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Exchange Rate Regimes and Growth Collapses

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Abstract

The loss of output in major recessions tends to be permanent. Using IMF *de facto* exchange rate regime classifications over the period 1980 to 2012 for up to 193 countries, it is shown that growth collapses are more frequent under less flexible exchange rate regimes, and particularly hard pegs. Our findings are robust to the marked shift in the pattern of growth collapses after the global financial crisis.

Keywords: exchange rate regimes, growth collapses, global financial crisis

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Disclamer: the views expressed here should not be taken to be those of the International Monetary Fund or of the IMF Executive Board.

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1. INTRODUCTION

Major recessions cause permanent losses of output. Although growth returns to its pre-recession trend, output does not rebound back to the level that it would have reached had it continued to follow its previous trend; instead it tends to remain below it (Cerra and Saxena, 2008; Cerra *et al.*, 2013). This raises some major issues for macroeconomic policy, such as the proper identification of the output gap after a big recession. Another implication is that, however well designed macroeconomic policy is in a general sense, it is particularly important not to make recessions worse, and if possible to make them milder.

Friedman (1953) argued that exchange rate flexibility could compensate for internal price rigidity in the face of external shocks, and that less flexible exchange rate regimes make output more vulnerable to shocks, because it is harder to compensate for the output effects of shocks by adjusting the real exchange rate. Broda (2004) and Edwards and Levy-Yeyati (2005) offer some evidence in support of this hypothesis. If this hypothesis is correct, there is a danger that major recessions might occur under less flexible exchange rates that might have been avoided, or been significantly milder, with greater exchange rate flexibility.

This issue is addressed in this paper. We find significant evidence that growth collapses, in a sense to be defined, occur more frequently under less flexible exchange rate regimes, and particularly under hard pegs, than under more flexible ones, even allowing for the substantial shift in the cross-country pattern of these episodes after the global financial crisis.

The rest of the paper is structured as follows. Previous research is reviewed in Section Two. Data sources are explained and the empirical model is presented in Section Three. Empirical results appear in Section Four, and Section Five concludes.

2. LITERATURE REVIEW

Cerra and Saxena (2008) show that negative political and financial shocks often lead to a permanent loss of output relative to the pre-crisis trend. Cerra *et al.* (2013) undertake a detailed analysis of recoveries from episodes of negative growth, and find that the pace of growth in the first two years of the recovery is significantly slower than in other expansion years. They also find that more expansionary monetary and fiscal policies are associated with faster recoveries, and they present some evidence that recovery is stimulated by real exchange rate depreciation and that recovery is faster under floating exchange rates. These results motivate our interest in the correlation between the exchange rate regime and an economy's susceptibility to a major recession.

Some previous work has examined the relationship between the exchange rate regime and the output effect of shocks. Broda (2004) finds evidence that terms-of-trade shocks have bigger output effects under less flexible exchange rate regimes in a sample of 75 developing countries over the period 1973-96. Edwards and Levy-Yeyati (2005) obtain similar results for a somewhat larger sample of 100 countries, and claim that output is more sensitive to negative than to positive shocks.

Lane and Milesi-Ferretti (2011) examine the output effects of the global financial crisis, which (as we shall see below) dramatically changed the cross-country incidence of growth collapses. They model GDP growth in the two-year period 2008-09 for a large sample of countries, including dummy variables for a hard peg and an intermediate exchange rate regime along with a variety of other variables. These exchange rate regime dummies emerge with negative coefficients (relative to the omitted category of a float), implying a deeper recession in less flexible regimes, but the evidence is no more than suggestive, because these variables never reach the five per cent level of significance. The significant variables in this regression are per capita GDP, the 2007 current account balance and the growth in private credit between 2004 and 2007. The 2008-09 recession was particularly bad in richer countries, and in those with fast credit growth and current account deficits. Calderón and Fuentes (2014) analyse the business cycle of 71 industrial and middle-income countries. They find that in middle-income countries recessions are generally deeper, steeper and costlier, but that the global financial crisis changed the pattern only in the industrial countries, where the recession was unusually deep and the recovery unusually slow.

Hausmann *et al.* (2005) were the first to focus attention on the turning points in growth rather than mean growth rates, in a study of growth accelerations.[1] The focus of this research is shifts in trend growth rates rather than big recessions, and this line of investigation has subsequently been pursued using Markov switching models by Jerzmanowski (2006), Kar *et al.* (2013) and Kerekes (2012). Hausmann *et al.* (2006) study growth collapses, which they define as episodes of negative growth in GDP per person of working age, but they do not investigate the role of the exchange rate regime.

Ghosh *et al.* (2015) consider the vulnerabilities of different exchange rate regimes in 51 middle-income countries over a number of dimensions, including lending booms, various types of crises and growth collapses. They find that, although pegs (either hard or soft) are not especially susceptible to banking crises, currency crises or sovereign debt crises, they are significantly more prone to growth collapses compared with independent floats. They define a growth collapse as the bottom fifth percentile of the distribution of the growth rate of real GDP in year *t* minus its average in the three years *t*-3 to *t*-1, which turns out to mean a fall of at least

[1] Rodrik (1999) was probably the first to use the term "growth collapse", but his empirical analysis does not focus on extreme events (his dependent variable is the change in the growth rate between 1960-75 and 1975-89).

