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The two-sided effect of financial globalization on output volatility

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Abstract This paper provides evidence for a significant relation between international financial markets integration and output volatility. In the framework of a threshold model, it is empirically shown that this relation depends on the financial risk of a country as perceived by investors. In order to proxy financial risk, a financial risk rating employed by multinational firms, banks, and equity and currency traders is used. This rating relies on debt to GDP ratios amongst other indicators. In countries with low financial risk, financial openness decreases output volatility while financial openness increases output volatility in countries with high financial risk. Extensive robustness checks confirm this result.

Keywords Output volatility · Financial openness · Financial risk

JEL Classification E32 · F36 · F41

1 Introduction

Much research has been conducted on the issue of economic growth. However, as important as economic growth is its volatility. High output volatility discourages investment into a country and it increases the risk premiums and thereby the cost of capital in and of the country; see Jayasuriya (2005). Next to these direct consequences of output volatility, it also has a lasting negative effect on output growth, as was demonstrated by Ramey and Ramey (1995) and others. After a crisis, which is nothing else than very high output volatility, there is almost always a drop in growth and a slowdown of the economy (Caprio 1997). The resulting high unemployment has a disproportionate impact on the poorest; see Stiglitz (2000).

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This might increase social inequality and even foster political unrest as can currently be observed in some European countries. Therefore, it is important to understand how the gross domestic product (GDP) volatility can be reduced.

With output volatility in mind, countries have to decide on the extent of their financial integration. Experience from the past 25 years has led to uncertainty regarding the effect of financial openness on output volatility. On the one hand, the financially deeply integrated United States had, from the 1980s until recently, been experiencing declining output volatility, termed the Great Moderation. On the other hand, some developing countries that had opened up their financial markets, i.e. Argentina, experienced deep economic crises in the 1980s or 1990s. Most recently, the financially integrated countries of the European Union were affected differently by the global financial crises. While the shock was exacerbated in some countries leading to a severe economic crisis as in Greece, Portugal or Spain, other countries, such as Germany, seem to recover quickly from a less severe economic downturn. With those different experiences we are left to wonder whether financial openness leads to a decline in output volatility or to economic crises. The lack of generally accepted criteria make the decision on the degree of openness with respect to international financial markets difficult.

No consensus has been reached yet on the question of whether financial openness reduces or increases output volatility. On the one hand, researchers expect financial openness to stabilize the economy. This is because financial openness allows investments and savings to be efficiently allocated across geographic areas; see Fischer (1998). Especially in recessions, greater access to (international) capital, and thus borrowing, decreases economic volatility by reducing the sensitivity of consumption and investments to negative income shocks. Since domestic output, in turn, depends on consumption and investment, there are fewer second-round effects on output. In other words, the "traditional multiplier" response is decreased; see Dynan et al. (2006). On the other hand, financial openness might increase output volatility due to movements of "hot money". Kim and Singal (2000) argue that international money is withdrawn if there is a deterioration in expectations about interest rates or economic growth. The real economy is not sufficiently supplied with credits and is hit harder by an economic downturn. Easterly et al. (2001) and Stiglitz (2000) therefore characterize international capital flows as potentially pro-cyclical and as inducing or amplifying output fluctuations. As theory is inconclusive, empirical research should shed light on the relation between financial openness and output volatility. However, empirical evidence is rather mixed and does not resolve the issue. Owing to the inconclusiveness of past research, Rogoff et al. (2009) hypothesize, without testing, that this relation might depend on a threshold level of one or several variable(s).

This paper develops the idea of a threshold effect further. We hypothesize that the effect of financial openness on output volatility can be positive or negative depending on how financially risky the country is perceived by investors. In order to capture investors' believes of financial risk, we choose the financial risk indicator of the international country risk guide (ICRG). It combines the information of five financial risk measures: Foreign debt as a percentage of GDP, foreign debt service as a percentage of exports of goods and services, current account as a percentage of

exports of good and services, net international liquidity as months of import cover and exchange rate stability. The ICRG advertises that this indicator assesses the ability of a country to pay its official, commercial and trade debts. The indicator, inter alia, is used by investors to asses the risk of a country before investing into this country. If a country bears more financial risk than a certain threshold level, financial openness increases output volatility. In those countries, investors withdraw their capital in times of recessions because they fear, e.g. a sovereign default or an exchange rate collapse. Thereby they deepen the recession. By contrast, countries which bear less financial risk than this threshold level attract new capital in times of recessions because investors are confident that their investment is repaid and even obtains a good yield due to better profit prospects.

In this paper we empirically test for the significance of these two opposing effects of financial openness on output volatility by using Hansen's (1999) panel threshold model. The model determines data-driven thresholds and classifies countries as bearing different levels of financial risk. In line with the hypothesis, we find that financial openness increases output volatility in the high-risk classes, while it decreases output volatility in the low-risk class. This relation between financial openness, financial risk and output volatility is very robust as it is invulnerable to modifications to the operating definition of the variables, the sample size and the functional form of the model. The results of this paper can contribute to the decision-making process of policy makers that (re)consider the financial integration of their country.

The paper is organized as follows. The next section embeds the paper into the empirical literature and describes the threshold model. Section 3 describes the choice of variables and the data. Section 4 reports the estimation results of a linear model, a model with interaction term and the panel threshold model. Section 5 demonstrates the robustness of the results. Section 6 illustrates the effect of financial openness on Argentina and briefly discusses the policy implication of this paper. Finally, Sect. 7 concludes.

2 Threshold model

2.1 Review of empirical literature motivating threshold variable

Two strands of literature empirically analyze the determinants of output volatility. The first one emerges from growth literature. The second strand is an almost independent discussion on the well documented decrease in output volatility in the United States since the 1980s, called the Great Moderation. Both strands of literature investigate among other factors the impact of financial openness on output volatility.

There is still no consensus of whether financial openness increases or decreases output volatility. Several studies find no significant or no robust relation between financial openness and output growth. Buch et al. (2005) test, in the framework of a stochastic dynamic general equilibrium model, the hypothesis whether financial openness affects output volatility by altering the effect of monetary and fiscal

policies. Analyzing a sample of 24 OECD countries in the period 1960–2000, they conclude that more financial openness leads to more output volatility in the 1970s. However this relation is not significant in the other periods and therefore not stable over time. Razin and Rose (1992) examine 138 countries in the period from 1950–1988 and come to the conclusion, that the effect of financial openness on output volatility is not significant. In a survey on the literature, Rogoff et al. (2009, p.17) summarize that "the existing evidence based on papers using a variety of regression models, different country samples and time periods leads to the conclusion that there is no systematic empirical relationship between financial openness and output volatility […]". Alternatively, one could also conclude that the relation exists but is non-linear or depends on some latent or omitted variable.

For example, Bekaert et al. (2006) investigate the volatility of GDP growth after financial liberalization. They study up to 95 developed and developing countries in the period 1980–2000. After financial liberalization, they almost always find a significant reduction in output volatility. However, they indicate that their results are average results and hypothesize that for a country which is "economically fragile, has low quality institutions, and a poorly developed financial sector" (p. 397) financial liberalization might even increase output volatility. In another study, Easterly et al. (2001) extent the standard competitive equilibrium model to examine output volatility by adding financial sector variables. They conduct their analysis on 74 countries in the time period 1960–1997. They find that the relation between growth volatility and depth of the financial system, not distinguishing between foreign and domestic credit, is nonlinear. An increase in financial depth decreases output volatility up to a certain level of financial depth. If financial systems increase beyond this level, depth increases output volatility. Calderón et al. (2004) find that the effect of financial openness on output volatility depends on the level of income. They show that financial openness reduces output volatility most in very poor and very rich countries and less in medium income countries.[1] Bekaert et al. (2006) and Jayasuriya (2005) find evidence suggesting quality of institutions as another mediating factor of the relationship. Better institutions are associated with a reduction of output volatility after financial liberalization. In line with that, Rogoff et al. (2009) hypothesize without testing that financial openness leads to less output volatility when a country has a certain threshold level of financial market development, institutional quality, governance, macroeconomic policies and trade integration. On the contrary, financial openness leads to more output volatility if the country is below this threshold.

Empirical work by Bordo and Meissner (2007) pinpoints another threshold criterion. They find that countries with high financial openness are likely to have economic crises *if* credibility and financial development are weak. On the contrary, countries that were credible and financially sound were able to borrow heavily and

[1] In an earlier study, Klein (2003) analyzed the relation between output growth and capital account openness and also detects that the relationship depends on the level of income. Interestingly, he finds that benefits in terms of increased growth materialize for the income group complementary to the gainers of reduced output volatility identified by Calderón et al. (2004). Middle-income countries benefit from increased growth, while there is no effect for rich countries. Poor countries are either not significantly or negatively affected by a liberalisation of capital accounts.

had relatively few financial crises. The criteria that made a country a winner or a looser of financial openness are credibility and financial development. Bordo and Meissner (2007) conducted their analysis on the first era of globalization (1880–1913) and we will examine whether their results still hold when analysing data starting in 1980, the beginning of the second wave of globalization.

