1982, 1985, 1988, 1991,1994, 1997, 2000)	Kazakhstan (2001)	Portugal (1976,1979,1982,1985,1988, 1991,1994, 1997)
Chile (1979, 1990, 1993, 1996)	Kenya (1981, 1984)	
China (1978, 1994, 1997, 2000)	Korea (1976,1979,1982,1985,1988, 1991,1994)	San Marino (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)
Colombia (1977, 1980, 1987, 1990, 1993, 1996)	Kuwait (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	Saudi Arabia (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)
Costa Rica (1977, 1985, 1988, 1991, 1994, 1997, 2000)	Latvia (1996, 1999)	Singapore (1976,1979,1982,1985,1988, 1991,1994)
Croatia (1996, 1999)	Lebanon (1975, 1978, 1981, 1994, 2000)	Slovak Republic (1995)
Cyprus (1976,1979,1982,1985,1988, 1991,1994,1997, 2000)	Liberia (1976,1979,1982,1985)	Slovenia (1994, 1997, 2000)
Czech Republic (1994)	Lithuania (1997, 2000)	Spain (1976,1979,1982,1985,1988, 1991,1994, 1997)
Denmark (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	Luxembourg (1976,1979,1982,1985,1988, 1991,1994, 1997)	Sri Lanka (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)
Dominican Republic (1976, 1979, 1994, 1997, 2000)		Suriname (1976,1979, 1996)
Ecuador (1976, 1979, 1996)		Sweden (1977, 1980, 1983, 1986, 1989)

Table A1 (continued)

Egypt (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	Macedonia (1997, 2000)	Switzerland (1985, 1988, 1991, 1994, 1997, 2000)
El Salvador (1976,1979, 1992, 1995, 1998, 2001)	Madagascar (1978, 1981, 1984)	Syrian Arab Republic (1976,1979,1990,1993, 1996, 1999)
Estonia (1994, 1997, 2000)	Malaysia (1976,1979,1982,1985,1988, 1991,1994, 2000)	Tanzania (1996, 1999)
Finland (1976,1979,1982,1985,1988, 1991, 1995, 1998)	Malta (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	Thailand (1976,1979,1982,1985,1988, 1991,1994)
France (1976,1979,1982,1985,1988, 1991,1994, 1997)	Marshall Islands (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	Tunisia (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)
Gambia, The (1975,1978,1993, 1996, 1999)	Mauritania (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	Uganda (1988,1995, 1998)
Greece (1975, 1978, 1988, 1991, 1994, 1997)	Mauritius (1979,1982,1985,1988, 1991,1994, 1997, 2000)	
Guatemala (1976,1979,1982,1993,1996, 1999)	Mexico (1979, 1992)	Uruguay (1999)
Guinea (1975, 1978, 1981,1987, 1990, 1993, 1996)	Micronesia, Federated States of (1988, 1991,1994, 1997, 2000,)	Venezuela (1977, 1980, 1998, 2001).
	Monaco (1976,1979,1982,1985,1988, 1991,1994, 1997, 2000)	
Haiti (1975, 1978, 1981, 1984, 1987, 1990)	Mongolia (2000)	

Source: Reinhart Rogoff (2004).