7.5 percentage points. Such a large fall almost certainly means that growth is negative, but there may be many episodes of negative growth in the sense of Hausmann *et al.* (2006) that do not qualify as a growth collapse according to this definition. A limitation of Ghosh *et al.*'s work is that, because their sample consists of middle-income countries only, it contains only a very limited number of hard pegs (nine); moreover they also find, somewhat surprisingly, that soft pegs to a single currency and basket pegs are even more susceptible to growth collapses than hard pegs. Thus there is no clear pattern of susceptibility to growth collapses decreasing with the flexibility of the exchange rate regime in their results.

3. DATA AND THE EMPIRICAL MODEL

Our basic hypothesis is that the probability of a growth collapse in country *j* in year *t* is greater, other things equal, if the exchange rate regime is less flexible, because a less flexible regime means that a given negative shock has a bigger effect on output. Empirically, we model the probability of a growth collapse as a function of a series of measures of vulnerability and of the exchange rate regime in force at the beginning of the year, and possibly the interaction between those two. The measures of vulnerability are of two types: features of the economy that make sizeable negative shocks more likely, and events that may trigger a recession, such as a banking crisis.

The exchange rate regime is captured by a set of one-zero dummy variables, the omitted category being the most flexible regime. The hypotheses are: (1) that the exchange rate dummies have positive coefficients that increase with the fixity of the regime, (2) that greater vulnerability is associated with a higher probability of a growth collapse, and (3) that the interaction variable has the same sign as the vulnerability measures, implying that for a given value of the vulnerability measure greater fixity of the exchange rate regime increases the probability of a growth collapse. Formally, the model may be written:

$$\Pr(growthcollapse_{jt}) = \Phi(\alpha + \beta REGIME_{jt-1} + \gamma VUL_{jt} + \eta REGIME_{jt-1} * VUL_{jt} + \varepsilon_{jt}) \tag{1}$$

where $\Pr(growthcollapse_{jt})$ is the probability of a growth collapse (in a sense yet to be defined) in country *j* in year *t*, $\Phi(.)$ is the cumulative distribution function of the normal distribution, *REGIME* is a set of exchange rate regime dummies, *VUL* is a set of measures of vulnerability to a growth collapse, and ε is a random error.

The exchange rate regime data are from Ghosh *et al.* (2015), which is essentially the IMF *de facto* classification. Growth collapses are defined as growth in the current year at least five percentage points below the average of the previous three years, where growth is the percentage rate of GDP growth in constant local currency, as given in the World Bank's World Development Indicators database. We also consider a more extreme definition with a drop in the growth rate of seven percentage points. This more stringent definition is closer to that used by Ghosh *et al.* (2015). Some people may consider that a negative growth rate is a necessary characteristic of a growth collapse, so we investigate whether this makes a difference to our results.

We form a panel dataset for currency crises by constructing an exchange market pressure index (EMPI) for each country. The EMPI is defined as the percentage depreciation in the exchange rate plus the percentage loss in foreign exchange reserves. This formulation makes indices comparable across countries.[2] A dummy variable for a crisis is formed for a

[2] The crisis literature often normalizes reserves and exchange rate movements by their within-country standard deviations, but then the magnitudes of the EMPI are comparable only within countries. Unlike some authors, we omitted interest rate because of the scarcity of data.

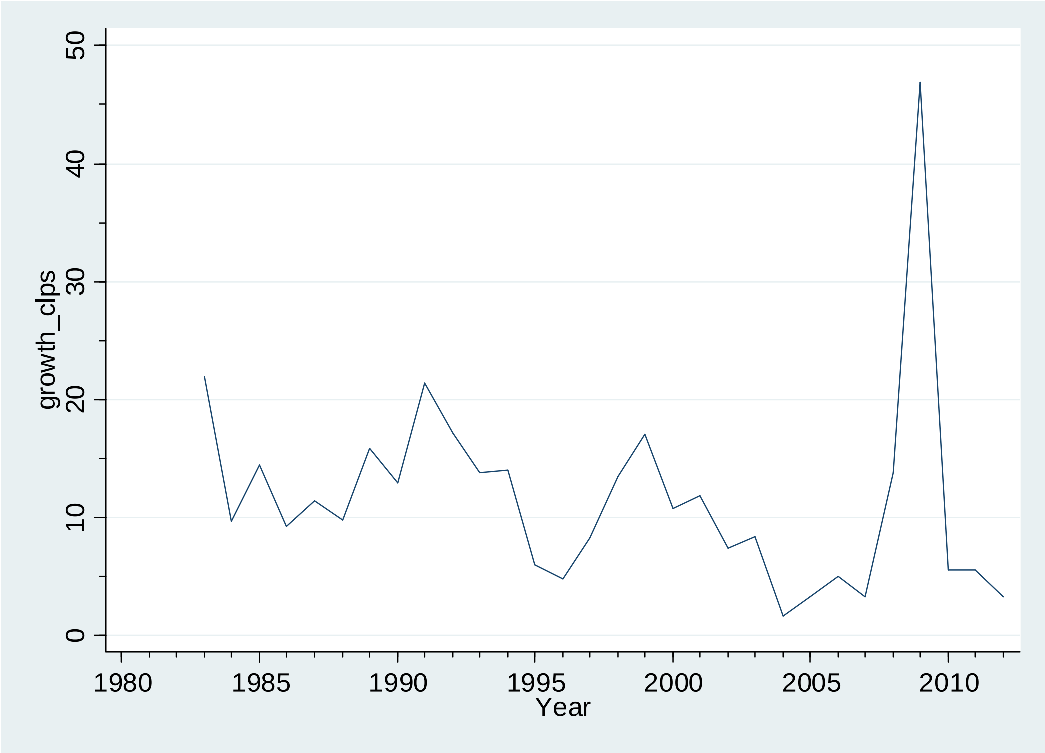
specific year and country if the EMPI is in the upper quartile of all observations across the panel.