In line with Bordo and Meissner (2007)'s work, this paper uses financial risk as threshold variable. To motivate this choice, we take the perspective of an investor. If an investor is almost sure that her investment is refunded irrespectively of the action of other investors, then there is no reason to withdraw her investment in downturns. On the contrary, the investor will even invest in such a recessive country as she expects high profits. She may buy stocks of relatively cheap firms with good future prospects. Or she may lend money to prospering projects which domestic banks might not be willing to finance in a recession.[2] Under this scenario, foreign capital inflows are counter-cyclical. By contrast, if an investor fears that her investment might be lost (owing, for example, to government default or exchange rate collapse), she will observe not only changes in the country's economy but also the action of other investors very carefully. If there is a sign of a recession, the investor withdraws her money as soon as possible. In that case, foreign capital inflows are pro-cyclical. The criterion whether foreign capital flows are pro-cyclical or counter-cyclical is therefore a certain threshold level of risk which an investors associates with the country in which she invests.

2.2 Estimation method

The panel threshold model developed by Hansen (1999) is used to test the paper's hypothesis. This model divides observations of the variable of interest into classes depending on the value of a certain threshold variable. The coefficient of the variable of interest is therefore a step function depending on the threshold variable. The model is particularly suitable if one expects that the coefficient of the variable of interest changes more or less abruptly at a certain threshold. This is the case in the paper's hypothesis. If output volatility is regressed on financial openness, then the coefficient of financial openness is expected to change its sign once a certain level of financial risk is exceeded. Using this model, data-driven thresholds can be found and their significance can be tested.

The model relies on some assumptions that have to be fulfilled. Firstly, the sample has to be balanced. Secondly, the error terms should be homoscedastic and serially uncorrelated. According to Hansen (1999), however, a violation of this assumption is not a severe problem. In the presence of heteroscedasticity or serial correlation, the threshold estimates are still consistent but the bootstrapped p-values are not reliable. To correct for a potential bias in the slope coefficients of threshold regression (1) below, White–Huber standard errors (SE) can be used. Thirdly, the

[2] Easterly et al. (2001) argue that during recessions, the default rate of credits is higher for domestic financial institutions. Therefore, they are less willing or able to bear risk and they provide fewer credits even to good projects.

explanatory variables have to be exogenous. However, a modification to this model which is proposed by Kremer et al. (2008) may also handle endogenous variables.

The general threshold model regression with K thresholds is defined as follows:

$$y_{it} = \delta \mathbf{Q_{it}} + \sum_{k=0}^{K-1} \beta_{k+1} x_{it} I(\gamma_k < q_{it} \leq \gamma_{k+1}) + \beta_{K+1} x_{it} I(\gamma_K < q_{it}) + \varepsilon_{it}, \qquad (1)$$

where $I(\cdot)$ is the indicator function and γ_k is the kth threshold and $\gamma_0 = 0$. Furthermore, y_{it} is the dependent variable, $\mathbf{Q_{it}}$ is the vector of control variables including country specific fixed effects, and x_{it} is the variable of interest which coefficient is suspected to depend on q_{it}, the threshold variable.

The threshold estimation is conducted in two steps as proposed by Hansen (1999). First, the 'best' threshold from a set of equally spaced values of the threshold variable is chosen. To that end, the sum of squared errors for all threshold models using each potential threshold is calculated. A restriction is impost to ensure that at least 10 % of all observations fall into each class. The 'best' threshold is then the one that corresponds to the threshold model with the smallest sum of squared errors. In a second step, it is verified whether the threshold effect is significant. Under the null hypothesis of no threshold, the threshold is not identified and the test does not have a known distribution. Therefore, bootstrapping is used in order to simulate a distribution that makes inference on the significance of the threshold possible. If the threshold is significant, it is tested whether there is another threshold. Significance is established at the 10 % significance level here. Given the first threshold, the same procedure as before is used in order to find a second threshold. Three or more thresholds can be found analogously.

3 Variable selection and data description

In this section, we elaborate on the measurement of financial openness and financial risk. Furthermore, output volatility and the control variables are introduced. Lastly, the source and coverage of the data are described.

Financial openness variables are either de facto or de jure measures. Most prominently used de jure measures are indicator variables for equity market liberalization used, for example, by Bekaert et al. (2006) and Jayasuriya (2005) or the number of restrictions on the capital account used, for example, by Buch et al. (2005), Chinn and Ito (2006). Rogoff et al. (2009) describe those measures in detail and emphasize that de jure measures cannot capture the actual effect of capital controls or liberalization. They argue that a country which has very liberal capital account laws does not necessarily have to be heavily involved in international financial investments. Furthermore, liberalizations do not necessarily happen at one point in time but materialize gradually. By contrast, de facto variables are continuous variables and do not suffer from these drawbacks.

A commonly used de facto measure of financial openness is gross capital flows divided by GDP used, for example, by Buch et al. (2005), Kose et al. (2003) and Kose et al. (2005). Another measure of financial openness is banks' foreign assets in

percent of banks' total assets used by Buch et al. (2005). Furthermore, Beck et al. (1999) construct two measures of foreign bank penetration: firstly, the ratio of the number of foreign banks to the number of domestic banks and secondly, the ratio of the assets of foreign banks to the assets of domestic banks. While the last two measures have a good cross-country coverage, they are available only since 1990.

Following Rogoff et al. (2009), the sum of gross stocks of foreign assets and liabilities as ratio to GDP is used in this analysis.[3] Rogoff et al. (2009) argue that this variable is less volatile and less prone to measurement errors than flow variables. Furthermore, this de facto measure has a broad coverage.

A country's financial risk as perceived by investors is measured by the financial risk rating, which is an element of the ICRG published by the Political Risk Services group.[4] The rating is mainly used by multinational firms, banks, and equity and currency traders but also academics. It measures a country's capacity to pay for its official, commercial, and trade debt obligations. A higher risk rating indicates low financial risk. The rating consists of 0–50 risk points aggregated over five financial risk components: Foreign debt as a percentage of GDP (0–10 risk points), foreign debt service as a percentage of exports of goods and services (0–10 risk points), current account as a percentage of exports of goods and services (0–15 risk points), net international liquidity as months of import cover (0–5 risk points) and exchange rate stability (0–10 risk points).[5] This weighting is the one published by the PRS group and, therefore, the one investors are most likely to work with. For that reason, this weighting is also employed in this paper.

The financial risk rating is used by academics and investors alike. According to Hoti and McAleer (2004), the interest in financial risk ratings is due to the increased international debt of developing countries since the 1970s and the incidences of debt rescheduling in the early 1980s. The rating influences investment decisions because they affect investors' expectations of the risk-return features of their investments (Hoti and McAleer 2004). Examples of academic studies employing the financial risk rating are Hoti and McAleer (2004), Hassan et al. (2003), IMF (2008), Girard and Omran (2007), Bekaert et al. (2006) and Jayasuriya (2005).

Next, the measu res of output volatility and of the control variables are presented. Output volatility is commonly measured as the standard deviation of GDP growth over a 5-year window. In order to enhance the presentation of the estimation results, this definition of output volatility is multiplied by a factor of 100. Variables which are most commonly used to explain output volatility are monetary policy quality,

[3] Foreign liabilities = Portfolio equity liabilities + FDI liabilities + debt liabilities + financial derivatives (liabilities). Foreign assets = portfolio equity assets + FDI assets + debt assets + financial derivatives (assets) + total reserves minus gold.

[4] According to Hoti and McAleer (2004), the ICRG is the only risk rating agency to provide detailed and consistent monthly data over an extended period for a large number of countries. More detailed information can be found on the website of the PRS group: http://www.prsgroup.com.

[5] Concerning the fourth risk component: Net international liquidity is the US dollar value of official reserves for a given year. This value is divided by the average monthly merchandise import cost in order to indicate how many months of imports can be financed with reserves. Concerning the fifth risk component: Exchange rate stability is measured as the percentage change of a currency against the US dollar (against the euro in the case of the US) over a calendar year.

fiscal policy quality, supply shocks and trade openness, e.g. Karras and Song (1996), Ferreira da Silva (2002) and Buch et al. (2005).

