Are We Floating Yet? Duration of Fixed Exchange Rate Regimes

Menna Bizuneh

Published online: 26 October 2021
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Abstract
This study examines the duration of fixed exchange rate regimes to determine the factors that impact the probability of an exit from a peg. Using de facto exchange rate regime classification, we find that duration of a peg is non-monotonic. The results of the semi-parametric proportional hazard model highlight that GDP growth and openness decrease the probability of an exit from a peg, while growing unemployment and increasing claims on government increase the likelihood of abandoning a peg. The negative impact of economic growth on the hazard rate is robust when we use marginal risk analysis and net foreign assets and inflation are found to influence the pegged regime duration.

Keywords Exchange rate regimes · Survival analysis · Marginal risk analysis

JEL Classification E42 · F31 · F33

Introduction
The choice of exchange rate regime is a central topic in international finance and one that has been debated extensively. The salience of exchange rate regime in the open economy context is driven by the “trilemma” which postulates that countries can have only two out of three policy options among free capital mobility, monetary policy autonomy, and exchange rate stability (Mundell 1961). The increased cross-border flow of capital coupled with recent global crises has garnered a renewed interest on how countries navigate this trilemma by choosing different policy combinations (Aizenman and Hutchison 2011). Exchange rate regime choice has long-lasting effects on macroeconomic outcomes including but not limited to economic growth, inflation, sustainable trade balance, and international capital flow (e.g. Cheng et al. 2013; Giannellis and Koukouritakis 2013; Kim and

Menna Bizuneh
Menna_Bizuneh@pitzer.edu

1 Department of Economics, Pitzer College, Claremont, CA 91711, USA
Hammoudeh 2013; Kodongo and Ojah 2012; Verheyen 2012). Therefore, a country’s choice of exchange rate regime as well as its decision to switch its exchange rate regime are important policy issues in open-economy macroeconomics.

Since the collapse of Bretton-Woods in the 1970s countries have had various exchange rate regimes where many have exited fixed (pegged) exchange rate regimes in favor of flexible (floating) exchange rate regimes. The determinants of which types of exchange rate regimes should be implemented depending on a country’s characteristics have been theoretically predicted (see Mundell 1961; McKinnon 1963; Rizzo 1998; Frankel 1999; Fischer 2001; Poirson 2001; Juhn and Mauro 2002; Von Hagen and Zhou 2007; Carmignani et al. 2008). The determinants of the choice of currency policy are argued from several perspectives including optimal currency areas, currency crises, and policy credibility. However, the existing literature could not identify a single generalizable variable as an unquestionable determinant of exchange rate regime choice.

Most of the empirical studies undertaken in the estimation of the determinants of exchange rate regime choice so far have been of the probit and logit nature (see Kumar et al. 1998; Eichengreen et al. 1995; Klein and Marion 1994; Klein and Marion 1997; Masson and Ruge-Murcia 2005). These binary dependent variable models are unable to account for the time dependence that may be present in the decision to abandon a fixed exchange rate regime in favor of a flexible exchange rate regime. Ideally, the empirical model to be used in the estimation of the determinants of exchange rate regime choice should take into consideration two conditions: the possibility of time-dependence and the effect of intra-subject correlation.

In this paper we argue that time is an important concept for the analysis of transition between exchange rate regimes. In particular, we argue that the probability of an exit from a particular exchange rate regime is likely to be determined by the time spent within a given regime. To this effect, we study the conditional probability of a particular exchange rate regime ending by adopting survival analysis for 178 countries. The duration of a given exchange rate regime is important in assessing currency stability. Exchange rate credibility depends not only on economic and institutional factors, but also on the time already spent in a regime for which a particular currency does not suffer from a speculative attack. Moreover, the time-dependence may be non-monotonic resulting in a probability of exit from an exchange rate regime, which increases during short duration but decreases for longer duration.

We contribute to the literature in two ways. First, empirical studies that tried to address the duration dependence effects on the choice of exchange rate regimes are limited (e.g. Setzer 2004; Tudela 2004; Wälti 2005; Tamgac 2013). None of the empirical studies provide a comprehensive analysis for different types of economies (i.e. advanced, emerging, developing) using de facto exchange rate regimes. Previous studies focus on either a subset of countries or utilize a de jure exchange rate regime. We provide a comprehensive list of countries in our analysis and include an extended time period which considers two of the most recent major economic shocks: the 2008–2009 global financial crisis and the 2011 Eurozone sovereign debt crisis. Having a larger sample of countries provides broad evidence base about how countries choose their exchange rate systems.
Second, analyzing multiple cycle data is important to address occurrence dependence in addition to duration dependence. However, when analyzing multiple exit (failure) data there is a potential for a lack of independence of the failure times. In these types of studies, exit times are correlated within a cluster (subject or group), violating the independence of failure times assumptions required in traditional “time-to-first event” survival analysis. Yet, the approach that has been applied by previous studies is the Cox (1972) proportional hazard estimate which is the standard “time-to-first event” survival analysis (e.g. Wälti 2005; Tamgac 2013) resulting in possible information about lack of independence of failure times begin lost. Correlated exit times from a particular exchange rate regime to another are important for they set up the platform for establishing the probabilities to possible realignment of exchange rate policy. Therneau and Grambsch (2000) suggest that for analyzing multiple cycle data, failure events should be classified according to two criteria: (1) whether they are recurrence of the same type of events, and (2) whether they have a natural order. As such, to explicitly address intra-country correlation, with ordered exits this paper uses marginal risk analysis, the Andersen and Gill [1982] and the Wei et al. (1989) models. To our knowledge, no such empirical work has been carried out.

Our results reveal that the probability of an exit from a fixed exchange rate regime is non-monotonically time-dependent. To control for country-specific heterogeneity, we include time-varying covariates in the Cox (1972) proportional hazard model. The findings from the semi-parametric approach suggest that factors, such as GDP growth, unemployment rate, openness, and government budget deficit affect the probability of a switch from fixed to flexible exchange rate regimes. Economic growth continues to be an impactful covariant through the marginal risk analysis in addition to net foreign asset position and inflation rate.

The remainder of the paper is organized as follows: Classification of exchange rate regimes section presents various classifications of exchange rate regimes, while Duration of fixed exchange regimes and definition of exits section discusses durations and provides definitions of exits from a peg. Then Methodological discussion section examines the methodological approaches and Time-varying covariates section presents the time-varying covariates and their expected relationship with the probability of abandoning a peg. Empirical results section follows with empirical results and in Final remarks section we provide concluding remarks.

1 Multiple failure-time data arise from time-to-occurrence studies when two or more events (failures) occur for the same subject (i.e. one country experiences multiple exits or from identical events occurring to related subjects (i.e. similar exit times/patterns to a group of countries, say in the same region).