The dates for banking and debt crises are taken from Laeven and Valencia (2013). They define a banking crisis as systemic if one of two conditions is met: either (i) there are significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations); or (ii) there are significant banking policy intervention measures in response to losses in the banking system. Debt crises are episodes of sovereign debt default or restructuring crises, the information for which is compiled from several sources.

Figure 1 shows the time pattern of growth collapses, defined as growth in the current year at least five percentage points below the average of the previous three years, from 1983 to 2011.[3] The 2009 peak, when growth collapses represented 44.6 % of the sample, dwarfs any other (maximum 17.6 % in 1991). To allow for the growth collapses associated with the global financial crisis to be somewhat different (for example sub-Saharan Africa was very little affected), we initially analyse the period 1983-2005 and 2006-2012 separately.

[3] In the sample growth collapses represent just over 10% of the observations, which is about twice as many as GOQ's definition, but a 5 % drop seems sharp enough to qualify.

Figure 1. Percentage of growth collapses by year



Note. A growth collapse is defined as a growth rate at least five percentage points below the average of the previous three years.

4. EMPIRICAL RESULTS

Recoveries are extremely weak after growth collapses

We begin by showing that growth collapses are potentially important because of their long-term output effects, as Cerra and Saxena (2005) and Cerra *et al.* (2013) argue. In fact our results are even stronger than theirs, in that not only is the output loss not regained, but even the growth rate seems to be significantly depressed for at least three years after a growth collapse. Table 1 shows fixed effects regressions of the growth rate of real GDP on dummies for (a) the year prior to a growth collapse, (b) the year of the growth collapse and (c) each of the four years subsequent to a growth collapse. The coefficients represent the difference between the growth rate in the year specified and the country's average growth in years other than immediately before and up to four years after a growth collapse. Columns (1) and (2) cover the whole period 1980-2012, without and with year fixed effects respectively. Column (3) covers the period up to 2005, and Column (4) the global financial crisis period (2006-12).

Column (1) of Table 1 shows that growth is significantly higher than average in the year preceding a growth collapse, but at least one percentage point below average in the three years after a growth collapse. This indicates that the recovery from a growth collapse is not only too weak for output to rebound to its pre-crisis trend, but even too weak for the growth rate to maintain its "normal" level, which implies a widening gap between output and its pre-crisis trend in the three years following a growth collapse. Column (2) confirms that the results are much the same if we add year dummies. Columns (3) and (4) show that the problem of weak growth after a growth collapse has been even more acute during the period of the global financial crisis.

Table 1. Growth rates of GDP before and after growth collapses 1980-2012

Dependent variable:	Growth rate of real GDP (%)			
	1980-2012	1980-2012	1980-2005	2006-12
	(1)	(2)	(3)	(4)
Year T-1 Dummy	2.21*** (3.53)	2.50*** (3.75)	2.89*** (3.13)	-0.85** (-2.06)
Year T Dummy	-9.44*** (-17.6)	-9.03*** (-16.5)	-9.78*** (-13.1)	-10.09*** (-18.0)
Year T+1 Dummy	-1.42*** (-3.74)	-1.28*** (-3.30)	-1.42*** (-2.74)	-2.59*** (-5.05)
Year T+2 Dummy	-1.12*** (-3.43)	-0.90*** (-2.63)	-1.18*** (-2.64)	-2.33*** (-4.62)
Year T+3 Dummy	-2.01*** (-5.31)	-1.95*** (-5.12)	-1.92*** (-4.60)	-3.56*** (-3.15)
Year T+4 Dummy	-0.92* (-1.97)	-0.90* (-1.85)	-0.62 (-1.36)	-2.51*** (-3.37)
Country fixed effects?	yes	yes	yes	yes
Year fixed effects?	no	yes	No	no
Sample size	4024	4024	2944	1080
RMSE	5.39	5.36	5.83	3.18

Notes. Year T is the year of a growth collapse, defined as a growth rate at least five percentage points below the average of the previous three years. The figures in parentheses are heteroscedasticity-robust *z*-statistics. *, **,***: significantly different from zero at the 10, 5 and 1 % levels respectively.