In this analysis, we mostly follow Ferreira da Silva (2002) in the selection of proxies for those control variables. As Ferreira da Silva (2002), Kose et al. (2003), Bekaert et al. (2006) and Yang (2008), we use inflation as a proxy for monetary policy. The success of monetary policy at controlling inflation is often measured in the level of inflation, where low but positive levels indicate a successful monetary policy. Moreover, Summers (2005) argues that low inflation rates themselves may have a reducing effect on output volatility: they reduce nominal distortions, e.g. from taxation, they decrease one source of uncertainty relevant for investment decisions and they result in lower expected inflation, giving monetary policy more room for maneuver to respond to crisis.[6] As Ferreira da Silva (2002) and Bekaert et al. (2006), we proxy fiscal policy quality using growth of government expenditure. High government expenditures may be a sign of macroeconomic imbalances indicating bad fiscal policy which is expected to increase output volatility.[7] Supply shocks are captured by terms of trade volatility, following Buch et al. (2005), Kose et al. (2003) and Spatafora and Sommer (2007). It is straight forward to claim that smaller supply side shocks should lead to smaller output volatility. Trade openness is captured by its standard measure: the sum of exports and imports divided by GDP. While it is standard to include this variable into growth as well as growth volatility analysis, for the latter see Bekaert et al. (2006), Ferreira da Silva (2002) and Calderón et al. (2004), its effect on growth volatility is controversial. In addition, financial risk is used as control variable. This assures that the effect of financial openness in different risk classes is not driven by financial risk solely but also by financial openness as a function of financial risk. Alternative measures to capture the control variables are discussed in the robustness section. Using an extreme bounds analysis this section reveals that the results of this paper do not hinge on the definition of the control variables.

In the empirical analysis, annual data for 26 developed countries and 36 developing countries are used. Countries are chosen on the grounds of data availability and are listed in Table 10 in the "Appendix". The sample period 1980–2007 is chosen, firstly, because financial globalization arguably gained pace from 1980 onwards and, secondly, because observations in the balanced panel are maximized for this sample period. Output volatility and control variables are available for the time period 1980–2007.[8] The financial risk rating covers the period 1984–2006. Financial openness is available for the period 1980–2004.[9] The variables are calculated over a 5-year period (seven years for the last time period)

[6] Alternative measures of monetary policy are the standard deviation of inflation, the standard deviation of short-term interest rates, average tenure of central bank governor, length of inflation targeting period.

[7] Alternative measures for fiscal policy are: large current account deficits and the standard deviation of the change in government expenditures.

[8] Data for 2007 are based on projections from the IMF (2007) world economic outlook database. Fiscal policy quality covers only the period 1981–2007 for the Netherlands, Portugal, Spain, New Zealand, South Africa, Bolivia, Brazil, the Dominican Republic, Israel, Cameroon, Kenya, Malawi, Senegal, Tanzania and Togo.

[9] Except for Malawi and Haiti, where financial openness covers 1980–2003.

using either averages or standard deviations according to their definition. The 5-year window is typically chosen because a full business cycle lasts about this long. For the analysis, non-overlapping windows instead of rolling windows are used in order to avoid problems stemming from serial correlation. The periods run from 1980–1984, 1985–1989, … , 2000–2007, if data availability permits. Consequently, the time series dimension contains five observations. In the "Appendix", definitions of the variables as well as the sources of the data are provided in Table 11. Moreover, descriptive statistics are presented in Table 12 and country-averages of output volatility, financial openness and financial risk are plotted over time in Fig. 1 in the "Appendix".

4 Empirical analysis

In this section, the effect of financial openness on output volatility is estimated. First, a linear regression is estimated revealing that there is no linear relation between financial openness and output volatility. Then, an interaction term is included and finally a threshold model is estimated to verify the working hypothesis of a two-sided effect of financial openness on output volatility.

As a benchmark for the threshold estimation, a linear regression is estimated:

$$\sigma_{Yit} = \delta \mathbf{Q_{it}} + \beta FinOpen_{it} + \varepsilon_{it} \quad (2)$$

The dependent variable is output volatility. **Q** is the vector of control, variables also including time- and country-specific fixed effects, and *FinOpen* is financial openness. The statistics of this regression can be found in Table 1. The usual OLS SE are not systematically different from the White–Huber SE. Nevertheless, the analysis of the coefficients in this and the following regressions relies on White–Huber SE which render the *p*-values robust to heteroscedasticity and serial correlation at no cost.[10]

The regression indicates that there is no significant linear relation between financial openness and output volatility. Turning to the control variables, more terms of trade volatility and higher inflation lead to more output volatility but not significantly. Rapid government expenditure growth significantly increases output volatility. This indicates that large government spending might be a sign of macroeconomic imbalances or profligacy and thereby destabilize the economy. More trade openness leads to more output volatility. This confirms the argument of Giovanni and Levchenko (2006) stating that firstly, traded sectors are more volatile than other sectors and that secondly, trade leads to specialization. Giovanni and Levchenko (2006) acknowledge that traded sectors have a smaller correlation with the domestic economy but this implicit negative relation with output volatility is offset by the former positive effects. Lastly, a high financial risk rating implying low financial risk, decreases output volatility.

[10] In contrast to time-series regressions, the White–Huber SE are robust to serial correlation in panel regressions of the form "small *T*, large *N*", see Wooldridge (2002).

Table 1 Benchmark: the linear model

$\sigma_{Yit} = \delta \mathbf{Q_{it}} + \beta FinOpen_{it} + \varepsilon_{it}$

Regressor	Coefficient	White SE	OLS SE
π	0.387	0.249 (0.121)	0.208 (0.064)
Δ_{Gov}	0.311**	0.144 (0.032)	0.100 (0.002)
σ_{ToT}	0.037	0.043 (0.386)	0.018 (0.042)
TraOpen	3.789**	1.815 (0.038)	1.234 (0.002)
FinRisk	−0.125**	0.031 (0.000)	0.035 (0.000)
FinOpen	0.064	0.125 (0.609)	0.150 (0.669)
$R^2[\bar{R}^2]$			0.25 [0.22]

The dependent variable is output volatility

Definitions of the variables can be found in Table 11 in the "Appendix". 62 countries and 5 time periods are used (i.e. 310 observations). 5-year non-overlapping windows are used

Q, control variables as well as time and country fixed effects; π, monetary policy; Δ_{Gov}, fiscal policy; σ_{ToT}, supply shock volatility; *TraOpen*, trade openness; *FinRisk*, financial risk; *FinOpen*, financial openness

** Significant at the 5 % level using White–Huber SE, *p*-values relying on normal approximation are given in parentheses

A general problem in the discussion on the effect of financial openness (or policy quality) on output volatility is the question of reversed causality and endogeneity. Economically, both problems are hard to argue against. This paper only tackles the question of whether the empirical results are biased due to statistical endogeneity. In order to test whether any regressor is endogenous, the regression-based Hausman test is applied to regression (2). Each variable is tested for exogeneity separately. Instrumental variables are particularly difficult to find for this large sample due to data availability. Not only must the instruments be correlated to the potentially endogenous variable, they must also provide more information on the potentially endogenous variable than all other exogenous variables in the regression. This "rank condition" is fulfilled if the instrument is significant in a reduced form regression.[11] The second condition that needs to be fulfilled is that of the instruments' exogeneity.

Two approaches are implemented to test endogeneity. Firstly, first differencing instead of within transformation is used in order to eliminate fixed effects. In that way, the second lag of the variable can be used as an instrument. The rank condition is fulfilled for inflation, government expenditure growth, financial risk and financial openness. As can be deduced from the *p*-values in the first panel of Table 2, the regression-based Hausman test indicates that the variables are exogenous, applying a 10 % significance level. Secondly, trade openness and terms of trade variation are instrumented by variables not used in the original regression: constraints on the

[11] In the reduced form regression, the instrument as well as all exogenous variables are regressed on the potentially endogenous variable. If the instrument is significant, then it can be used in the endogeneity test.

Table 2 Endogeneity tests

Variable	Instruments	Rank condition	Hausman
π	2. lag	0.000	0.395
Δ_{Gov}	2. lag	0.032	0.801
TraOpen	2. lag	0.203	0.238
σ_{ToT}	2. lag	0.788	0.489
FinRisk	2. lag	0.000	0.727
FinOpen	2. lag	0.011	0.185
TraOpen	*xconst*	0.001	0.847
σ_{ToT}	*CA*	0.003	0.315
xconst	2. lag	0.000	0.218
CA	2. lag	0.012	0.902

In the first and third panel, first differencing is used to eliminate fixed effects while in the second panel, the within transformation is used

In the last two columns, robust *p*-values are presented. A valid instrument must fulfill the rank condition, i.e. the *p*-value of the rank condition must be smaller than 0.10. A variable is exogenous if the *p*-value of the (regression-based) Hausman test is greater than 0.10

π, monetary policy; Δ_{Gov}, fiscal policy; σ_{ToT}, supply shocks; *TraOpen*, trade openness; *FinRisk*, financial risk; *FinOpen*, financial openness; *xconst*, constraints put on the executive; *CA*, current account balance/GDP

executive and current account balance divided by GDP, respectively.[12] Using those instruments, the rank condition and the Hausman test indicate that trade openness and terms of trade variation are exogenous as well; see second panel of Table 2. Therefore, all variables used in this analysis are statistically exogenous.