2 Tudela (2004) addresses both occurrence dependence and lagged duration dependence by defining exits based on transition intensities, a form of regression spline. Regression splines are piecewise polynomials joined at control point that are called knots. They are very attractive for nonparametric modeling; but choosing the number of knots or the location of the knots is arbitrary. Additionly, Chong et al. (2016) using competing risk models try to address the difference between an orderly exit and crisis-driven exit but focus on only 79 countries and the study period is limited to be between 1972 and 2001

3 The Andersen-Gill (1982) and Wei et al. (1989) models are extensions of the Cox model.
Classification of Exchange Rate Regimes

The classification of exchange rate regimes has some variation in different studies. The predominant number of the studies focus on the official de jure exchange rate regime classification retrieved from the IMF’s Annual Report on Exchange Arrangements and Exchange Restrictions, which is based on official declarations made by national governments once a year (Klein and Marion 1994). The obvious problem with this form of classification is that many countries which declare having floating exchange rates are characterized by pegs and many announced pegged regimes turn out to be a more flexible regime (Obstfeld and Rogoff 1995; Calvo and Reinhart 2002). On the other hand, some studies have constructed their own indicators to define exchange rate regime (Tudela 2004), while other research uses pure or hybrid de facto classification (Ilzetzki et al. 2017; Setzer 2004; Levy-Yeyati and Sturzenegger 2005; Dutttagupta and Otker-Robe 2003). The de facto classifications that are commonly used are Ghosh et al. (2002), Levy-Yeyati and Sturzenegger (2005), Ilzetzki et al. (2017) as well as Klein and Shambaugh (2008), which have significant variation among exchange rate regime classifications.

Following Tamgac (2013) we use Ilzetzki et al. (2017)’s annual de facto classification of exchange rate regime which provides two classifications: the coarse classification which places countries into six broad categories and the fine classification which classifies countries into fifteen disaggregated categories as seen in Table 1. This de facto classification is chosen for three main reasons. First it avoids identifying short spells of exchange rate stability as regimes, which is a common problem associated with most de facto exchange rate regime classifications. Unlike other de facto classifications, which identify short-term spells of exchange rate stability within a regime, Ilzetzki et al. (2017) identify longer-term regimes by considering a 5-year horizon. This enables us to differentiate between long-term regime trends and short-term events within a regime (Hussain et al. 2005).

Second, it considers the fact that countries may have dual or multiple exchange rates and/or parallel markets. Failing to look at market-determined rates can lead to misleading perceptions about the underlying monetary policy and the ability of the economy to adjust to shocks. This can result in an underlying inflationary monetary policy, which may not be captured by the official exchange rate.

Finally, the Ilzetzki et al. (2017) de facto classification is not based on official declaration but rather on the action of monetary authorities, avoiding a possible discrepancy between officially reported exchange rate regimes and the actual characterization of the exchange rate regimes in the countries. Previous empirical studies on exchange rate regimes that relied on the classification available from the Annual Report on Exchange Arrangements and Exchange Restrictions published by the IMF were missing important information.

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Ilzetzki et al. (2017)’s classification also includes “free falling” as a category which allows for the differentiation between countries that have complete lack of monetary policy and the associated hyperinflation and countries that have low inflation floating exchange rate regimes.

For other de jure and de facto classifications see Shambaugh (2004), Bubula and Otker-Robe (2002).
Table 1 Ilzetzki et al. (2017) Fine and Coarse De Facto exchange rate arrangement classification

| Fine classification | Coarse classification |
|---------------------|-----------------------|
| Code                | Description           | Code | Description                        |
| 1                   | No separate legal tender or currency union | 1      | No separate legal tender           |
| 2                   | Pre-announced peg or currency board arrangement | 1      | Pre-announced peg or currency board arrangement |
| 3                   | Pre-announced horizontal band that is narrower than or equal to ± 2% | 1      | Pre-announced horizontal band that is narrower than or equal to ± 2% |
| 4                   | De facto peg          | 1      | De facto peg                       |
| 5                   | Pre-announced crawling peg; de facto moving band narrower than or equal to ± 1% | 2      | Pre-announced crawling peg         |
| 6                   | Pre-announced crawling band that is narrower than or equal to ± 2% or de facto horizontal band that is narrower than or equal to ± 2% | 2      | Pre-announced crawling band that is narrower than or equal to ± 2% |
| 7                   | De facto crawling peg | 2      | De facto crawling peg              |
| 8                   | De facto crawling band that is narrower than or equal to ± 2% | 2      | De facto crawling band that is narrower than or equal to ± 2% |
| 9                   | Pre-announced crawling band that is wider than or equal to ± 2% | 3      | Pre-announced crawling band that is wider than or equal to ± 2% |
| 10                  | De facto crawling band that is narrower than or equal to ± 5% | 3      | De facto crawling band that is narrower than or equal to ± 5% |
| 11                  | Moving band that is narrower than or equal to ± 2% (i.e., allows for both appreciation and depreciation over time) | 3      | Moving band that is narrower than or equal to ± 2% (i.e., allows for both appreciation and depreciation over time) |
| 12                  | De facto moving band ± 5%/ Managed floating | 3      | Managed floating                   |
| 13                  | Freely floating       | 4      | Freely floating                    |
| 14                  | Freely falling        | 5      | Freely falling                     |
| 15                  | Dual market in which parallel market data is missing. | 6      | Dual market in which parallel market data is missing. |
The sample period studied extends from 1970 to 2016. 1970 is chosen as the starting point since it marks the collapse of the Bretton Wood Systems, where many countries experienced a decline in fixed exchange rate regimes and a trending move towards flexible exchange rate as seen in Figure 1. However, in the 2000, especially in the latter part of the 2000s after the 2008–2009 Financial Crisis, the number of countries on fixed exchange rate has increased. During the Great Recession numerous central banks found themselves constrained by the zero-lower bound on interest rates in terms of being able to implement monetary policy to adjust domestic monetary stance and control inflation. This has led the literature to reconsider the case for flexible exchange rates (e.g. Galí and Monacelli 2016; Cook and Devereux 2016; Schmitt-Grohé and Uribe 2016) and has made the ‘straightjacket’ of fixed-exchange rate regimes appear less detrimental. In addition, high income countries experience the highest number of switches to floating exchange rate regimes post Bretton Woods. Furthermore, contrary to the bipolar hypothesis intermediate regimes remain prevalent for middle income countries as can be seen in Figure 2.6

**Duration of Fixed Exchange Regimes and Definition of Exits**

Duration of a spell in this study is defined as the time that a currency is pegged. We use Ilzetzki et al. (2017)’s fine definition of exchange rate regimes and group exchange rate regimes into two broader categories: fixed regimes and floating regimes. Exchange rate regimes that have strict rigidity in the regime are categorized as fixed while the remaining categories are grouped as floating exchange rate

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6 See Eichengreen (1994), Fischer (2001), and Eichengreen (2008) for more information about the “bipolar” hypothesis.
regimes. We define an exit from a fixed exchange rate regime as the shift from a strict fixed category to announced pegs, crawling pegs, managed float or free-floating exchange rate regime or an exit to a dual market of exchange rates. Therefore, each duration period corresponds to the number of years from the time of origin until an exit. If a regime is still in place by the end of the sample period, we register the observation as being censored.

Table 2 provides information about the characteristics of the duration of pegs in our data sample. The second column of Table 2 reports the frequency of the spell length, the duration of fixed exchange rate regime from its beginning until the occurrence of an exit, for the 47 spells. We see that we have 4942 years of pegs (among all countries). We also see that the highest frequency of pegged countries occurs during spells 38–47. In particular, we see that the highest number of frequencies of spell duration during spell length 47 (41.57%), which reflects the right censoring of the data. This in turn means that 58.3% were completed spells (resulting in an exit from a peg). The third column of Table 2 presents percent of completed spells, the spells that ended with an occurrence of an exit for each duration spell. We see the highest rate of duration completion is for fixed exchange rate regimes that have been pegged for 29 years, demonstrating a reluctance to devalue among countries. The next section further investigates this regime persistence by using survival analysis.