Table A2: Exit Cases under 2 Models

		Models			Criteria		Events♥		
Country	**Time**	**EXIT**	**DGAPT**	**COMBINED***	**dgapt****	**dep66**	**CB**	**RCG**	**SP**
Algeria	1988m1	0	1	.	0.9	23.3		t-4	
Argentina	1981m3	0	0	DISORDERLY	-11.7	294.3		t=0	
Australia	1982m8	0	0	DISORDERLY	-3.4	18.9			1
Brazil	1999m2	0	0	DISORDERLY	0.7	52.9			
Burundi	1996m5	1	0	.	-5.0	0.6			1
Chile	1982m6	0	0	DISORDERLY	-22.1	120.9	t-2		
Chile	1999m9	0	0	DISORDERLY	-5.2	4.5			
China	1981m3	1	1	ORDERLY	-4.0	3.3	t=0		1
Colombia	1983m5	0	1	.	-2.5	49.6		t-3	
Colombia	1999m10	1	0	.	-5.0	25.3			
Democratic Rep. of Congo	1975m1	0	0	DISORDERLY	-12.0	31.6			
Costa Rica	1980m10	0	0	DISORDERLY	-6.7	119.0	t=0		
Czech Republic	1997M6	0	0	DISORDERLY	-5.9	27.2			
Dominican Republic	1982m9	1	1	ORDERLY	-0.4	23.6	t=0		
Ecuador	1982m3	0	0	DISORDERLY	-8.1	77.5			
Ecuador	1999m2	0	0	DISORDERLY	-7.7	99.0			
El Salvador	1985m9	0	1	.	1.1	180.8	t=0		1
Greece	1981m7	0	0	DISORDERLY	-5.3	26.8	t=0		
Guinea	1999m11	1	1	ORDERLY	-0.9	22.8	t-2		
Haiti	1993m5	1	1	ORDERLY	-6.8	44.7	t-3		
Iceland	1975m8	1	0	.	-4.1	78.1			
Iceland	2000m10	1	0	.	1.5	27.8		t=0	
Indonesia	1997m8	0	0	DISORDERLY	-16.0	282.6		t=0	1
Iran	1978m11	0	0	DISORDERLY	-18.9	45.1		t-1	
Iraq	1981m1	0	0	DISORDERLY	-54.7	30.7			
Italy	1975m10	0	1	.	-2.7	60.1			
Japan	1977m2	1	1	ORDERLY	1.5	-7.9		t-4	
Kenya	1987m1	1	1	ORDERLY	4.2	31.5			
Korea	1997m12	0	0	DISORDERLY	-12.7	59.6		t=0	
Lebanon	1984m3	0	0	DISORDERLY	.	49.9			
Liberia	2000m12	0	1	.	8.7	32.1			
Madagascar	1987m6	0	1	.	2.4	96.3			
Malawi	1997m7	0	0	DISORDERLY	1.4	42.2			
Malaysia	1997m8	0	0	DISORDERLY	-11.3	52.2			1
Mexico	1982m2	0	0	DISORDERLY	-10.7	352.8	t=0		
Mexico	1995m1	0	0	DISORDERLY	-7.4	81.2	t-1		
Moldova	1998m8	0	0	DISORDERLY	-10.8	85.1		t=0	1
New Zealand	1985m3	0	1	.	-0.2	-15.8			
Nicaragua	1979m4	0	0	DISORDERLY	-22.7	157.9			
Norway	1982m8	0	1	.	-2.7	20.3			
Norway	1992m12	0	1	.	-1.1	14.9			
Paraguay	1981m9	0	0	DISORDERLY	-5.9	14.5	t-4		
Paraguay	2000m12	0	1	.	0.4	14.4			
Philippines	1983m10	0	0	DISORDERLY	-8.9	74.3	t-3		
Philippines	1997m7	0	0	DISORDERLY	-2.7	58.8	t=0		
Poland	2000m4	1	0	.	-2.4	11.5	t=0	t-1	
Russia	1998m9	0	1	.	-6.9	266.4			
Singapore	1997m7	0	0	DISORDERLY	-4.6	22.5		t=0	
Slovak Republic	1998m10	0	1	.	-2.3	22.2		t=0	
Suriname	1982m5	0	0	DISORDERLY	-7.0	25.0		t-3	
Sweden	1992m12	0	0	DISORDERLY	-5.8	34.6			
Syria	1982m6	0	0	DISORDERLY	-4.0	-3.7	t-1	t-1	
Thailand	1997m7	0	0	DISORDERLY	-19.5	102.9			
Turkey	1980m1	0	0	DISORDERLY	-5.0	58.1	t=0	t-3	
Turkey	2001m2	0	0	DISORDERLY	-5.5	107.9			
United Kingdom	1992m9	0	1	.	-2.0	16.1	t-3		1
Uruguay	1982m11	0	0	DISORDERLY	-22.9	165.8	t-2		
Venezuela	1983m3	0	0	DISORDERLY	-3.9	225.6	t=0	t-4	1
Zimbabwe	1983m7	0	0	DISORDERLY	-7.5	129.0			

*Labeled as ORDERLY (DISORDERLY) if case has been placed in orderly (disorderly) nodes by both EXIT and DGAPT models, . otherwise.