The susceptibility of a growth collapse increases with the rigidity of the exchange rate regime, and more so for advanced economies after the global financial crisis

We begin our analysis of growth collapses with a simple model in which the probability of a growth collapse is a function of the exchange rate regime and a vulnerability measure, without any interaction between them. We assume that different types of countries may have different degrees of susceptibility to a growth collapse, by including dummy variables for (a) the advanced countries, (b) emerging markets and (c) sub-Saharan Africa, the omitted category being developing countries outside sub-Saharan Africa¸ or alternatively by estimating the model separately for these country sub-samples. We also allow for the cross-country incidence of growth collapses to have changed during the global financial crisis. The vulnerability measure is a banking, debt or currency crisis in the previous year, which is always statistically significant. This model reveals a strong association between the (in)flexibility of the exchange rate regime and the economy's susceptibility to growth collapses. We test the robustness of the model in a variety of ways.

Our basic results for the probability of a growth collapse (defined as a GDP growth rate at least five percentage points below the average of the previous three years) are presented in Table 2. The coefficients shown are marginal effects. The first two columns use data from before the global financial crisis (1980-2005) and the last two use more recent data (2006-12). The reason for this split is immediately apparent when we compare the coefficients which are often quite different in the two periods. For example the advanced country dummy has a highly significant negative coefficient up to 2005, but a positive one thereafter, whereas the dummy for sub-Saharan Africa displays precisely the opposite pattern. In other words, the norm before the global financial crisis was that growth collapses were more common in poorer countries (supported by Cerra and Saxena, 2005), but during the crisis they were more common in richer countries.

The first column of Table 2 uses a coarse exchange rate regime classification: hard pegs, independent floats (the omitted category) and intermediate regimes (the rest). Controlling for crises and the type of country, up to 2005 the probability of a growth collapse under an intermediate exchange rate regime was 3.4 percentage points greater than under an independent float, and under a hard peg the probability difference was more than twice as high, at 8.6 percentage points. Both these coefficients are significant at the five per cent level. In other words, the less flexible the exchange rate regime, the greater the risk of a growth collapse.

The second column of Table 2 uses the fine classification of exchange rate regimes, also for the period up to 2005, but otherwise the specification is identical to that of the first column. Hard pegs are separated into two categories: those countries that are members of a currency union or have adopted the currency of another country (no separate legal tender) and currency boards. Intermediate regimes are separated into three categories: horizontal single-currency pegs, managed floats, and lastly other pegs and bands, a grouping which combines the thinly populated categories of horizontal bands, basket pegs, crawling pegs, and crawling bands.[4] The regime coefficients are all significant at the 5% level, except a managed float, where the estimated effect is very small (0.2%). Currency boards (14.2%) are estimated to have a larger impact on the probability of a growth collapse than currency unions (7.7%), but theses coefficients are higher than for soft pegs to a single currency (5.0%) and other pegs and bands (2.1%). The non-regime coefficients in column (2) of Table 2 are very similar to those in column (1).

[4] A band allows a greater range of variation about the central rate than a peg..

Table 2. A probit analysis of exchange rate regimes and growth collapses

	1983-2005		2006-12	
	(1)	(2)	(3)	(4)
Hard peg (t-1)	0.0855*** (2.81)		0.1962*** (2.83)	
No separate legal tender (t-1)		0.0769** (2.48)		0.2431*** (2.95)
Currency board (t-1)		0.1415** (2.10)		0.1330 (1.43)
Intermediate regime (t-1)	0.0342** (2.24)		0.1001*** (3.00)	
Peg to single currency (t-1)		0.0500** (2.02)		0.1517** (2.31)
Other peg/band (t-1)		0.0211** (2.46)		0.1727** (2.18)
Managed float (t-1)		0.0022 (0.11)		0.1224** (2.18)
Advanced country dummy	-0.0402*** (-2.76)	-0.0420** (-2.14)	0.0769* (1.76)	0.0883* (1.94)
Emerging markets dummy	0.0214 (1.40)	0.0226 (1.50)	-0.0064 (-0.26)	0.0003 (0.01)
SSA dummy	0.0522*** (3.20)	0.0570*** (3.32)	-0.0446* (-1.81)	-0.0479* (-1.91)
Crisis (t-1)	0.0519*** (4.46)	0.0508*** (4.39)	0.1564*** (4.24)	0.1505*** (4.08)
Sample size	2969	2969	999	999
Pseudo-R squared	0.0449	0.0504	0.0576	0.0606

Notes. The estimation method is probit, with a binary dependent variable (growth collapse=1; no growth collapse=0), where a growth collapse is defined as a growth rate at least five percentage points below the average of the previous three years. Marginal effects at the means of the independent variables are shown (in the case of dummy variables, marginal effects report the estimated effect of a shift from 0 to 1). The omitted regime category is an independent float, and the omitted country category is developing countries outside sub-Saharan Africa. The figures in parentheses are heteroscedasticity-robust *z*-statistics. *, **,***: significantly different from zero at the 10, 5 and 1 % levels respectively.