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7 We define an exit from a fixed exchange rate regime as a shift from categories 1–11 to categories 12, 13, 14 or 15 using Ilzetzki et al. (2017)’s fine grid.

8 Calvo and Reinhart (2002) termed this reluctance to abandon a fixed exchange rate regime “fear of floating”.

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Fig. 2 Exchange rate regimes by income group. Source: Data from Ilzetzki et al. (2017)
| Duration of spells in years | Total spells |
|----------------------------|--------------|
|                            | Frequency | Percent | Cum. |
| 2                          | 47        | 0.56    | 0.56 |
| 3                          | 47        | 0.56    | 1.12 |
| 5                          | 47        | 0.56    | 1.69 |
| 8                          | 47        | 0.56    | 2.25 |
| 9                          | 47        | 0.56    | 2.81 |
| 10                         | 94        | 1.12    | 3.93 |
| 11                         | 47        | 0.56    | 4.49 |
| 12                         | 47        | 0.56    | 5.06 |
| 13                         | 94        | 1.12    | 6.18 |
| 14                         | 47        | 0.56    | 6.74 |
| 15                         | 94        | 1.12    | 7.87 |
| 16                         | 141       | 1.69    | 9.55 |
| 18                         | 188       | 2.25    | 11.8 |
| 19                         | 47        | 0.56    | 12.36|
| 20                         | 188       | 2.25    | 14.61|
| 22                         | 235       | 2.81    | 17.42|
| 23                         | 94        | 1.12    | 18.54|
| 25                         | 141       | 1.69    | 20.22|
| 26                         | 94        | 1.12    | 21.35|
| 28                         | 141       | 1.69    | 23.03|
| 29                         | 235       | 2.81    | 25.84|
| 30                         | 94        | 1.12    | 26.97|
| 31                         | 94        | 1.12    | 28.09|
| 32                         | 94        | 1.12    | 29.21|
| 33                         | 141       | 1.69    | 30.9 |
| 35                         | 94        | 1.12    | 32.02|
| 36                         | 94        | 1.12    | 33.15|
| 37                         | 94        | 1.12    | 34.27|
| 38                         | 188       | 2.25    | 36.52|
| 39                         | 188       | 2.25    | 38.76|
| 40                         | 235       | 2.81    | 41.57|
| 41                         | 188       | 2.25    | 43.82|
| 42                         | 141       | 1.69    | 45.51|
| 43                         | 282       | 3.37    | 48.88|
| 44                         | 329       | 3.93    | 52.81|
| 45                         | 235       | 2.81    | 55.62|
| 46                         | 235       | 2.81    | 58.43|
| 47                         | 3478      | 41.57   | 100  |

Mean: 220  
Standard deviation: 548  
Total: 8366
Methodological Discussion

Survival Analysis

Given that time is an important factor in the decision to transition between exchange rate regimes, the use of probabilistic regression methods become problematic. As such, to model time dependence along with the inclusion of time-varying variables we make use of survival analysis.9

The survival function, which describes the probability that the regime will last \( t \) periods or longer, is given by

\[
S(t) = 1 - F(t) = \Pr (T > t) \quad \text{for } t = 0, S(t) = 1 \quad \text{and for } t = \infty, S(t) = 0
\]  

(1)

where \( T \) is a nonnegative random variable which represents the length of time, in years, that a country spends in a certain type of exchange rate regime. In other words, \( T \) represents the duration (spell length) of that exchange rate regime. In our study \( T \) represents the time during which a country is in a fixed exchange rate regime until the exit to a floating exchange rate regime. The random variable \( T \) can be described through its cumulative distribution function given by equation (2).

\[
F(t) = \int f(t) \, dt = \Pr (T \leq t) = 1 - S(t)
\]  

(2)

where the probability density function, \( f(t) \), represents the probability that an exchange rate regime will survive less than some given value \( t \) specified in equation (3).

\[
f(t) = \frac{dF(t)}{dt} = \frac{d}{dt} \{ 1 - S(t) \} = -S'(t)
\]  

(3)

Duration analysis focuses on conditional probabilities. To this effect the hazard function becomes a central concept. The hazard function determines the instantaneous probability that an exit from a particular exchange rate regime will occur in \( t + \Delta t \), given the exchange rate regime has survived up to time \( t \). Thus, the hazard function10 is defined as

\[
h(t) = \lim_{\Delta t \to 0} \frac{\Pr (t \leq T \leq t + \Delta t)}{\Delta t} = \frac{f(t)}{S(t)}
\]  

(4)

The negative time derivative relationship between the survival function \( S(t) \) and the hazard rate can be expressed by eq. (5) while the cumulative hazard function \( H(t) \) is presented in eq. (6).

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9 Survival analysis are also known as time-to-first event analysis.

10 The hazard function, sometimes known as the hazard rate, contains the same information as the probability density function but duration dependence is easily interpreted based on the shape of the hazard function.
The estimation of the hazard function requires some assumptions about the duration pattern. If such assumptions cannot be made, the nonparametric approach of Kaplan–Meier (1958) estimation allows for a preliminary analysis of duration dependence. The Kaplan–Meier estimate at a given time $t$ is calculated as the product of survival probabilities in period $t$ and the preceding periods as specified in eq. (7).

$$h(t) = \frac{f(t)}{S(t)} = \frac{dF(t)/dt}{S(t)} = -\frac{dS(t)}{dt} = \frac{S'(t)}{S(t)} = -\frac{\ln S(t)}{dt}$$  \hfill (5)

$$H(t) = \int_0^t h(u)du$$ \hfill (6)

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$$\hat{S}(t) = \prod_{j|t_j \leq t} \frac{n_j - d_j}{n_j}$$ \hfill (7)

where $n_j$ is the number of individuals (countries) at risk at time $t_j$ and $d_j$ is the number of failures (exists) at time $t_j$.

The cumulative hazard function in nonparametric analysis is estimated via the Nelson (1972) and Aalen (1978) estimator as the summation of all distinct failure times less than or equal to $t$ in the following equation.

$$\hat{H}(t) = \sum_{j|t_j \leq t} \frac{d_j}{n_j}$$ \hfill (8)

**Nonparametric Analysis**

The Kaplan–Meier (1958) calculation of the hazard function makes use of the number of regimes that are eligible to exit. Therefore, this number will capture the fact that the regimes are not at risk of exiting a fixed exchange rate regime (since they all survived) until they come under observation. The semi-parametric approach uses only observation at times of exit. The simple fact that a regime is observed in 1970 means that it did not exit a fixed exchange rate regime before. This is true for all regimes observe in 1970, so none of these regimes could have abandoned a peg before that date. Hence, we would not have any observation to contribute to the partial likelihood.

Probability of exit from a fixed exchange rate regime to a floating exchange rate regime can be graphically illustrated with the nonparametric Kaplan–Meier estimator. The graphical representations of Kaplan–Meier estimate, the Nelson-Alan cumulative hazard estimate and the smoothed hazard estimate are presented in Figure 3 panels (a), (b) and (c), respectively. Duration dependence can be defined through the hazard rate over time. Positive duration dependence at $t^*$ occurs when the hazard rate increases as the spell continues. On the other hand, a negative
duration dependence at $t^*$ occurs when the hazard rate decreases as the spell continues. As can be seen, especially from the plot of the smoothed hazard estimate, the probability of exit initially increases followed by a decreasing hazard indicating a non-monotonic hazard rate similar to Setzer (2004). The non-monotonic pattern of the hazard rate implies that duration dependence cannot be qualified as positive nor negative, it depends upon survival time. Although, the duration dependence is not clearly linear, negative duration dependence exists after approximately 18 years on a fixed exchange rate regime, showing that the probability of leaving the peg decreases with duration. It could be that at the very beginning of the peg that agents are not very confident in the peg. Then, as the peg goes on, the probability of an exit from the peg starts to decline as durable fixed exchange rate regimes prove to be effective and sustainable.