In order to motivate an analysis for a non-linear relation between financial openness and output volatility, we add an interaction term between financial openness and financial risk to the base-line regression. The estimation results of the variables of interest can be found in column (1) in Table 3. Financial openness as well as the interaction term are significant and exhibit the expected signs: Financial openness increases output volatility but by less the higher financial soundness, measured by a higher financial risk rating. At a financial risk rating of 36, the overall effect of financial openness on output volatility turns negative. For financially sound countries, having a financial risk rating of 36 or more, financial openness decreases output volatility.

[12] Instruments are chosen on the grounds of passing the rank condition. "Constraints on the executive" is an index running from 1 to 7 measuring the extent of institutionalized constraints on the decision-making powers of chief executives, such as the legislatures. The variable was initially compiled and described by Gurr et al. (1989). Current account balance divided by GDP is retrieved from the IMF's World Economic Outlook database. Exogeneity of the instruments is tested in the following way. The variable to be instrumented is substituted by its instrument in regression (2). Using first differencing instead of the within transformation and the variables second lag as an instrument, as before, yields the test regression. From the statistics in the third panel of Table 2, it can be deduced that both variables, constraints on the executive and current account balance, pass the rank condition and the Hausman test.

Table 3 Inclusion of interaction terms in linear model

$\sigma_{Yit} = \delta \mathbf{Q_{it}} + \beta \mathbf{X_{it}} + \varepsilon_{it}$			
$\mathbf{X_{it}}$	(1)	(2)	(3)
FinOpen	1.99* (0.02)	−0.22 (0.45)	
FinOpen * *FinRisk*	−0.05** (0.02)		
FinOpen * π		0.19 (0.18)	
FinOpen * Δ_{Gov}		0.07 (0.15)	
FinOpen * *HighIC*			0.05 (0.75)
FinOpen * *MiddleIC*			0.74 (0.29)
FinOpen * *LowIC*			0.69 (0.11)
R^2 [$\bar{R}^2$]	0.30 [0.27]	0.27 [0.24]	0.27 [0.24]

The dependent variable is output volatility

HighIC (*MiddleIC*/*LowIC*) are equal to 1 if a country has high (middle/low) income

A star between variables indicate their interaction term

Q, control variables as well as time and country fixed effects analog to regression (2); *FinRisk*, financial risk; *FinOpen*, financial openness; π, monetary policy; Δ_{Gov}, fiscal policy

** Significant at the 5 % level. Robust *p*-values are given in parentheses

Rogoff et al. (2009) and Buch et al. (2005) hypothesize that the non-linear relation between financial openness and output volatility depends on monetary and fiscal policy. We test this hypothesis by including interaction terms between financial openness and monetary as well as fiscal policy in the base-line regression. The test results are displayed in column (2) of Table 3 and confirm the empirical findings of Buch et al. (2005): the hypothesis that monetary and fiscal policy influence the relation between financial openness and output volatility can be rejected as the interaction terms are not significant.[13] Another non-linear relation was tested by Calderón et al. (2004) who found evidence for the hypothesis that financial openness has distinct effects in low-, middle- and high-income countries. In order to test this hypothesis, we divide financial openness using exogenously given thresholds for low-, middle- and high-income groups as defined by the World Bank and replace financial openness by the three new variables in the baseline regression. The variables are equal to financial openness if the country belongs to a given income group and zero otherwise. The estimation results of the variables of interest are displayed in column (3) of Table 3. We reject the hypothesis that the relation between financial openness and output volatility depends on a country's income as the three variables are insignificant.[14]

We conclude that there exists a non-linear relationship between financial openness and output volatility. While we find no evidence for the hypotheses that monetary or fiscal policy or income affects the relation between financial openness

[13] When adding the policy interaction terms to the regression with the financial risk interaction term, the coefficient of the latter remains −0.05 and its *p*-value is 0.01.

[14] When including the income group threshold variables in the regression with the financial risk interaction term, the coefficient of the latter remains −0.05 and its *p*-value is 0.01.

Table 4 Test statistics determining the number of thresholds

$\sigma_{Yit} = \delta \mathbf{Q_{it}} + \sum_{k=0}^{K-1} \beta_{k+1} FO_{it} I(\gamma_k < FR_{it} \leq \gamma_{k+1}) + \beta_{K+1} FO_{it} I(\gamma_K < FR_{it}) + \varepsilon_{it}$

Test against triple threshold: (H_0: $K = 2$, H_1: $K = 3$)	
F_3	6.17
p-value	0.259
Critical values (10 %, 5 %, 1 %):	(9.23, 11.42, 17.44)
Test against double threshold: (H_0: $K = 1$, H_1: $K = 2$)	
F_2	17.77
p-value	0.058
Critical values (10 %, 5 %, 1 %):	(12.24, 19.01, 33.74)
Test against single threshold: (H_0: $K = 0$, H_1: K=1)	
F_1	25.48
p-value	0.065
Critical values (10 %, 5 %, 1 %):	(17.52, 29.77, 55.15)

The dependent variable is output volatility. The definition of all variables can be found in Table 11 in the "Appendix". $\gamma_k = k$th threshold level (where $\gamma_0 = 0$) and $K =$ number of thresholds. The test statistic of a likelihood ratio, testing whether there are $k - 1$ versus k threshold(s), is denoted by F_k and indicates that the number of thresholds is 2. 1,000 bootstrap replications were used to obtain the critical values and *p*-values. Each risk class is required to contain at least 10 % of all observations

Q, control variables as well as time and country fixed effects; *FO*, financial openness; *FR*, the threshold variable financial risk rating

and output volatility, we find evidence for our hypothesis that financial risk changes the relation between financial openness and output volatility. The less risky a country, the more output volatility is reduced.

As we found evidence for a non-linear relation, we now test whether there is evidence for a threshold relation as argued by Rogoff et al. (2009). For that purpose, we apply Hansen's threshold model. The statistics of the first panel in Table 4 indicate that the significance of a double threshold is not rejected if the alternative is a triple threshold. Furthermore, the *p*-values of 0.058 in the second panel and of 0.065 in the third panel of Table 4 imply that the hypotheses of a single and no threshold are rejected at the 10 % level, respectively. Therefore, the double threshold model is the appropriate model to work with.[15] As the upper part of Table 5 indicates, the two thresholds are estimated to be at a financial risk rating of 23 and 29. Therefore, countries are divided into three classes according to their level of financial risk. Countries with a level of financial risk of 23 or below are classified as having 'high risk' and are in class one. Countries with a level of financial risk above 23 and less than or equal to 29 have 'high-intermediate risk' and are in class two. Countries with a level of financial risk above 29 are classified as having 'low risk' and are in class three.

Having determined the number of thresholds as well as their point estimates, the appropriate threshold regression (3) is estimated:

[15] It might be argued that a 10 % significance level is not sufficient to establish the significance of the double threshold. In view of the significance of financial openness in the second step, displayed in Table 5, the choice of the double threshold model seems, however, appropriate.

Table 5 Estimation results of double threshold regression

$\sigma_{Yit} = \delta \mathbf{Q_{it}} + \beta_1 FO_{it} I(FR \leq \hat{\gamma}_1) + \beta_2 FO_{it} I(\hat{\gamma}_1 < FR_{it} \leq \hat{\gamma}_2) + \beta_3 FO_{it} I(FR > \hat{\gamma}_2) + \varepsilon_{it}$

Threshold estimates		
$\hat{\gamma}_1$	23	[20, 24]
$\hat{\gamma}_2$	29	[27, 39]
Regression estimates		
π	0.144	(0.474)
Δ_{Gov}	0.362***	(0.007)
σ_{ToT}	0.037	(0.409)
TraOpen	3.989***	(0.007)
FinRisk	−0.064**	(0.035)
FinOpen $I(FinRisk \leq 23)$	1.826***	(0.001)
FinOpen $I(23 < FinRisk \leq 29)$	0.513***	(0.003)
FinOpen $I(29 < FinRisk)$	−0.248*	(0.086)
$R^2[\bar{R}^2]$		0.34 [0.32]

The dependent variable is output volatility

Definitions of the variables can be found in Table 11 in the "Appendix". 62 countries and five 5-year non-overlapping time periods are used (i.e. 310 observations)

Q, control variables as well as time and country fixed effects; π, monetary policy; Δ_{Gov}, fiscal policy; σ_{ToT}, supply shocks; *TraOpen*, trade openness; *FinRisk*, financial risk; *FinOpen*, financial openness

***, **, * Significant at the 1, 5 and 10 % level, respectively. Robust *p*-values are given in parentheses and bootstrapped confidence intervals are given in brackets

$$\sigma_{Yit} = \delta \mathbf{Q_{it}} + \beta_1 FinOpen_{it} I(FinRisk_{it} \leq 23) + \beta_2 FinOpen_{it} I(23 < FinRisk_{it} \leq 29) + \beta_3 FinOpen_{it} I(FinRisk_{it} > 29) + \varepsilon_{it} \quad (3)$$

As shown in the lower panel of Table 5, financial openness is significant in all three financial risk classes and has the expected signs. In countries with very high financial risk, financial openness increases output volatility. In high-intermediate risk countries, financial openness also increases output volatility but by less than in risky countries. By contrast, more financial openness decreases output volatility in a low-risk country. As the adjusted R^2 has increased from 0.27 to 0.34, the threshold model goes beyond the simpler 'interaction term model' in terms of explanatory power.