The third and fourth columns of Table 2 reproduce the specifications of columns (1) and (2), but applied to data from 2006 to 2012. In both regressions the estimated regime effects are rather larger than those in Column (1), as is also the estimated crisis effect. For example in the coarse classification (Column (3)), the estimated hard-peg effect is 19.6% and the estimated intermediate-regime effect is 10.0%. In the fine classification (Column (4)), the regime coefficients are all considerably higher than in Column (2), except in the case of currency unions. In both cases, the crisis coefficient is about three times as high as in the earlier period. Taken as a whole these results are highly consistent with the theory that flexibility of the exchange rate regime reduces a country's susceptibility to a growth collapse, and that the greater the degree of flexibility, the lower is this susceptibility.

It is also of interest to estimate the model separately for the different country groups: advanced economies, emerging markets, sub-Saharan Africa and other developing countries. This is done in Table 3. In each case we combine the data for the two periods, but we allow for a shift in the probability of a growth collapse after 2005 by including a dummy variable that is equal to one only from 2006 onwards, and zero before then. As was to be expected from our previous results, the coefficient of this dummy variable varies considerably by country type. The estimated crisis effect is considerably greater in emerging markets (13.7%) than for the other three categories (5.6%, 4.5% and 4.1% respectively).

Table 3. A probit analysis of exchange rate regimes and growth collapses by country group

	Advanced economies	Emerging markets	Sub-Saharan Africa	Developing economies (except SSA)
	(1)	(2)	(3)	(4)
Hard peg (t-1)	0.2469*** (3.03)	0.1791** (2.34)	0.0403 (1.06)	0.0390 (0.58)
Intermediate regime (t-1)	0.0580*** (3.45)	0.0429** (2.04)	-0.004 (-0.01)	0.0240 (0.53)
Dummy 2006-12	0.1348*** (3.76)	0.0592*** (2.69)	-0.0322 (-1.42)	0.0658** (2.47)
Crisis (t-1)	0.0563** (2.47)	0.1372*** (5.64)	0.0453** (2.04)	0.0405* (1.69)
Sample size	724	1254	1158	925
Pseudo-R squared	0.1808	0.0637	0.0115	0.0157

Notes. The estimation method is probit, with a binary dependent variable (growth collapse=1; no growth collapse=0), where a growth collapse is defined as a growth rate at least five percentage points below the average of the previous three years. The data period is 1980-2012. Marginal effects at the means of the independent variables are shown (in the case of dummy variables, marginal effects report the estimated effect of a shift from 0 to 1). The omitted regime category is an independent float. The figures in parentheses are heteroscedasticity-robust z-statistics. *, **,***: significantly different from zero at the 10, 5 and 1 % levels respectively.

The estimated regime effects in Table 3 are much stronger in advanced economies and emerging markets than in developing countries. The hard-peg coefficients are 24.7% for advanced economies, 17.9% for emerging markets, 4.0% for sub-Saharan Africa and 3.9% for other developing countries. The intermediate-regime coefficients are much lower: 5.8% for advanced economies, 4.3% for emerging markets, zero for sub-Saharan Africa and 2.4% for other developing countries. Unsurprisingly, the dummy for the post-crisis period is strongest for advanced economies, given that they were hardest hit during the global financial crisis.

In Table 4 we explore what happens if we use the data for the whole period, but allow the coefficients of the dummies for country type to be different in the later period. As in Table (2), Column (1) refers to the coarse classification and Column (2) to the fine classification. In Column (1) all the coefficients are significant at the 5% level except those relating to emerging markets. The estimated hard-peg effect of 11.2% is more than twice as large as the estimated intermediate-regime effect, and the coefficient of the crisis dummy is highly significant. We shall use this regression as the benchmark for the rest of the paper. In Column (2) the estimated coefficient of the dummies for both types of hard peg are larger than those for any type of intermediate regime, which are in their turn always positive, implying a greater susceptibility to growth collapses than the omitted regime category of an independent float.

Table 4. The full sample with structural breaks and omitting years succeeding a growth collapse