The graphed hazard function by the Kaplan–Meier estimator affords us the opportunity to test whether time already spent in a fixed exchange rate regime has an independent effect on the likelihood of an exit into a flexible exchange rate regime beyond the control of time-varying variables. However, the nonparametric Kaplan–Meier estimator does not allow the inclusion of constant or time-varying explanatory variables.

**Semi-Parametric Analysis**

To incorporate time-varying covariates and to specify the duration model we utilize the Cox (1972) approach of proportional hazard. The Cox (1972) proportional hazard model is one of the most common methods used in the analysis of time to event (survival) data. The idea of the model is to define hazard level as a dependent variable which is being explained by the time-related component (baseline hazards) and covariates-related component. This semi-parametric method requires less than complete distributional specification of the base-line hazard. Given the lack of theory regarding the duration of fixed exchange rate regimes, the proportional hazard model seems a reasonable compromise between the nonparametric approach of

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11 If $\frac{dh(t)}{dt} > 0$ at $t = t^*$ then there is positive duration dependence, while $\frac{dh(t)}{dt} < 0$ at $t = t^*$ indicates a negative duration dependence.
Kaplan–Meier estimator, which does not allow for various explanatory factors, and the possibly wrongly specified parametric approach.

The Cox (1972) proportional hazard model assumes that covariates shift the baseline hazard multiplicatively. As such in a continuous time and with time-varying covariates it is introduced in the following functional form:

$$h(t, x(t), \beta) = \phi(x(t), \beta)h_0(t)$$  \hspace{1cm} (9)

where $h_0(t)$ is the baseline hazard, $\phi(x(t), \beta)$ is a function of $x(t)$, which are time-varying regressors and a vector of unknown coefficients $\beta$. In a semi-parametric model, the baseline hazard $h_0(t)$ has an unspecified functional form and represents the case where $x(t)=0$. In other words, the baseline hazard provides the hazard function for a mean country and information about duration dependence. The explanatory variables found in $x(t)$ shift the hazard function for different countries with given length of time spent in a given exchange rate regime by multiplying the baseline hazard.

The most common choice of $\phi(x(t), \beta)$ is the exponential form

$$\phi(x(t), \beta) = \exp(\dot{x}(t)\beta),$$  \hspace{1cm} (10)

ensuring that $\phi(x(t), \beta) > 0$ and allowing coefficient to be easily interpreted.

In this paper, duration spell of countries on fixed exchange rate regimes is measured in terms of years. But the exact time in the year is not given. In such a case the transitions from a fixed exchange rate regime to a non-fixed exchange rate regime is said to be grouped. Discrete-time proportional hazard models handle this type of data better than continuous-time proportional hazard models. In discrete-time proportional hazard model the regressors are constant within the interval but can vary across intervals, while the baseline hazard, $h_0(t)$, can vary within the interval. In implementation the complementary log-log model is utilized. The complementary log-log hazard function becomes

$$h(t) = 1 - \exp\left(-\exp\left(\dot{x}(t)\beta + \gamma(t)\right)\right),$$  \hspace{1cm} (11)

where $\gamma(t) = \ln \int_t^{t+1} h_0(s)ds$.

We conduct semi-parametric analysis with time-varying covariates to see if the patterns in duration dependence could be explained by time-varying factors.

**Marginal Model Analysis**

When looking at the data for transitions between fixed and flexible exchange rates we need to consider that the data consists of $N$ countries each of which has

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12 Equation (11) is derived through some algebra on equations (9) and (10) as follows:

$$h(t) = 1 - \exp(-\exp(\dot{x}(t)\beta)) = 1 - \exp\left(-\int_t^{t+1} h_0(s)ds\right) = 1 - \exp\left(-\int_t^{t+1} h_0(s)ds\exp(\dot{x}(t)\beta)\right)$$

$$= 1 - \exp\left(-\exp\left(\ln \int_t^{t+1} h_0(s)ds\right) + \dot{x}(t)\beta\right)$$
multiple-cycle data, where countries experience multiple transitions. Hence, the hazard function may depend upon the number of previous spells of fixed exchange rate regime (occurrence dependence) as well as the lengths of previous time spent in the fixed-exchange rate regime state (lagged duration dependence). As such conducting an analysis of multiple transition data by just examining time to first event (e.g. Cox 1972), ignoring additional failures and correlations, is inadequate because it wastes possibly relevant information and will lead to converging and non-proportional marginal hazards (Hougaard 1991) as well as underestimated variances for parameter estimates (Wei et al. 1989). The major issue in extending proportional hazards regression models to multiple events per subject is the intra-subject correlation (Therneau and Grambsch 2000).

In the time period covered in this study, countries have multiple exits from a peg to a floating exchange rate regime. Table 3 presents the proportion of spells that have multiple exits. About 48% of the duration spells are right censored (meaning there is no exit from the peg), while about 28% our observation experience only one exit from a peg. The remaining 25% of our observation experience multiple exits from a peg. These multiple exits reaffirm the existence of multiple-cycle in the data.

Another important issue to consider with multiple events dataset is distinguishing between data where the multiple events have a distinct ordering and those where they do not. When a given subject may have multiple events, the assumption of independent observations in the standard Cox (1972) model does not hold. Lipsitz et al. (1990) show that marginal models can overcome this assumption for the estimation of the variance of the coefficients by an appropriate correction based on a grouped jackknife estimate. Therefore, in order to incorporate multiple spells per country and associated ordered multiple exits and to avoid the errors resulting from analyzing correlated repeated events, this paper uses marginal model analytical techniques for survival data. We use the Andersen and Gill (1982)) (henceforth Andersen-Gill) and the Wei et al. (1989) (henceforth WLW) models. 13 Both of these models extend the ordinary Cox (1972) model, which ignores the possible intra-subject correlation (i.e.

| No. of exits | Frequency | Percent | Cum |
|-------------|-----------|---------|-----|
| 0           | 3995      | 47.75   | 47.75 |
| 1           | 2303      | 27.53   | 75.28 |
| 2           | 1551      | 18.54   | 93.82 |
| 3           | 376       | 4.49    | 98.31 |
| 4           | 94        | 1.12    | 99.44 |
| 5           | 47        | 0.56    | 100   |
| Total       | 8366      | 100     |      |

13 For multiple events the common approaches that generalize the Cox (1972) framework are the independent increment [Andersen and Gill 1982] and marginal [Wei et al. 1989] models. These two models estimate $\hat{\beta}$ through a fit that ignores the correlation between the events followed by a correction of the variance but differ considerably in their creation of risk set.
treating multiple events from a country as independent) by replacing the standard variance estimate with one which is corrected for the possible correlations. Marginal models offer flexibility in the formation of strata and risk sets, definition of the time scale, and have a well-developed estimator of the variance.