Section 6 will illustrate the magnitude of the estimated effect of financial openness on output volatility in each risk class using the example of Argentina. Before that, the robustness of the estimation result is tested in the next section.

5 Assessing the robustness of the results

In order to check the robustness of the estimation results, three variations are analysed. Firstly, the robustness of the results with respect to the variables'

operational definitions is tested. Secondly, alternative model specifications are implemented. And thirdly, the sample is extended and shortened. The robustness checks confirm that countries with low financial risk profit from financial globalization in terms of reduced output volatility while financially risky countries are negatively affected by financial openness.

5.1 Variation to the definitions of the variables

In this subsection, we use alternative definitions of financial openness, output volatility and the control variables in order to assess the robustness of the paper's result.

It might be argued that foreign companies' location decision concerning foreign direct investments (FDI), which are included in the measure of financial openness, is affected by countries' output volatility. Since it was demonstrated that financial openness is exogenous, this issue does not seem to affect the estimation results. And indeed, the exclusion of FDI has virtually no effect on the number and level of thresholds or the significance and sign of financial openness. A table with the estimation results is available upon request.

Next, the standard deviation of the cyclical component of GDP is used as an alternative measure of output volatility. In order to retrieve the cyclical component, GDP is filtered using the band-pass filter advocated by Baxter and King (1999).[16] When repeating the analysis of Sect. 4 using the cyclical component of GDP, the main results do not change. Selected statistics of this regression can be found in Table 13 in the "Appendix".

Lastly, the robustness of the results with respect to the choice of control variables is established. To that end, alternative measures of the control variables are used to estimate threshold model (3). This robustness check is a variant of Leamer's (1983) and Levine and Renelt's (1992) extreme bounds analysis. The extreme bounds analysis yields upper and lower bounds for the three coefficients of financial openness from all possible combinations of control variables. As alternative measures of policy quality the variance of inflation and government expenditure growth are used. Furthermore, terms of trade growth was used instead of its standard deviation. As an alternative to the financial risk rating, short-term interest rates were used. Threshold regression (3) is then run 16 times. Each regression includes all five control variables, but a different combination of their measures. Out of these regressions, Table 6 lists the highest and lowest coefficients together with the *p*-value of financial openness in each of the three risk classes. The sign of the coefficients of financial openness has changed in none of the 16 regressions, and the coefficients are significant in all regressions. Therefore, the results of this paper are robust to those alternative measurements of the control variables.

[16] We follow Baxter and King (1999) who propose using those fluctuations that last at least 2 years and at most 8 years to capture the business cycle. In order to enhance the presentation of the estimations, output volatility is defined here as the standard deviation of the cyclical component of per capita GDP multiplied by 100.

Table 6 Robustness to measurement of control variables

	Coefficient	*p*-value
Financial openness in high-risk class		
High	2.57***	(0.00)
Base	1.83***	(0.00)
Low	1.74***	(0.01)
Financial openness in intermediate-risk class		
High	0.84***	(0.00)
Base	0.51***	(0.00)
Low	0.45***	(0.01)
Financial openness in low-risk class		
High	−0.24*	(0.10)
Base	−0.25*	(0.09)
Low	−0.32**	(0.02)

Regression (3) is run sixteen times. In each regression, different measures of the control variables and their permutations are used. The estimated coefficient and *p*-value for "base" refer to the threshold model of Sect. 4. The rows labelled "high" and "low" give the highest and lowest estimate of the 16 regressions

***, **, * Significant at the 1, 5 and 10 % level, respectively.

5.2 Variation to the model specification

In this subsection, the threshold model specifications are modified in various ways to determine the model which best fits the data. A first modification concerns the functional form. Output volatility cannot be negative and, therefore, it might enhance the fit of the model to take the logarithm of output volatility. Estimation results of the thus modified version of regression (3) reveal that all three risk classes remain significant and keep their signs. Since the adjusted R^2 is smaller than for the original regression and for the sake of comparison with previous research, output volatility and not its logarithm is used in this paper. A table with the estimation results is available upon request.

The last model modification changes the interaction between financial openness and financial risk. First, we allow for the third, insignificant threshold at $FinRisk = 40$ and estimate the triple threshold model:

$$\begin{aligned}\sigma_{Yit} = {} & \delta \mathbf{Q_{it}} + \beta_1 FinOpen_{it} I(FinRisk_{it} \leq 23) + \beta_2 FinOpen_{it} I(23 < FinRisk_{it} \leq 29) \\ & + \beta_3 FinOpen_{it} I(29 < FinRisk_{it} \leq 40) + \beta_4 FinOpen_{it} I(FinRisk_{it} > 40) + \varepsilon_{it}\end{aligned} \tag{4}$$

The estimation results can be seen in Table 7. All four classes are significant and the signs are consistent with the results of the double threshold model. The coefficient of financial openness is positive for the two more risky classes and negative for the two less risky classes. The adjusted R^2 is higher than in the double threshold model. Furthermore, Wald tests indicate that the coefficients of financial openness in the different classes are significantly different from each other.

The coefficients decrease monotonously from more risky to less risky classes. This leads to the notion that the relation between financial risk and the coefficient of

Table 7 Estimation results: triple threshold regression

$\sigma_{Yit} = \delta \mathbf{Q_{it}} + \beta_1 FO_{it} I(FR \leq \gamma_1) + \cdots + \beta_4 FO_{it} I(FR > \gamma_3) + \varepsilon_{it}$		
Threshold estimates		
$\hat{\gamma}_1$	23	[20, 24]
$\hat{\gamma}_2$	29	[27, 39]
$\hat{\gamma}_3$	40	[34, 45]
Regression estimates		
π	0.130	(0.513)
Δ_{Gov}	0.344***	(0.009)
σ_{ToT}	0.037	(0.396)
TraOpen	4.815***	(0.003)
FinRisk	−0.054*	(0.079)
$FinOpen\, I(FinRisk \leq \hat{\gamma}_1)$	1.879***	(0.000)
$FinOpen\, I(\hat{\gamma}_1 < FinRisk \leq \hat{\gamma}_2)$	0.537***	(0.002)
$FinOpen\, I(\hat{\gamma}_2 < FinRisk \leq \hat{\gamma}_3)$	−0.230*	(0.075)
$FinOpen\, I(\hat{\gamma}_3 < FinRisk)$	−0.520***	(0.010)
$R^2[\bar{R}^2]$		0.36 (0.33)

The dependent variable is output volatility. Definitions of the variables can be found in Table 11 in the "Appendix". 62 countries and five 5-year non-overlapping time periods are used (i.e. 310 observations)

Q, control variables as well as time and country fixed effects; π, monetary policy; Δ_{Gov}, fiscal policy; σ_{ToT}, supply shocks; *TraOpen*, trade openness; *FinRisk*, financial risk; *FinOpen*, financial openness

*** and * Significant at the 1 and 10 % level, respectively. Robust *t*-statistics are given in parentheses and confidence intervals are given in brackets

financial openness might be smoother than the step function of the threshold model. A threshold model with smooth-transition might fit the data even better, but is left for future research. In case more thresholds and smoother transitions are added to the current threshold model, it will ultimately resemble the model including the financial risk interaction term reported in column (1) of Table 3. The lower adjusted R^2 of the financial risk interaction term model (0.27) indicates, however, that more thresholds and smoother transitions will ultimately not fit the data better than the double or triple threshold model.

Compared to the double threshold model, the triple threshold model has a higher adjusted R^2, while the linear regression with the interaction term has a lower adjusted R^2. In terms of this model selection criterion, the triple threshold model is the superior model. Therefore, estimation results and tables of the triple threshold model are presented as a supplement when analysing the effect of sample variation.