	Growth collapse (GDP growth 5% or more below average of previous three years)		Omitting observations within four years of a growth collapse	
	(1)	(2)	(3)	(4)
Hard peg (t-1)	0.1119*** (3.84)		0.1032*** (2.89)	
No separate legal tender (t-1)		0.1130*** (3.59)		0.1104*** (2.78)
Currency board (t-1)		0.1140** (2.22)		0.0818 (1.39)
Intermediate regime (t-1)	0.0485*** (3.40)		0.0297* (1.88)	
Peg to single currency (t-1)		0.0684*** (2.79)		0.0479* (1.78)
Other peg/band (t-1)		0.0725*** (3.21)		0.0456* (1.84)
Managed float (t-1)		0.0305 (1.42)		0.0135 (0.62)
Advanced country dummy	-0.0398** (-2.54)	-0.0408*** (-2.62)	-0.0152 (-0.32)	-0.0161 (-0.77)
Emerging markets dummy	0.0233 (1.45)	0.0250 (1.55)	0.0382* (1.75)	0.0398* (1.81)
SSA dummy	0.0555*** (3.13)	0.0577*** (3.22)	0.0524** (2.15)	0.0522** (2.12)
Dummy 2006-12	0.0733*** (2.87)	0.0795*** (3.08)	0.1056*** (3.30)	0.1106*** (3.42)
Dummy 2006-12 * Advanced	0.1190** (2.26)	0.1178** (2.25)	0.0642 (1.25)	0.0623 (1.23)
Dummy 2006-12 * EM	-0.0232 (-1.31)	-0.0249 (-1.19)	-0.0271 (-1.33)	-0.0260 (-1.27)
Dummy 2006-12 * SSA	-0.0651*** (-4.59)	-0.0648*** (-4.74)	-0.0622*** (-5.66)	-0.0622*** (-5.71)
Crisis (t-1)	0.0697*** (5.94)	0.0685*** (5.85)	0.0647*** (4.26)	0.0625*** (4.12)
Sample size	3968	3968	2333	2333
Pseudo-R squared	0.0484	0.0512	0.0690	0.0726

Notes. See notes to Table 2. The sample is 1980 to 2012.

So far we have assumed that the probability of a growth collapse is independent of whether one has recently occurred. This seems implausible for two reasons. One is that if the growth rate falls sharply in each of the two years *T* and *T*+1, there is a strong possibility that year *T*+1 will qualify as a growth collapse if year *T* has done so. This could happen if there is a prolonged deceleration of output growth. The other is that, once the growth rate starts to recover, its lagged three-year average will be low, which makes a further growth collapse unlikely. So, after a growth collapse in year T, a further collapse in years *T*+2 and *T*+3 is improbable. To address this issue, in Columns (3) and (4) of Table 2 we re-estimate the regressions of Columns (1) and (2) with exactly the same specification but omitting years where there was a growth collapse in any of the previous four years. This loses about 1600 out of nearly 4000 observations, which inevitably increases the standard errors. It is also true that the exchange rate regime coefficients are somewhat lower in Columns (3) and (4) of Table 4 than in Columns (1) and (2), particularly in the case of intermediate regimes. Nevertheless they are still always positive and, in the case of hard pegs, significant at the one percent level.

No evidence of a link between exchange rate regime flexibility and the growth impact of crises

Table 5 tests the link between exchange regime flexibility and the growth impact of crises. In Column (1) we allow for interaction between crises and exchange rate regimes, to test whether less flexible regimes make recessions associated with crises more intense, which would be shown by a significant positive coefficient of the interaction term. In fact this coefficient turns out to be negative and insignificant, for both hard pegs and intermediate regimes, so the data do not support that hypothesis.

Table 5. Some additional tests

	Growth collapse (GDP growth 5% or more below average of previous three years)		
	(1)	(2)	(3)
Hard peg (t-1)	0.0617** (2.12)	0.0958*** (3.40)	0.1286*** (3.74)
Intermediate regime (t-1)	0.0181 (1.22)	0.0432*** (3.09)	0.0604*** (3.44)
Advanced country dummy	-0.0405*** (-3.83)	-0.0465*** (-3.16)	0.0119 (0.34)
Emerging markets dummy	0.0089 (0.72)	0.0141 (0.90)	0.0470** (2.11)
SSA dummy	0.0359*** (2.61)	0.0531*** (3.00)	0.0266*** (3.64)
Dummy 2006-12	0.0404** (1.97)	0.0548** (2.18)	0.1163*** (3.67)
Dummy 2006-12 * Advanced	0.1140** (2.00)	0.0921* (1.77)	0.0424 (0.63)
Dummy 2006-12 * EM	-0.0098 (-0.56)	-0.0100 (-0.42)	-0.0445** (-2.10)
Dummy 2006-12 * SSA	-0.0322*** (-02.75)	-0.0563*** (-3.64)	-0.0815*** (-5.96)
Crisis (t-1)	0.0676** (2.16)		0.0842*** (5.83)
Hard peg (t-1) * crisis (t-1)	-0.0183 (-0.91)		
Intermediate regime (t-1)* crisis (t-1)	-0.0128 (-0.60)		
Banking crisis (t-1)		0.1795*** (4.13)	
Currency crisis (t-1)		0.0447*** (3.82)	
Debt crisis (t-1)		0.0149 (0.33)	
DlnTOT			-0.0526 (-1.15)
Sample size	3968	3889	3094
Pseudo-R squared	0.0547	0.0490	0.0501

Notes. See notes to Table 2. The sample is 1980 to 2012. TOT = terms of trade.