The Andersen-Gill is an independent increment model, which extends Cox (1972)’s proportional hazards model from single event data to recurrent event data. Each country is represented as a series of observations with non-overlapping time intervals, where the end of time for each interval is determined by an occurrence of an exit or change in any time-varying covariates. The Andersen-Gill model assumes that events are equal and thus treats them independently, which is a strong assumption. This allows the exit to be measured as time to first exit, time from first exit to second exit and so on. Each country contributes to the risk set for a specific time as long as they are under observations, as defined by inclusion of the specified time in the country’s interval set.14 The difference between the Andersen-Gill model and the standard Cox (1972) model can be seen through the definition of the hazard function. The intensity process for subject \(i\) in the Andersen-Gill model is given by equation (12).

\[
h_i(t) = Y_i(t)h_0(t) \exp \left( X_i(t)\beta \right),
\]

where \(Y_i(t)\) is the indicator function that country \(i\) is still under observation at time \(t\), \(h_0(t)\) is the baseline hazard, \(X_i\) denotes the covariate vector for country \(i\), and \(\beta\) is a vector of coefficients. In the standard Cox (1972) model, the individual country ceases to be at risk when the event, exit from a peg occurs, and \(Y_i(t)\) remains one as exits occur until the last time the exit is observed.

In the WLW model, the ordered outcome data set is treated as if it were an unordered competing risk case. The number of strata in the analysis will be equal to the maximum number of exits a country experiences in the time period. Unlike the Andersen-Gill model, the WLW model allows for a separate underlying hazard for each exit. In the WLW model a country is at risk until the country exits a peg or there is censoring. Hence, the hazard function for the \(j\)th event for country \(i\) becomes

\[
h_{ij}(t) = Y_{ij}(t)h_{0j}(t) \exp \left( X_i(t)\beta_j \right),
\]

where \(Y_{ij}(t)\), the at-risk indicator for the \(i\)th country, is one until the occurrence of the \(j\)th exit. If the \(j\)th exit occurs or if there is censoring then \(Y_{ij}(t)\) becomes zero, indicating that the country is no longer at risk after the last given exit.15

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14 While the Andersen-Gill formulation has several advantages, including the ability to accommodate left-censored data, time-varying covariates, multiple events, and discontinuous intervals of risk, a major limitation of this approach is it doesn’t allow more than one event to occur at a given time. Some of these practical advantages are discussed in an applied framework by Johnson et al. (2004).

15 Metcalfe and Thompson (2007) have shown that the WLW model infringes on the proportional hazard’s assumption when applied to multiple spells, maybe causing a bias. However, they have also shown that such a bias is not behind the distinctive effect estimates and that the infringement of the proportional hazard assumption is not necessarily greater than experienced with other applications of proportional hazard regressions. As such we do not see a prohibition to the application of the WLW method to the multiple spells data.
Time-Varying Covariates

To determine the factors that affect the likelihood of exit from a peg, we include country-specific time-varying covariates.\footnote{To avoid feedback effects of the occurrence of a switch from a peg into macroeconomic variables, variables from year $t$ are used to determine the probability of exit from the peg in year $t + 1$.} As indicators of the domestic economic conditions, we introduce real GDP growth ($GDP\ Growth$), inflation rate ($Inflation$), monetary policy related interest rate ($MP\ Interest$) and unemployment rate ($Unemployment$). $Inflation$, measured as an annual percent change in CPI, is expected to have a positive sign implying that high inflation increases the likelihood of exit from a fixed exchange rate regime. In a country with a peg, higher inflation than partner countries result in significant overvaluation of the real exchange rate. This in turn can impact resources allocation, competitiveness, and macroeconomic stability (Kumar et al. 1998), increasing the probability that a peg is abandoned.

The decision to abandon a peg may stem from monetary authorities’ concern about the evolution of other key economic variables. For example, Ozkan and Sutherland (1995) present a model in which the objective function of the monetary authorities depends positively on benefits derived from maintaining a fixed exchange rate and negatively on the deviations of output and unemployment from certain level. As such a higher level of $Unemployment$ is expected to result in an increase on the probability to abandon a peg.\footnote{See Levy-Yeyati and Federico Sturzenegger (2003).}

Pegged regimes are associated with low nominal volatility and higher economic growth. The literature has suggested that countries experiencing faster growth usually adopt fixed exchange rate regime to avoid potential credibility problems (Edwards 1996; Ghosh et al. 2002; Husain et al. 2005; Bleaney and Francisco 2007; Ebeke 2015). However, in the event of a negative external shock the need to defend a peg implies a significant cost in terms of real interest rate and a decrease in investment prospects (Levy-Yeyati and Sturzenegger 2003). Therefore, there is a negative link between $GDP\ Growth$ and the duration of fixed exchange rate regime.

Another way to measure the adverse consequences of policies targeted to maintain a peg is through the monetary policy related interested rate, $MP\ interest$, which represents the monetary policy stance in the country. Under a credible peg with perfect capital mobility, domestic interest rates cannot be set independently. As such if there is a pressure to increase interest rate with respect to the interest rate of the base economy,\footnote{See Shambaugh (2004) and Calvo and Reinhart (2002) and others for discussion of the “open economy trilemma” as well as “fear of floating”.} adjusting for differences in risk and liquidity in the investment options, then the hazard rate for abandoning a peg should increase.

External conditions are measured through the degree of openness ($Openness$) and current account balances as a ratio of GDP ($Current\ Account$). $Openness$, constructed as exports plus imports over GDP, reflects how connected the economy is to the rest of the world and reflects trade liberalization. On one hand, the more open the economy the trade-enhancing effects of fixed exchange rates increase making...
the case for pegging currencies (McKinnon 1963; Milesi-Ferreti and Razin 1998). On the other hand, open economies are more likely to be exposed to external shocks resulting in a flexible exchange rate regime being a better choice. Therefore, the expected sign for the coefficient associated with Openness can be either positive or negative. Similarly, governments facing trade deficit will favor a less stringent exchange rate constraint (Bodea 2010). A flexible exchange rate regime facilitates current account adjustment while a fixed exchange rate regime delays the adjustment process. As such countries with strong current accounts should have a lower probability of an exit from a peg resulting in a negative coefficient associated with Current Account (Wälti 2005).

As indicators of the domestic monetary condition and capital flow we include real effective exchange rate (REER), international reserves (Reserves) and net foreign assets as a ratio of M2 (NFA/M2). In addition, claims on government (Claims on Government) and domestic credit as a percent of GDP (Credit) are included as indicators of possible credit expansion. The currency crisis literature shows that the collapse of a pegged exchange rate regime is associated with a steady erosion of international reserves (e.g. Krugman 1979; Obstfeld 1996; Jeanne 1997). Therefore, a negative sign is expected for the coefficient associated with Reserves because a country that has a high level of foreign reserves can maintain its peg easily. Similar reasoning can be applied for expecting the negative sign associated with NFA/M2. Foreign asset holdings are linked to the ability of the government to maintain a peg and hence to the probability of devaluation. We expect a negative value on the variable NFA/M2 since a decline in net foreign asset holdings should increase the probability of leaving a fixed exchange rate regime (Klein and Marion 1997). To account for capital flows and their effect on the survival of a peg we also include foreign direct investment as a ratio of GDP (FDI/GDP) into the analysis. Fixed exchange rate regimes encourage more inward flow of FDI than do floating exchange rate regimes (e.g. Aizenman 1992) as such the estimated coefficient for FDI/GDP should be negative. Real Effective Exchange Rate (REER) can be used as a proxy for the loss of international price competitiveness as well as for exchange rate misalignment. When a country devalues its currency, the trading partners’ position deteriorates with regards to that country’s economy. A higher value of the exchange rate index implies a more appreciated domestic real exchange rate leading to a lower likelihood of abandoning a fixed exchange rate regime in that country Kumar et al. (1998). As such REER is expected to have a positive sign.