5.3 Variations to the sample

As the last robustness check, the sample is varied. The use of Hansen's panel threshold model restricts the panel to be balanced. However, the panel has to be balanced only in order to determine the number and the value of the thresholds. By

Table 8 Estimation results: the unbalanced panel

Regressor	Double threshold		Triple threshold	
*FinOpen*2.1/*FinOpen*3.1	1.531***	(0.004)	1.590***	(0.003)
*FinOpen*2.2/*FinOpen*3.2	0.451***	(0.002)	0.475***	(0.001)
*FinOpen*2.3/*FinOpen*3.3	−0.113	(0.332)	−0.083	(0.474)
*FinOpen*3.4			−0.282*	(0.087)
$R^2[\bar{R}^2]$	0.27 [0.24]		0.26 [0.24]	

FinOpen k.l equals financial openness if the observation is in risk class *l* of a model with *k* thresholds, and equals zero otherwise. An observation is, e.g. in risk class 1 if $FinRisk \leq \hat{\gamma}_1$. 86 countries and four to five-year non-overlapping time periods are used, leading to 406 observations. Time and country fixed effects are included

*** and * Significant at the 1 and 10 % level, respectively. Robust *p*-values are given in parentheses. The thresholds of regression [(3) and (4)] are used: [23, 29, 40]

taking the thresholds of the balanced panel as given, one may estimate the double threshold regression (3) and the triple threshold regression (4) in order to obtain coefficients of financial openness in the different risk classes for an unbalanced panel. The extended panel consists of 86 instead of 62 countries with four to five time observations, leading to a total of 406 observations.[17]

Table 8 presents the estimation results of the double threshold regression (3) and the triple threshold regression (4) when using the unbalanced panel. The signs of financial openness in all risk classes are unchanged. Further, financial openness is highly significant for the two most risky classes. However, financial openness turns insignificant in the low-risk class of the double threshold model and the low-intermediate-risk class of the triple threshold model. Remarkably, the very low-risk class of the triple threshold model is significantly negative, emphasizing that the relation between financial openness and output volatility is significant for very low-risk countries in the extended panel, too. The main results obtained for the balanced panel are therefore also applicable to this even greater sample.

Besides the extension of the sample, its reduction is considered as well. The countries are divided into three income groups according to their World Bank classification: low-income, middle-income and high-income. The double and triple threshold regressions, (3) and (4), are then estimated leaving out one of those groups at a time. Financial openness continues to have the same signs in all three/four risk classes, except for the insignificant second risk class if high-income countries are excluded; see Table 15 in the "Appendix". However, the third risk class turns insignificant when leaving out low and middle-income countries. More importantly, the first and the fourth risk class in the triple threshold model are always significant. Therefore, the general result of this paper is confirmed even under sample variations.

[17] The sample is extended with the following countries, covering the time period 1985–2007: Angola, Botswana, Burkina Faso, Chile, China, Colombia, El Salvador, Ethiopia, Guinea, Hungary, Ivory Coast, Republic of Korea, Madagascar, Malaysia, Mali, Mozambique, Niger, Nigeria, Oman, Poland, Switzerland, Trinidad and Tobago, Uganda, Zimbabwe.

The robustness checks in this section demonstrated that the general result of this paper is valid even under the conducted modifications to variables, model and sample: financial openness significantly decreases output volatility in high-risk countries and significantly reduces output volatility in low-risk countries.

6 Interpretation and implication of the estimation results

In this section, we would like to give a meaning to the coefficients of financial openness and interpret the results of this paper in terms of policy implications.

As can be seen in Table 5, an increase in financial openness by one unit (i.e. an increase of the sum of a country's foreign assets and liabilities by the amount of its GDP) leads to an increase in output volatility of 1.826 (0.513) units if a country has high (high-intermediate) financial risk. Low-risk countries experience a reduction in output volatility of 0.248 units under the same scenario.

But how great is the effect of financial openness on output volatility in percentage terms in reality? By how much does financial openness in an exemplary country change from one period to the next? In order to illustrate the estimated effect of financial openness on output volatility, Argentina is described, since it is a country with an eventful past which has been in all three risk classes in the past 27 years. In Argentina, financial openness increased from 0.5 to 2.1 units between the early 1980s and the early 2000s.

In the 1980s, Argentina suffered from economic stagnation and hyperinflation as a result of protectionist and populist economic policies (Hoti and McAleer 2004). In this period, output volatility was, on average, 5.6 and financial risk was high. Combining this information with the estimation results of the last section, financial openness was responsible for about 19 % of output volatility in the 1980s.[18]

In the 1990s, Argentina successfully developed its economy and brought back confidence in the domestic currency. Argentina got through the Mexican and Asian financial crisis relatively well, partly because the falling dollar increased its competitiveness in European markets; see Krueger (2002). In this period, output volatility was 4.9 on average and financial risk was low. Financial openness in combination with the low level of financial risk reduced output volatility by 4 % in comparison with a hypothetical situation with closed financial markets. In 1999–2002, Argentina experienced an economic crisis: the currency peg had to be abandoned, bank deposits had to be frozen to prevent further bank runs, and external debt payments had to be suspended. During this period, output volatility was 7.3 and financial risk was high-intermediate. According to the estimation

[18] This is computed as follows: financial openness in the period 1980–1984 was 0.451. Multiplying financial openness by the coefficient of financial openness in risk class 1, gives 0.824. The actual output volatility at that time was 4.603. If financial openness had been zero, output volatility should have been less, namely $4.603 - 0.824 = 3.780$. Therefore, if financial openness had been zero, output volatility would have been 17.9 % smaller. Putting it differently, financial openness was responsible for 17.9 % of output volatility. In the period 1985–1989, financial openness was responsible for 20.9 % of output volatility. Hence, in the period 1980–1989, financial openness was responsible for around 19 % of output volatility.

Table 9 Percentage of countries in each risk class by year

	1980 (%)	1985 (%)	1990 (%)	1995 (%)	2000 (%)
Very high risk	29	29	6	2	0
High-intermediate risk	26	31	23	8	8
Low risk	45	40	71	90	92

The table displays the percentage of countries in the sample which have been in a certain risk class during a certain time period. The table indicates a shift towards less financial risk

results, financial openness in combination with intermediate-risk was responsible for 14 % of output volatility.

The case of Argentina illustrates how great the estimated effect of financial openness on output volatility can be. The estimation results of the earlier analysis attribute up to 21 % of output volatility in Argentina to financial openness. This stresses that policy-makers should attempt to reduce financial risk in order to prevent high output volatility stemming from financial openness.

For that matter, policy-makers are given clear criteria on how to improve their financial risk. If a country's financial risk is below the threshold value of 28, policy-makers should make an effort to improve in terms of one or more components of the risk rating. For example, the financial risk component "foreign debt as a percentage of GDP" can be raised from an initial five risk points to its maximum value of ten risk points if policy-makers are able to reduce foreign debt from 50 to <5 % of GDP. In the case of the financial risk component "exchange rate stability", the currency of a country having five risk points in this component has an annual depreciation with respect to the US dollar of more than 50 % or an appreciation between 30 and 34.9 %. In order to increase the risk rating to the maximum of 10 risk points, the country must ensure that its exchange rate changes only within the boundary of −5 to 10 %. Accordingly, policy-makers have clear criteria on how to reap the benefits of financial openness for output volatility.[19]

The risk class of all countries for each period can be found in Table 16 in the "Appendix. Table 9 summarizes the number of countries that belong to either one of the three risk classes in a given year. In the 1980s, countries were relatively evenly spread over the risk classes. However, a shift from higher risk classes to lower risk classes over time becomes apparent. Therefore, more and more countries may benefit from financial globalization in terms of reduced output volatility.

7 Concluding remarks

This paper identifies a country's financial risk rating as a variable that determines whether financial openness increases or decreases output volatility. We

[19] As a somewhat smoother transition from one risk class to the next is not unlikely, a reduction in financial risk might always be beneficial even if no threshold is passed.

hypothesized that financial risk affects an investor's decision on whether to make pro- or counter-cyclical investments. In the case of low-risk countries, investors invest during recessions because firms with good future prospects are relatively cheap. Furthermore, they lend money to prospering projects which domestic banks might not be willing to finance as they are less able to bear risk in recessions.[20] Therefore, international capital inflows are counter-cyclical and reduce output volatility. In the case of high risk countries, investors fear big losses due to government default, exchange rate collapse or panic selling by other investors. Investors carefully observe changes in growth expectations and the action of other investors. If there are signs of a recession, they withdraw their money as soon as possible. In that case, international capital inflows are pro-cyclical and financial openness increases output volatility.

The results of an empirical analysis using a threshold model support this hypothesis. They indeed indicate that financial openness increases output volatility if a country has high risk (financial risk rating of 28 or below) and it decreases output volatility for low-risk countries (financial risk rating above 28). As the risk rating is based on objective criteria, countries have clear guidance on what they need to improve in order to profit from financial openness in terms of reduced output volatility. Therefore, the result of this paper is important for policy decisions. Nevertheless, output volatility is not the only issue policy-makers are concerned with when taking decisions on financial market regulations. It might be the case that growth opportunities outweigh high output volatility, see Ranciere et al. (2006). In this case, high risk countries should not take the route of constraining capital markets but of decreasing financial risk. Most likely, such a strategy will not have a negative effect on growth, while significantly reducing volatility. However, a thorough analysis of the interacting effects between financial risk, output volatility and growth is not pursued here but left for further research. In general, the paper provides evidence that financial openness becomes more favourable in the context of output volatility as financial risk decreases.