In Column (2) we split the crisis variable into three types: banking crises, currency crises and debt crises. This regression not only allows the effects of different types of crises to differ, but also assumes that the effect of multiple crises is additive, whereas the "any crisis" specification imposes the same impact for multiple crises as for single crises. All three types of crises have positive coefficients, but in the case of debt crises the coefficient is small and statistically insignificant. The estimated coefficient of banking crises is four times as large as that of currency crises, but both coefficients are significant at the one percent level. Cerra and Saxena (2005) also find that banking crises have the strongest output effects.

The third column of Table 5 adds terms-of-trade shocks to the model; as expected, the coefficient is negative, but it is not statistically significant. The inclusion of this variable makes the regime coefficients slightly larger than in the first column of Table 4, but since the difference is small and more than 20 percent of the observations are lost, we omit it from subsequent tables. The statistical insignificance of the terms-of-trade variable is disappointing, and may reflect the lack of accurate and consistent data on export and import prices for many countries.

Robustness tests

In this section we test the robustness of our results based on the specification used in Table 4.

Alternative definition of growth collapse

Some authors include a condition of negative growth in their definition of a growth collapse. In Table 6, we separate the cases of growth collapses where growth stays positive from the more frequent cases where it turns negative, and estimate a multinomial probit. Columns (1) and (2) show the results for a growth collapse with a positive and a negative growth rate respectively, and Column (3) shows the results for no growth collapse, which are the negative of those shown in Column (1) of Table 4. Comparing Columns (1) and (2), it can be seen that the regime effects are far stronger in the case of negative growth than in the case of positive growth. For negative growth, the estimated regime effects are significant at the one percent level, whereas for positive growth they are quite small and statistically insignificant, although still with the expected positive sign. These results imply that restricting the definition of growth collapses to cases of negative growth would, if anything, strengthen our conclusions. A possible reason for this is that sudden decelerations in fast-growing economies, where the growth rate remains positive, have different causes from major recessions. This merits some investigation, but is beyond the scope of the present paper. For present purposes, the main point is that our conclusions are robust to an alternative definition of a growth collapse.

In Table 7 we use the probability of what we call an "extreme growth collapse" as the dependent variable. An extreme growth collapse is defined as a growth rate at least seven percentage points below the average of the previous three years, rather than five. The picture is broadly the same as Table 2, but the estimated regime effects are lower, although still positive. Since the unconditional probability of an extreme growth collapse is lower than for "standard" growth collapse, smaller coefficients are to be expected.

Table 6. Multinomial probit separating out growth collapses with positive growth rates

	(1)	(2)	(3)
	Growth collapse with GDP growth ⩾ 0	Growth collapse with GDP growth < 0	No growth collapse
Hard peg dummy (t-1)	0.0105 (0.80)	0.1020*** (3.69)	-0.1189*** (-3.84)
Intermediate regime (t-1)	0.0125 (1.61)	0.0341*** (2.84)	-0.0485*** (-3.40)
Advanced country dummy	-0.0103 (-1.17)	-0.0297** (-2.33)	0.0398** (2.54)
Emerging markets dummy	0.0044 (0.48)	0.0179 (1.33)	-0.0233 (-1.45)
SSA dummy	0.0264** (2.33)	0.0285** (2.08)	-0.0555*** (-3.13)
Dummy 2006-12	0.0306** (1.97)	0.0410* (1.94)	-0.0733*** (-2.87)
Dummy 2006-12 * Advanced	-0.0129 (-1.00)	0.1413** (2.52)	-0.1190** (-2.26)
Dummy 2006-12 * EM	-0.0073 (-0.65)	-0.0188 (-1.10)	0.0272 (1.31)
Dummy 2006-12 * SSA	-0.0193*** (-2.84)	-0.0438** (-3.76)	0.0651*** (4.59)
Crisis (t-1)	0.0019 (0.33)	0.0682*** (6.37)	-0.0697*** (-5.94)
Sample	119	294	3555
Pseudo-R-squared	0.0248	0.0603	0.0484

Notes. See notes to Table 2. Sample period: 1980-2012. Sample size: 3968.

Table 7. The full sample with a more stringent definition of a growth collapse

	Extreme growth collapse (GDP growth 7% or more below average of previous three years)		Extreme growth collapse (omitting obs within four years of an extreme growth collapse)	
	(1)	(2)	(3)	(4)
Hard peg (t-1)	0.0492*** (2.36)		0.0343 (1.52)	
No separate legal tender (t-1)		0.0401* (1.92)		0.0248 (1.15)
Currency board (t-1)		0.0987** (2.22)		0.0879 (1.62)
Intermediate regime (t-1)	0.0128 (1.11)		0.0175 (1.53)	
Peg to single currency (t-1)		0.0240 (1.45)		0.0277 (1.44)
Other peg/band (t-1)		0.0155 (1.04)		0.0230 (1.30)
Managed float (t-1)		0.0005 (0.03)		0.0118 (0.73)
Advanced country dummy	-0.0405*** (-3.82)	-0.0402*** (-3.85)	-0.0239* (-1.94)	-0.0240** (-1.97)
Emerging markets dummy	0.0091 (0.73)	0.0103 (0.85)	0.0005 (0.04)	0.0012 (0.09)
SSA dummy	0.0357*** (2.61)	0.0406*** (2.88)	0.0241 (1.54)	0.0280* (1.73)
Dummy 2006-12	0.0403** (1.96)	0.0435** (2.13)	0.0455** (2.11)	0.0465*** (2.67)
Dummy 2006-12 * Advanced	0.1106** (1.96)	0.1028* (1.91)	0.0643 (1.29)	0.0632 (1.29)
Dummy 2006-12 * EM	-0.0099 (0.57)	-0.0111 (-0.66)	0.0048 (0.23)	0.0047 (0.23)
Dummy 2006-12 * SSA	-0.0318*** (-2.68)	-0.0321*** (-2.81)	-0.0297*** (-2.95)	-0.0295*** (-2.98)
Crisis (t-1)	0.0492*** (5.21)	0.0496*** (5.25)	0.0552*** (4.59)	0.0560*** (4.62)
Sample size	3968	3968	2720	2720
Pseudo-R squared	0.0543	0.0577	0.0630	0.0663