Claims on Government is expected to have a positive estimated parameter because credit expansion due to the monetarization of the government budget deficit increases the likelihood of a speculative attack resulting in the abandonment of a peg. Furthermore, the literature has shown that excessive credit creation, measured here through the variable Credit, can lead to a currency crisis resulting in an abandonment of a peg (e.g. Aghion et al. 2001; Mishkin 1999; McKinnon and Pill 1998).

Political and institutional quality play a significant role in the choice of exchange rate regimes (e.g. Alesina and Wagner 2006; Broz and Frieden 2006). As such we include an index of political rights from the Polity IV (2014) dataset, Polity 2, where a higher number represents a more democratic country to account for the impact of political institutions on fixed exchange rate regime duration. In
Are We Floating Yet? Duration of Fixed Exchange Rate Regimes

In a more democratic country, where elections take place on a regular basis and the public can potentially punish elected officials for bad economic policy decisions through the voting process, government is likely to avoid frequent policy changes with unknown results. It is likely that countries with a stronger political institutional framework will be able to sustain a fixed exchange rate regime for a longer period.

Finally, we use central bank independence measure from Garriga (2016), CBI, in the analysis of the duration of fixed exchange rate regimes. Bodea (2010) presents the argument that central bank independence and fixed rate exchange rate regimes can go hand in hand or can be substitutes. On one hand, an increased central bank independence would increase regime sustainability by lowering inflationary pressures. On the other hand, central bank independence can be a substitute to a fixed exchange rate regime in order to avoid the risk of extreme misalignment and the associated pegged currency devaluations. This will lead to central bank independence increasing the probability of selecting a flexible exchange rate regime and decreasing the probability of selecting a fixed exchange rate regime (e.g. Leblang 1999; Broz 2002; Crowe and Meade 2008).

Table 4 presents the explanatory variables and their expected signs. The expected signs are based on economic theory and the findings of previous empirical studies using duration analysis. The data assembled is annual data from 1970 through 2016 for 178 countries. Data for explanatory variables is collected from the World Development Indicators (WDI) published by the World Bank, International Financial

| Explanatory variables | Expected signs | Literature |
|-----------------------|----------------|------------|
| Inflation             | +              | Tudela (2004), Wälti (2005), Chong et al. (2016) |
| GDP growth            | –              | Tudela (2004), Wälti (2005), Tamgac (2013), Chong et al. (2016) |
| Unemployment          | +              | Tudela (2004), Wälti (2005) |
| Reserves              | –              | Wälti (2005), Tamgac (2013), Chong et al. (2016) |
| Openness              | ±              | Tudela (2004), Wälti (2005), Tamgac (2013), Chong et al. (2016) |
| Current account       | –              | Tudela (2004), Wälti (2005), Tamgac (2013) |
| Claims on government  | +              | Tudela (2004), Wälti (2005), Tamgac (2013) |
| NFA/M2                | –              | Tamgac (2013), Chong et al. (2016) |
| REER                  | +              | Wälti (2005), Tamgac (2013) |
| Domestic credit       | –              | Tudela (2004) |
| FDI/GDP               | –              | Tudela (2004), Wälti (2005) |
| CBI                   | ±              | Wälti (2005), Tamgac (2013), Chong et al. (2016) |
| MP interest rate      | +              | Chong et al. (2016) |
| Polity 2              | –              | Wälti (2005), Tamgac (2013), Chong et al. (2016) |

None of the studies include a comprehensive list of countries in their sample.
Table 5  Cox (1972) proportional hazard estimations

| Variables          | (1)     | (2)          | (3)          | (4)          |
|--------------------|---------|--------------|--------------|--------------|
| Inflation          | 6.04e−05 | 0.00110*     | 7.55e−05     | 8.10e−05     |
|                    | (6.06e−05) | (0.000617) | (7.19e−05) | (7.33e−05)     |
| GDP growth         | −0.000198*** | −0.000750* | −0.000227*** | −0.000239*** |
|                    | (6.38e−05) | (0.000453) | (7.25e−05) | (7.44e−05)     |
| Unemployment       | 0.000698*** | −0.000442 | 0.000795*** | 0.000732**   |
|                    | (0.000250) | (0.00153) | (0.000270) | (0.000291)     |
| Reserves           | −0.000185* | −0.000867 | −0.000200* | −0.000176 |
|                    | (9.66e−05) | (0.000707) | (0.000112) | (0.000116)     |
| Openness           | −5.97e−05* | −0.000139 | −8.88e−05** | −9.36e−05** |
|                    | (3.45e−05) | (0.00181) | (4.08e−05) | (4.27e−05)     |
| Current account    | 6.69e−05  | 0.000852     | 8.17e−05     | 6.22e−05     |
|                    | (9.48e−05) | (0.00864) | (0.000110) | (0.000111)     |
| Claims on government | 0.000159*** | 0.000908 | 0.000135* | 0.000158** |
|                    | (7.02e−05) | (0.00643) | (7.92e−05) | (8.02e−05)     |
| NFA/M2             | 1.93e−08  | 0.00159      | 2.02e−08     | 2.46e−08     |
|                    | (6.03e−08) | (0.00163) | (5.77e−08) | (6.06e−08)     |
| REER               | 0.000146  | 0.00304*     | 0.000260     | 0.000251 |
|                    | (0.000156) | (0.00179) | (0.000175) | (0.000183)     |
| Domestic credit    | −6.89e−05 | −0.000591    | −7.73e−05    | −7.85e−05    |
|                    | (8.19e−05) | (0.000525) | (9.59e−05) | (9.73e−05)     |
| FDI/GDP            | 4.22e−05  | −0.355       | −4.31e−05    | −3.02e−05    |
|                    | (0.000112) | (0.330) | (0.000190) | (0.000188)     |
| MP interest Rate   |         | 0.0614       | (0.0936)     |              |
| CBI                |         | −0.225       | −0.113       |              |
|                    |         | (0.980) | (0.990) |              |
| Political rights   |         |             |              | 0.00144 |
|                    |         |             |              | (0.0206) |
| Wald chi2          | 34.84   | 29.40        | 37.42        | 37.22        |
| Degrees of freedom | 11      | 12           | 12           | 13           |
| Prob>chi2          | 0.0003  | 0.0034       | 0.0002       | 0.0004       |
| Number of obs.     | 4008    | 600          | 3093         | 2700         |

Standard errors in parenthesis

***,**,*Indicates statistical significance at the 1 (5, 10) percent level

Statistics (IFS) published by the IMF, Polity IV (2014) dataset, and External Wealth of Nations from Lane and Milesi-Ferretti (2018).19

19 The source, definitions, and summary statistics of the variables are presented in Table 8 in the Appendix.
Empirical Results

Semi-Parametric Survival Analysis with Time-Varying Covariates

The results of the Cox (1972) model estimation are reported in Table 5. The dependent variable is the probability of leaving a fixed exchange rate regime for a non-fixed exchange rate regime. If the sign on the estimated parameters is negative we interpret it as a decline in the probability of exit from a peg based on that variable. On the other hand, if the sign on the estimated parameter is positive then that implies that the probability of exit from a peg increases with an increase in that variable.