**Change in output gap between t-1 and t+1 and depreciation rate between t-6 and t+6

♥ CB: Credit boom peak year vis a vis exit year, t.; RCG: Rapid Credit Growth episode peak year; SP: Stabilization program dummy

Table A3: Data Description and Source

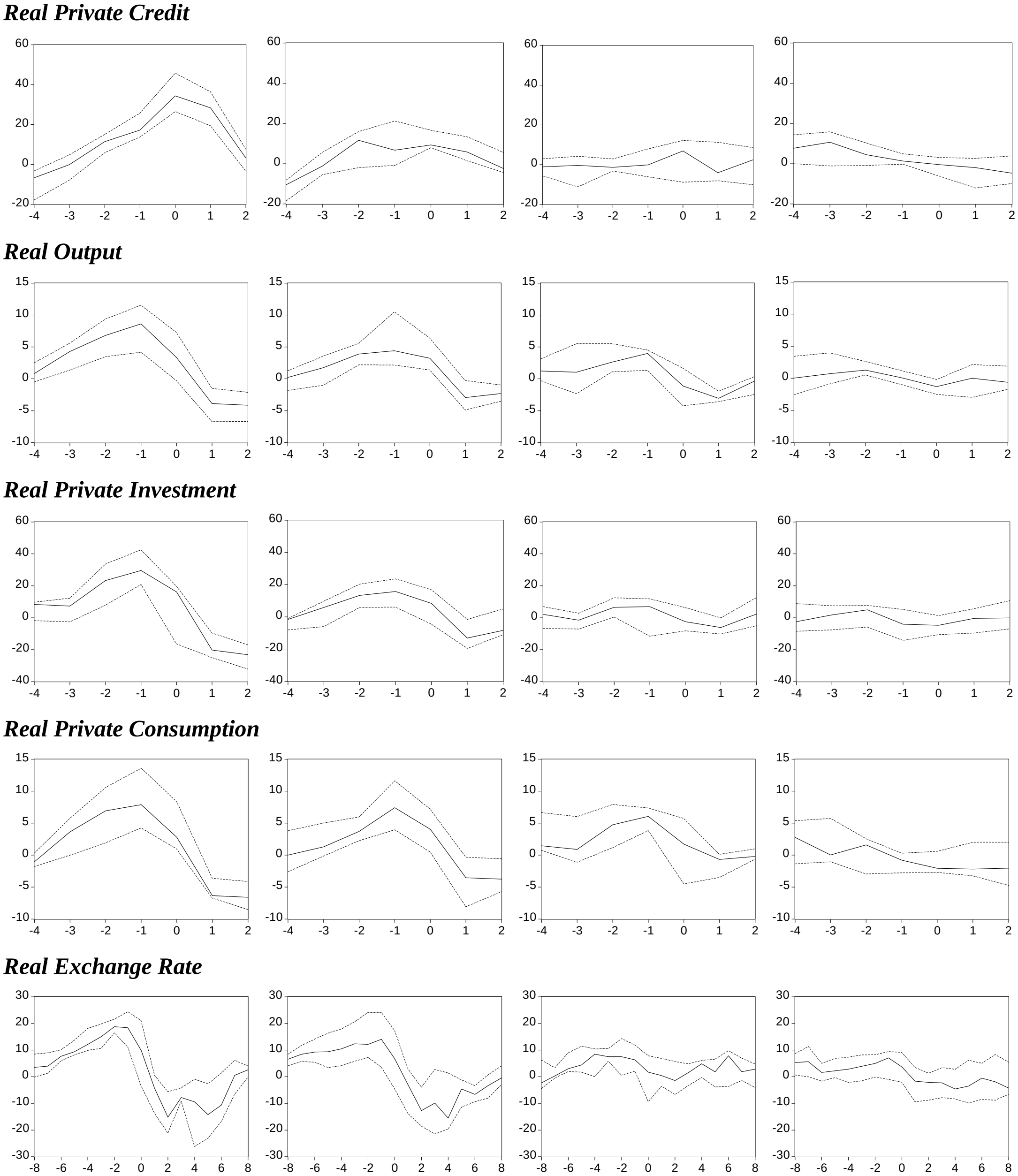
Name	Description	Source	Freq.
Output Gap	Deviation of Output from its HP Trend, GDP constant local currency	WDI, NY.GDP.MKTP.KN	Annual
Change in Output Gap	Change in Output gap between t-1 and t+1	author's calculation	Annual
Overvaluation	Deviation of quarterly Real Effective Exchange Rate from its HP trend	IFS	Quarterly
Openness	Trade in GOODS and SERVICES (% of GDP)	WDI, NE.TRD.GNFS.ZS	Annual
Speculative Pressure Index (Forced)	Weighted average of depreciation, change in interest rate and reserves	R&R(2004) dataset and IFS, 1L.DZF and 60.ZF	Monthly
Depreciation Before	Depreciation between t-1 and t-12	R&R(2004) dataset and IFS line AE.DZF	Monthly
Commodity Price Index	Weighted average of Food and Mineral Prices including oil, 2000=100	UNCTAD Trade Statistics	Annual
Trade Balance	Trade Balance as a percentage of GDP	WDI, NE.RSB.GNFS.ZS	Annual
Exports to Imports Ratio		WDI, NE.EXP.GNFS.CD, NE.IMP.GNFS.CD	Annual
M2 to GDP ratio		IFS line 34 and 35	Annual
Liquid Liabilities	Liquid Liabilities as a percentage of GDP	WB Financial Structure Database	Annual
M3 to GDP ratio		WDI, FS.LBL.LIQU.GD.ZS	Annual
Incidence of Exits	Incidence of exits in the previous 12 months	author's calculation	Monthly
Inflation		IFS line 64…XZF	Monthly
Budget Balance	Budget Balance as a percentage of GDP	WDI, GB.BAL.OVRL.GD.ZS and IFS, line 80.ZF	Annual
US Interest Rate		IFS line 11160B..ZF	Monthly
Duration	Number of months under the fixed exchange rate regime before the exit	author's calculation	
FDI	Foreign Direct Investment as a percentage of GDP	WDI, BX.KLT.DINV.CD.WD and BOPs	Annual