Properly implemented, financial openness is an important determinant of output volatility. Based on the finding of this paper, the effect of financial openness on output volatility depends on the country's financial risk. Therefore, financial openness should be included as a function of financial risk in macroeconomic models and regressions explaining output volatility. If financial risk is not used as a mediating variable, then the two opposing effects of financial openness might cancel each other out, rendering financial openness insignificant. Financial risk is therefore likely to be what Buch et al. (2005) call the 'missing link' in determining the effect of financial openness on output volatility.

The result is robust. Several variables were included to control for the quality of fiscal and monetary policy, for supply shocks, for trade openness and for financial risk. Furthermore, time- and country-specific fixed effects were included. In a first analysis using interaction terms we found evidence that the non-linear relation between financial openness and output volatility does depend on financial risk and not on a country's monetary and fiscal policy nor its income. In order to test the

[20] Easterly et al. (2001) argue that during recessions, the default rate of credits is higher for domestic financial institutions. Therefore, banks are less willing or able to bear risk and they provide fewer credits.

robustness of the threshold model, the measures of the variables were changed: FDIs were excluded from financial openness, output volatility was measured as the standard deviation of the business-cycle component of GDP and different measures for the control variables were used. Further, the robustness to modifications of the threshold model specifications was tested: using the logarithm of output volatility and using three thresholds or an interaction term of financial openness and financial risk. While the interaction term model already reveals the effect of financial risk on the relation between financial openness and output volatility, it was argued by means of an information criterion that the relation is better captured by a threshold model than an interaction term. Moreover, country groups were included in and excluded from the sample. None of these modifications changed the result that financial openness increases output volatility in high risk countries and decreases output volatility in low-risk countries.

Over the past three decades, the number of countries in the sample having very high or high-intermediate-risk decreased. Therefore, more and more countries may benefit from financial globalization in terms of reduced output volatility rather than suffer from economic crises. Nevertheless, the Greek debt crisis is a vivid reminder of how dangerous financial openness can be if the country is (suspected to be) unable to repay its debt. In 2010, Greece was in the class of intermediate-risk and may serve as an example of how capital is withdrawn within a recession if the country is not financially sound. In the same time, Germany had very low financial risk illustrating that financial openness may help to recover from a recession if the country is financially sound.

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Appendix

See Tables 10, 11, 12, 13, 14, 15, 16 and see Fig. 1.

Table 10 List of countries in the balanced sample

26 developed countries
Australia; Austria; Belgium; Canada; Denmark; Finland; France; Germany; Greece; Hong Kong; Iceland; Ireland; Israel; Italy; Japan; Netherlands; New Zealand; Norway; Portugal; Singapore; South Africa; Spain; Sweden; Taiwan; United Kingdom; United States
36 developing countries
Argentina; Bolivia; Brazil; Cameroon; Costa Rica; Dominican Republic; Ecuador; Egypt; Haiti; Indonesia; Iran; Jamaica; Jordan; Kenya; Kuwait; Lebanon; Libya; Malawi; Mexico; Morocco; Nicaragua; Pakistan; Panama; Paraguay; Peru; Philippines; Senegal; Sri Lanka; Sudan; Syria; Tanzania; Thailand; Togo; Tunisia; United Arab Emirates; Zambia

Singapore; Taiwan and Hong Kong are termed neither as 'developed' nor 'developing' countries. However, they belong to the group of 'advanced' economies as termed by the IMF and are therefore included in the group of 'developed' countries

Table 11 Variables: definition and source

Variable	Definition	Source
Output volatility	(Standard deviation of real per capita GDP growth) × 100	Real per capita GDP (2,000 international dollars): PWT[N3] and WEO[N4]
Monetary policy quality	ln(|inflation|)	Inflation (% change in CPI): WEO and WDI[N5]
Fiscal policy quality	Government expenditures (% of GDP) growth	General government expenditure and net lending (% of GDP): WEO
Supply shock	Standard deviation of terms of trade growth	Terms of trade in goods and services: WEO
Trade openness	(Exports + imports)/GDP	Exports and imports of goods and services: WDI and WEO
Financial openness	(Total liabilities[N1] + total assets[N2])/GDP	Lane and Milesi-Ferretti (2007)
Financial risk indicator	Aggregation of financial risk components	Index constructed by PRS group[N6]

Standard deviations are taken over a 5-year non-overlapping window, otherwise averages are taken over the same period. Most data were kindly provided to me by Nikola Spatafora who used the data in Spatafora and Sommer (2007)

[N1] Total Liabilities = portfolio equity liabilities + FDI liabilities + debt liabilities + financial derivatives liabilities; [N2] Total Assets = portfolio equity assets + FDI assets + debt assets + financial derivatives assets + total reserves − gold; [N3] PWT: Heston et al. (2006), Penn World Table Version 6.2; [N4] WEO: IMF (2007), World Economic Outlook; [N5] WDI (2007), The World Bank, World Development Indicators; [N6] PRS group: Political Risk Service group; International Country Risk Guide. More information on http://www.prsgroup.com

Table 12 Descriptive statistics

Variable	Mean	σ	Min	Max	1980	2000
Output volatility (σ_Y)	3.47	3.71	0.30	32.55	4.36	2.26
Monetary policy (π)	1.89	1.35	−1.28	8.00	2.61	1.14
Fiscal policy (Δ_{Gov})	−0.04	1.56	−8.43	7.79	0.35	0.03
Supply shock (σ_{ToT})	9.14	11.78	0.00	94.77	13.13	6.28
Trade openness (*TraOpen*)	0.74	0.54	0.14	4.21	0.71	0.85
Financial risk (*FinRisk*)	33.99	9.49	9.71	49.83	29.81	36.95
Financial openness (*FinOpen*)	1.88	2.05	0.26	16.23	1.28	2.68

Statistics are calculated using 310 observations for the first columns and 62 for the last two columns. '1980' ('2000') is the mean of the variable in 1980–1984 (2000–2007). For definitions of the variables see Table 11

Table 13 Alternative measure of output volatility

$\sigma^*_{Yit} = \alpha_i + \delta \mathbf{Q_{it}} + \sum_{k=0}^{K-1} \beta_{k+1} FO_{it} I(\gamma_k < FR_{it} \leq \gamma_{k+1}) + \beta_{K+1} FO_{it} I(\gamma_K < FR_{it}) + \varepsilon_{it}$		
$\hat{\gamma}_1$	20.2	[20.1, 22.5]
$\hat{\gamma}_2$	28.9	[26.5, 39.7]
$FinOpen\, I(FinRisk \leq \hat{\gamma}_1)$	1.537**	(0.027)
$FinOpen\, I(\hat{\gamma}_1 < FinRisk \leq \hat{\gamma}_2)$	0.223	(0.143)
$FinOpen\, I(\hat{\gamma}_2 < FinRisk)$	−0.243**	(0.021)
$R^2 [\bar{R}^2]$		0.39 [0.36]

The dependent variable is output volatility measured as the standard deviation of the cyclical component of GDP, multiplied by 100

Country and time fixed effects are included. Definitions of the variables can be found in Table 11. 62 countries and five 5-year non-overlapping windows are used. 1,000 bootstrap replications were used to obtain [confidence intervals]

γ threshold, *FinRisk* financial risk rating, *FinOpen* financial openness

** Significant at the 5 % level. Robust *p*-values are given in parentheses

Table 14 Estimation results: interaction term

$\sigma_{Yit} = \alpha_i + \delta \mathbf{Q_{it}} + \beta_1 FinOpen_{it} + \beta_2 FinOpen_{it} * FinRisk_{it} + \varepsilon_{it}$		
FinOpen	1.993***	(0.001)
FinOpen * *FinRisk*	−0.055***	(0.001)
$R^2 [\bar{R}^2]$		0.30 [0.27]

The dependent variable is output volatility. Definitions of the variables can be found in Table 11. 62 countries and five 5-year non-overlapping time periods are used, leading to 310 observations. Country and time fixed effects are included