We find that GDP Growth and Openness have a negative effect on the probability of abandoning a peg and are robustly significant across all specifications. The negative sign of the estimated parameter associated with GDP Growth indicates that a decline in economic growth rate leads to an increase in the probability of ending the spell of fixed exchange rate regime. This result is consistent with the predictions of economic theory in that countries facing a recession would be more likely to abandon a peg to be able to stimulate exports and boost output. That is, if growth is declining there would be pressure to ease financial policies through currency devaluation to stimulate activity. This will increase the probability of exit from a fixed exchange rate regime. Similarly, Openness also has a negative estimated coefficient. The negative impact on the hazard rate associated with openness demonstrates that more open economies are less likely to suffer an exchange rate crash.

On the other hand, the estimated coefficients for Unemployment and Claims on Government are positive and statistically significant. The positive hazard rate illustrates that higher unemployment rate will increase the probability of an exit from a fixed exchange rate regime. An increase in unemployment reflects the fall in economic activity, which increases the vulnerability to currency crisis. In a similar vein, an increase in government budget deficit increases the likelihood of switching out of a fixed exchange rate regime.

With regards to current account balances we find that Current Account has a surprising positive sign on its estimated coefficient value. We expect that when the current account balance is positive that exports are greater than imports, in which case a country on a peg should continue its peg for currency stability as opposed to abandoning the peg, which is not our finding. However, it is worth noting that the estimated probability value associated with Current Account is extremely small and close to zero.

The other time-varying covariates all had the expected sign associated with the coefficient, albeit not robustly statistically significant. Notably, the estimated hazard rate for Reserves remains negative and has statistical significance in model specification (1) and (2) but the significance is not robust to controlling for monetary policy related interest rates and for political institution quality. The negative sign on reserves is expected for a country that has a high level of foreign reserves, which can maintain its peg easily. Lastly, REER had a positive estimated coefficient but didn’t remain statistically significant throughout all model specifications.
Table 6 Andersen and Gill (1982) estimations (ordered multiple exit)

| Variables       | Dependent variable: The probability of exit from a peg |
|-----------------|-------------------------------------------------------|
|                 | (1)         | (2)         | (3)         | (4)         |
| Inflation       | 6.14e−05   | 0.00111***  | 7.76e−05   | 8.37e−05   |
| (5.99e−05)      | (0.000294) | (7.44e−05)  | (7.32e−05) |
| GDP growth      | −0.000204*** | −0.000771*** | −0.000237*** | −0.000249*** |
| (6.77e−05)      | (0.000243)  | (7.73e−05)  | (7.93e−05) |
| Unemployment    | 0.000736*** | −0.000357   | 0.000844*** | 0.000794*** |
| (0.000234)      | (0.00116)   | (0.000245)  | (0.000284) |
| Reserves        | −0.000192*  | −0.000886*  | −0.000212*  | −0.000188  |
| (0.000102)      | (0.000489)  | (0.000125)  | (0.000132) |
| Openness        | −6.38e−05*  | −0.000142   | −9.45e−05** | −9.93e−05** |
| (3.51e−05)      | (0.000110)  | (4.21e−05)  | (4.55e−05) |
| Current account | 7.04e−05    | 0.000870    | 8.69e−05    | 6.62e−05   |
| (0.000101)      | (0.000664)  | (0.000125)  | (0.000125) |
| Claims on government | 0.000166** | 0.000928*** | 0.000146*   | 0.000169** |
| (7.79e−05)      | (0.000256)  | (8.12e−05)  | (8.15e−05) |
| NFA/M2          | 2.06e−08    | 0.00155**   | 2.09e−08    | 2.54e−08   |
| (4.36e−08)      | (0.000616)  | (4.17e−08)  | (4.50e−08) |
| REER            | 0.000153    | 0.00305***  | 0.00272    | 0.00268    |
| (0.000160)      | (0.000841)  | (0.000174)  | (0.000192) |
| Domestic credit | −7.28e−05   | −0.000636   | −7.99e−05   | −8.34e−05  |
| (9.37e−05)      | (0.000473)  | (0.000114)  | (0.000117) |
| FDI/GDP         | 3.92e−05    | −0.346**    | −4.14e−05   | −2.88e−05  |
| (9.58e−05)      | (0.170)     | (0.000165)  | (0.000161) |
| MP interest Rate| 0.0694      |             |           |           |
| (0.0728)        |             |             |           |           |
| CBI             | −0.262      | −0.153      |           |           |
| (1.057)         |             |             |           |           |
| Political rights| −0.000915   |             |           |           |
| (0.0217)        |             |             |           |           |
| Wald chi2       | 34.72       | 101.28      | 38.89      | 40.26      |
| Degrees of freedom | 11        | 12          | 12         | 13         |
| Prob>chi2       | 0.0003      | 0.0000      | 0.0001     | 0.0001     |
| Number of obs.  | 4008        | 600         | 3093       | 2700       |

Standard errors in parenthesis.

***, **, *Indicates statistical significance at the 1 (5, 10) percent level.
Table 7 Wei et al. (1989) estimations (ordered multiple exit)

| Variables          | Dependent variable: The probability of exit from a peg |
|--------------------|-------------------------------------------------------|
|                    | (1)         | (2)         | (3)         | (4)         |
| Inflation          | 9.53e−05** | 0.000253** | 0.000123*** | 0.000129*** |
|                    | (4.09e−05) | (0.00104)  | (4.63e−05) | (4.88e−05)  |
| GDP growth         | −0.000163***| −0.000308***| −0.000155***| −0.000175***|
|                    | (4.54e−05) | (0.00104)  | (5.27e−05) | (5.34e−05)  |
| Unemployment       | 0.000145   | −0.000360  | 3.78e−05   | 7.91e−05    |
|                    | (8.00166)  | (0.000328) | (0.000193) | (0.001998)  |
| Reserves           | −8.07e−05 | 0.000128   | −0.000133  | −0.000126   |
|                    | (8.20e−05) | (0.00138)  | (9.33e−05) | (9.52e−05)  |
| Openness           | 3.25e−05   | −2.32e−05  | 2.78e−05   | 2.48e−05    |
|                    | (2.52e−05) | (4.38e−05) | (2.86e−05) | (2.94e−05)  |
| Current account    | 3.57e−05   | 0.000156   | 4.46e−05   | 4.76e−05    |
|                    | (6.35e−05) | (0.000164) | (7.78e−05) | (7.97e−05)  |
| Claims on government| −1.14e−05 | 4.86e−05   | −3.87e−05  | −2.19e−05   |
|                    | (5.66e−05) | (0.000115) | (6.31e−05) | (6.27e−05)  |
| NFA/M2             | −4.51e−07***| −8.35e−08  | −4.87e−07***| −4.71e−07***|
|                    | (8.80e−08) | (1.38e−06) | (8.93e−08) | (9.05e−08)  |
| REER               | 8.70e−05   | 0.000322*  | 1.97e−05   | 4.06e−05    |
|                    | (0.000100) | (0.000189) | (0.000135) | (0.000139)  |
| Domestic credit    | 3.73e−05   | 4.22e−05   | 5.12e−05   | 3.57e−05    |
|                    | (5.12e−05) | (0.000141) | (6.06e−05) | (6.26e−05)  |
| FDI/GDP            | 9.37e−05   | 0.000385***| 7.43e−06   | −7.53e−05   |
|                    | (6.45e−05) | (0.000127) | (0.000124) | (0.000133)  |
| MP interest rate   | 0.000542   |            |            |            |
|                    | (0.0101)   |            |            |            |
| CBI                |            | 1.238*     | 1.002      |            |
|                    |            | (0.654)    | (0.622)    |            |
| Political rights   |            |            | 0.00115    |            |
|                    |            |            | (0.0125)   |            |
| Wald chi2          | 49.10      | 45.80      | 50.87      | 48.43      |
| Degrees of freedom | 11         | 12         | 12         | 13         |
| Prob>chi2          | 0.0000     | 0.0000     | 0.0000     | 0.0000     |
| Number of obs.     | 1849       | 328        | 1434       | 1394       |

Standard errors in parenthesis.