Long-term Debt	Long-term Debt as a percentage of GDP	WDI, DT.DOD.DLXF.CD	Annual
Public Debt	Public Debt as a percentage of GDP	WDI, DT.DOD.DPPG.CD	Annual
Short-term to Total External Debt		WDI, DT.DOD.DSTC.ZS	Annual
Bank's Liquid Reserves to Assets		WDI, FD.RES.LIQU.AS.ZS	Annual
Depreciation	Depreciation between t-6 and t+6	R&R (2004), and IFS line AE.DZF	Monthly
Exit	Exit dummy equals 1 if country exits, 0 otherwise	R&R (2004), Eichengreen et al. (2006)	
Capital Control	Capital Control Dummy	Ghosh et al. (2003) dataset	Annual
Concentration	Merchandise Export Concentration Index	UNCTAD Trade Statistics	Annual
Current Account	Current Account Balance as a percentage of GDP	WDI, BN.CAB.XOKA.GD.ZS, IMF BOP	Annual
Terms of Trade	2000=100	WEO (2003), UNCTAD and Ghosh et al.(2003)	Annual
Volatility of Terms of Trade Index	Standard deviation of TOT over 5 previous years		Annual
Domestic Credit to Private Sector	Domestic Credit to Private Sector as a percentage of GDP	WDI, FS.AST.PRVT.GD.ZS	Annual
Private Consumption	% growth and % deviation from its HP-trend, constant US dollars	WDI, NE.CON.PETC.KD.ZG	Annual
Private Invsetment	% growth and % deviation from its HP-trend, constant US dollars	WDI, NE.GDI.TOTL.KD.ZG	Annual
Volatility of Investment	Standard deviation of GFC formation to GDP over 5 previous years	IFS line 93E…ZF, and WDI, NE.GDI.FTOT.ZS	Annual
Stabilization Program dummy		Hamann et al. (2005), Calvo and Vegh (1999)	

Figure A1: DGAPT Model: Selected Variables around Exit Time

Bold line : Median **Dashed lines** : Upper and lower quartiles

DISORDERLY TNs — ORDERLY TN

1. Credit Boom *2. Rapid Credit Gr.* *3. No Boom/Gr.* *4. No Boom/Gr.*



Note: The upper (lower) quartile is the smallest (largest) value of the highest (lowest) 25 percent of all observations in each year (quarter for real exchange rate series). Under the DGAPT model the only orderly node is TN4, disorderly nodes are TN5, TN6 and TN7.