Notes. See notes to Table 2. The sample is 1980 to 2012.

Alternative exchange regime classifications

In Table 8 we use two alternative regime classifications. The differences are in the boundary between intermediate regimes and the omitted category, rather than between hard pegs and intermediate regimes. Bleaney and Tian (2017) generate a measure of exchange rate flexibility by regression methods that can be used as a binary classification to separate pegs from floats, as in Bleaney and Tian (2014). Since the float category (the omitted dummy variable) may contain some managed floats or bands, making it wider than in the Ghosh *et al.* (2015) classification, it would not be surprising if the estimated regime effects are smaller than before. Reinhart and Rogoff (2004) use a fine classification that separates managed from free floats, so all managed floats are included in the intermediate category, but the sample size is about 15% smaller, so we also run the regression on the Ghosh *et al.* (2015) for this reduced sample.

Table 8. Using alternative regime classifications

	Probability of growth collapse		
	(1)	(2)	(3)
	Bleaney-Tian (2014) classification	Reinhart-Rogoff (2004) classification	Table 3 classification; same sample as (2)
Hard peg dummy (t-1)	0.0676*** (3.68)	0.0755** (2.07)	0.1364*** (4.03)
Intermediate regime (t-1)	0.0212* (1.91)	0.0168 (0.72)	0.0540*** (3.42)
Advanced country dummy	-0.0366** (-2.25)	-0.0385** (-2.27)	-0.0337*** (-2.01)
Emerging markets dummy	0.0333** (1.96)	0.0200 (1.07)	0.0120 (0.68)
SSA dummy	0.0602*** (3.29)	0.0444** (2.19)	0.0418** (2.13)
Dummy 2006-12	0.0841*** (3.12)	0.0892*** (2.92)	0.0977*** (3.12)
Dummy 2006-12 * Advanced	0.0882* (1.80)	0.0892* (1.79)	0.1317** (2.25)
Dummy 2006-12 * EM	-0.0326 (-1.60)	-0.0189 (-0.80)	-0.0036 (-0.14)
Dummy 2006-12 * SSA	-0.0675*** (-4.82)	-0.0574*** (-3.54)	-0.0546*** (-3.44)
Crisis (t-1)	0.0700*** (5.83)	0.0707*** (5.17)	0.0600*** (4.53)
Sample size	3867	3226	3112
Pseudo-R-squared	0.0444	0.0533	0.0672

Notes. See notes to Table 2. Sample period: 1980-2012. Omitted regime categories: float (BT), free float (RR).

The first column of Table 8 shows the results for the Bleaney-Tian classification. As expected, the estimated regime coefficients are smaller than in the first column of Table 4, but the hard-peg coefficient is still easily significant at the one percent level. The estimated intermediate-regime coefficient is less than half the size of that in Table 4, and is not quite significant at the five percent level. Using the Reinhart-Rogoff classification (Column (2)), the coefficients are fairly similar to those in Column (1), but less statistically significant because the standard errors are rather larger. In order to investigate whether the differences between the Column (2) results and those in Table 4 derive from the differences in the classification rather than in the sample, in Column (3) the Ghosh *et al.* (2015) classification is used on a reduced sample similar to that in Column (2). The regime coefficients are similar to but even slightly larger than in Table 4, indicating a genuine difference in the results with different classifications. Nevertheless Table 8 confirms our main result – that susceptibility to growth collapses increases with the fixity of the exchange rate regime.

5. CONCLUSIONS

Growth collapses have serious consequences, resulting in a weak recovery and a permanent loss of output. This makes avoiding them an important objective of macroeconomic policy. Theory suggests that negative shocks are likely to have larger output effects under fixed than under flexible exchange rates, and previous empirical work has offered some support to this hypothesis. The contribution of the present paper has been to examine susceptibility to growth collapses under different exchange rate regimes for a wide range of countries over a thirty-year period. The clear conclusion is that susceptibility increases with the fixity of the exchange rate regime, being greatest for hard pegs and smallest for independent floats.

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