***,**,* Indicates statistical significance at the 1 (5, 10) percent level
Intra-Country Correlation and Marginal Analysis

The results of the marginal risk models Andersen-Gill estimations are presented in Table 6, while the estimated results for the WLW model are found in Table 7. The results of the Andersen-Gill estimation match those of the Cox (1972) model with regards to statistical significance and signs, even though magnitudes of the coefficients are greater. Under all four specifications in the Andersen-Gill model increasing GDP Growth and Openness decrease the likelihood of abandoning a peg, while increased Unemployment and Claims on Government lowered the likelihood of remaining in a fixed exchange rate regime. Notably, within the Andersen-Gill model FDI/GDP becomes statistically significant in column (2) of Table 6 indicating an increase in net foreign direct investment as a ratio of GDP will increase the probability of abandoning a peg supporting the findings of Tudela (2004). However, this result is not robust.

In Table 7 we see that the estimates obtained through the WLW model20 have Inflation, GDP Growth and NFA/M2 being statistically significant determinants of the likelihood to exit from a peg. The negative and significant results associated with GDP Growth are reiterated in the WLW estimations. In addition, higher inflation rate increases the hazard rate for leaving a peg while increased net foreign assets decrease the probability of switching from a fixed exchange rate regime to a flexible exchange rate regime supporting the findings of Tamgac (2013).

Final Remarks

In this paper we employ survival analysis towards the determination of the choice of exchange rate regime, in particular the conditional probability of exit from a fixed exchange rate regime. To this effect, we use both nonparametric and semi-parametric techniques to estimate hazard functions. The results from the nonparametric Kaplan–Meier estimator uncover significant negative duration dependence with a small positive dependence at the beginning of the investigated time frame. It appears that time spent within a regime is a significant determinant of the probability of exit from a peg. This fact may suggest that as the credibility of the peg increases over time the need to abandon a peg decreases.

Furthermore, to the extent that duration dependence may be driven by time-varying covariates, we estimated a semi-parametric proportional hazard model as well

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20 Recall, unlike the Andersen-Gill model, the WLW model allows for multiple events to occur at a given time, t.
as marginal riks models. In the semi-parametric proportional hazard model as well as the Andersen-Gill marginal risk analysis model, government budget deficit and unemployment increased the probability of abandoning a peg while GDP growth and openness decreased it. In addition, GDP growth is the only variable that continued in its robust impact on the conditional probability to abandon a peg when we estimate the WLW marginal risk model. However, new variables such as inflation rate and net foreign assets become significant positive determinants of the probability to leave a fixed exchange rate regime within the specification of the WLW estimations. Other time-varying macroeconomic, financial, and institutional variables do not appear to have a significant effect on the probability of abandoning a peg.

However, the issue of duration dependence deserves further investigation. It is especially imperative to understand the different paths that countries take to move from fixed exchange rate regimes to flexible exchange rate regimes. Some exits have been orderly while other exits have been very disruptive due to the fact that authorities are devaluing without a choice. Moreover, even though a negative GDP growth is a highly significant determinant of an increase in the probability to abandon a peg, the recent global financial crisis has shown that some emerging economies are still holding on to their peg despite economic hardship. This puzzle indicates that there is a gap between economic theory and currency policy implementation which needs to be further explored. Finally, the most recent global pandemic, COVID-19, has resulted in severe economic shock for almost all countries. As such it would be interesting to see if exchange rate regimes choices have been affected as countries face severe drop in their economic output and growth rates as indicated by the findings in our study.

Appendix

See Table 8.
| Source                                      | Variable                                    | No. obs. | Mean       | Std. dev. | Min | Max   |
|---------------------------------------------|---------------------------------------------|----------|------------|-----------|-----|-------|
| Itzetski et al. (2017)                      | Defacto exchange rate regime classification  | 8366     | 6.255917   | 4.759878  | 1   | 15    |
| WDI, world bank                             | GDP growth (annual %)                       | 8366     | 953.0357   | 703.0781  | 1   | 2604  |
| WDI, world bank                             | Inflation (% CPI)                           | 8366     | 2402.034   | 1960.378  | 1   | 6216  |
| WDI, world bank                             | Current account (% GDP)                     | 8366     | 402.8405   | 449.707   | 1   | 2594  |
| WDI, world bank                             | Unemployment, total (% of total labor force)| 8366     | 784.8772   | 661.5197  | 71  | 2603  |
| WDI, world bank                             | Claims on central government (% GDP)        | 8366     | 749.303    | 638.2687  | 1   | 2630  |
| WDI, world bank                             | Real effective exchange rate index (2010 = 100) | 8366 | 744.8893 | 711.5089 | 1 | 2672 |
| WDI, world bank                             | Domestic credit (% of GDP)                  | 8366     | 943.4387   | 678.7881  | 71  | 2648  |
| WDI, world bank                             | Foreign direct investment (net, %GDP)       | 8366     | 0.4913306  | 0.5826743 | 0.0134116 | 8.541285 |
| WDI, world bank                             | Reserves and related items (in US$)         | 8366     | 693.4607   | 657.289   | 19  | 2676  |
| WDI, world bank                             | Openness                                   | 8366     | 2204.851   | 1246.559  | 142 | 5187  |
| WDI, world bank                             | M2                                         | 8366     | 978.5326   | 654.5947  | 71  | 2659  |
| Lane and Miledi-Ferretti (2018)              | Net foreign asset                           | 6826     | − 7670.22  | 264808.2  | − 7597421 | 3420487 |
| IFS, international monetary fund            | Monetary policy related interest rate 9%    | 1692     | 8.780207   | 10.43326  | − 0.5 | 183.2 |
| Garriga (2016)                               | Central bank independence                  | 5619     | 0.4774247  | 0.1914493 | 0.01667 | 0.979 |
| Polity IV (2014) project                     | Polity 2                                    | 6734     | 1.541135   | 7.302426  | − 10 | 10    |
**Acknowledgements** I would like to thank Shiferaw Gurmu, Neven Valev, James Marton, and the participants at the International Trade and Finance seminar for their valuable comments and suggestions. I am also grateful for the constructive feedback received from the participants at the Macroeconomics at the Liberal Arts Colleges, Midwestern Political Science Association, Southern Economic Association, and Western Economic Association International conferences in Los Angeles, Chicago, New Orleans, and New Castle, respectively. I also wish to thank the anonymous reviewer and *Easter Economic Journal* editor Julie Smith for their recommendations that has improved this paper. All errors are mine.

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