FinRisk financial risk rating, *FinOpen* financial openness

*** Significant at the 1 % level. Robust *p*-values are given in parentheses

Table 15 Estimation results: excluding income groups

Regressor	Double threshold		Triple threshold	
Excluding 9 low-income countries				
*FinOpen*2.1/3.1	*2.006****	(0.001)	*2.065****	(0.001)
*FinOpen*2.2/3.2	0.464***	(0.002)	0.488***	(0.002)
*FinOpen*2.3/3.3	−0.177	(0.191)	−0.162	(0.199)
*FinOpen*3.4			−0.435**	(0.029)
$R^2[\bar{R}^2]$	0.42 (0.39)		0.43 [0.40]	
Excluding 26 middle-income countries				
*FinOpen*2.1/3.1	*1.739****	(0.001)	*1.914****	(0.001)
*FinOpen*2.2/3.2	*1.416***	(0.015)	*1.504****	(0.010)
*FinOpen*2.3/3.3	−0.074	(0.538)	−0.093	(0.475)
*FinOpen*3.4			−0.392*	(0.087)
$R^2[\bar{R}^2]$	0.40 [0.35]		0.42 [0.37]	
Excluding 27 high-income countries				
*FinOpen*2.1/3.1	1.124**	(0.028)	1.206**	(0.022)
*FinOpen*2.2/3.2	−0.057	(0.860)	−0.014	(0.967)
*FinOpen*2.3/3.3	−1.820**	(0.046)	−1.719*	(0.059)
*FinOpen*3.4			*−3.092***	(0.011)
$R^2[\bar{R}^2]$	0.39 [0.35]		0.40 [0.35]	

The countries are divided according to their World Bank classification: low-income, middle-income and high-income. The double and triple threshold regressions, (3) and (4), are estimated leaving out one income group at a time. If there are 30 or fewer observations in a certain risk class, the coefficient is printed in italics. Country and time fixed effects are included

***, **, * Significant at the 1, 5, and 10 % level, respectively. Robust *p*-values are given in parentheses

Table 16 Countries in each time period by class

Countries with very high financial risk

1980: Argentina, Bolivia, Brazil, Costa Rica, Dominican Republic, Ecuador, Haiti, Iran, Jamaica, Lebanon, Libya, Morocco, Nicaragua, Peru, Philippines, Sudan, Syria, Zambia

1985: Argentina, Bolivia, Dominican Republic, Ecuador, Egypt, Haiti, Iran, Lebanon, Libya, Nicaragua, Pakistan, Peru, Philippines, Sri Lanka, Sudan, Syria, United Arab Emirates, Zambia

1990: Haiti, Lebanon, Sudan, Zambia

1995: Sudan

Countries with high-intermediate financial risk

1980: Cameroon, Egypt, Greece, Indonesia, Israel, Jordan, Kenya, Malawi, Mexico, Pakistan, Panama, Senegal, Sri Lanka, Tanzania, Togo, Tunisia

1985: Brazil, Cameroon, Costa Rica, Greece, Indonesia, Israel, Jamaica, Jordan, Kenya, Malawi, Mexico, Morocco, Panama, Paraguay, Senegal, South Africa, Tanzania, Togo, Tunisia

1990: Cameroon, Dominican Republic, Jordan, Kenya, Libya, Malawi, Nicaragua, Pakistan, Peru, Senegal, Sri Lanka, Syria, Tanzania, Togo

1995: Haiti, Malawi, Nicaragua, Tanzania, Zambia

2000: Argentina, Malawi, Nicaragua, Tanzania, Zambia

Table 16 continued

Countries with low-intermediate financial risk
1980: Hong Kong, Iceland, Italy, Kuwait, Paraguay, Portugal, South Africa, Spain, Taiwan, Thailand, United Arab Emirates
1985: Hong Kong, Kuwait, Portugal, Singapore, Spain, Thailand
1990: Argentina, Bolivia, Brazil, Costa Rica, Ecuador, Egypt, Greece, Iran, Israel, Jamaica, Kuwait, Mexico, Morocco, Panama, Paraguay, Philippines, South Africa, Tunisia, United Arab Emirates
1995: Argentina, Australia, Bolivia, Brazil, Cameroon, Costa Rica, Dominican Republic, Ecuador, Egypt, Greece, Iceland, Indonesia, Iran, Israel, Italy, Jamaica, Jordan, Kenya, Lebanon, Libya, Mexico, Morocco, New Zealand, Pakistan, Panama, Paraguay, Peru, Philippines, Portugal, Senegal, South Africa, Sri Lanka, Sweden, Syrian Arab Republic, Thailand, Togo, Tunisia
2000: Australia, Belgium, Bolivia, Brazil, Cameroon, Costa Rica, Dominican Republic, Ecuador, Egypt, Finland, France, Germany, Greece, Haiti, Iceland, Indonesia, Ireland, Israel, Italy, Jamaica, Jordan, Kenya, Lebanon, Mexico, Morocco, Netherlands, New Zealand, Pakistan, Panama, Paraguay, Peru, Philippines, Portugal, Senegal, South Africa, Spain, Sri Lanka, Sudan, Sweden, Syrian Arab Republic, Thailand, Togo, Tunisia, United Kingdom, United States
Countries with very low financial risk
1980: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Netherlands, New Zealand, Norway, Singapore, Sweden, United Kingdom, United States
1985: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, Taiwan, United Kingdom, United States
1990: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Iceland, Indonesia, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Taiwan, Thailand, United Kingdom, United States
1995: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Japan, Kuwait, Netherlands, Norway, Singapore, Spain, Taiwan, United Arab Emirates, United Kingdom, United States
2000: Austria, Canada, Denmark, Hong Kong, Iran, Japan, Kuwait, Libya, Norway, Singapore, Taiwan, United Arab Emirates

List of countries belonging to a certain financial risk class during a certain period. In order to provide additional information, the low-risk class is divided into low-intermediate and very low-risk using the threshold which is estimated by the triple threshold model

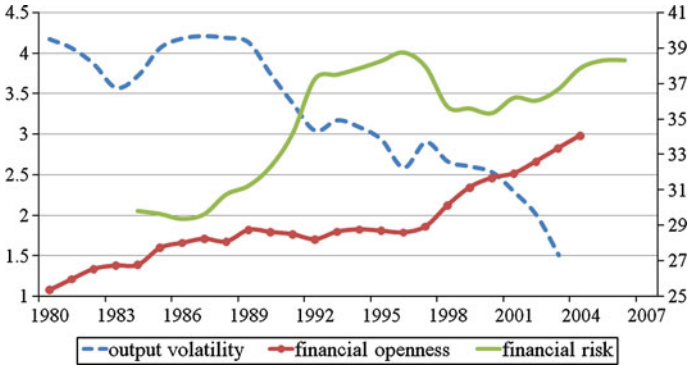

Fig. 1 Country-averages over time. *Note* In order to make this graph more informative, output volatility is presented as the 5-year *rolling* window, financial openness and financial risk are presented as their respective value in a given year and *not* as its 5-year mean

References

Baxter, M., & King, R. G. (1999). Measuring business cycles: Approximate band-pass filters for economic time series. *Review of Economics and Statistics, 81*, 575–593.

Beck, T., Demirgüç-Kunt, A., & Levine, R. (1999). A new database on financial development and structure. (*Policy Research Working Paper Series 2146*). Washington, DC: The World Bank.

Bekaert, G., Harvey, C., & Lundblad, C. (2006). Growth volatility and financial liberalization. *Journal of International Money and Finance, 58*, 370–403.

Bordo, M. D., & Meissner, C. M. (2007). Foreign capital and economic growth in the first era of globalization. (*NBER Working Paper 13577*). Cambridge, MA: National Bureau of Economic Research.

Buch, C. M., Doepke, J., & Pierdzioch, C. (2005). Financial openness and business cycle volatility. *Journal of International Money and Finance, 24*, 744–765.

Calderón, C., Loayza, N., & Schmidt-Hebbel, K. (2004). Openness, vulnerability, and growth. Paper prepared for the eighth annual conference of the Central Bank of Chile on "External Financial Vulnerability and Preventive Policies," (August 10 and 11, 2004). Santiago, Chile.

Caprio, G. (1997). Safe and sound banking in developing countries: We're not in Kansas anymore. (*Policy Research Working Paper 1739*). Washington, DC: World Bank.

Chinn, M. D., & Ito, H. (2006). What matters for financial development? Capital controls, institutions, and interactions. *Journal of Development Economics, 81*, 163–192.

Dynan, K. E., Elmendorf, D. W., & Sichel, D. E. (2006). Can financial innovation help to explain the reduced volatility of economic activity? *Journal of Monetary Economics, 53*, 123–150.

Easterly, W., Islam, R., & Stiglitz J. E. (2001). Shaken and stirred: Explaining growth volatility. In *Annual World Bank Conference on Development Economics 2000* (pp. 191–211), Washington, DC.

Ferreira da Silva, G. (2002). The impact of financial system development on business cycles volatility: cross-country evidence. *Journal of Macroeconomics, 24*, 233–253.

Fischer, S. (1998). Capital-account liberalization and the role of the IMF. Should the IMF pursue capital-account convertibility? (*Essays in international finance no. 207*). Princeton: Princeton University.

Giovanni, J., & Levchenko, A. A. (2006). Openness, volatility and the risk content of exports. Paper presented at the Trade Conference, Research Department (April 13, 2006). Hosted by the International Monetary Fund, Washington, DC.

Girard, E., & Omran, M. (2007). What are the risks when investing in thin emerging equity markets: Evidence from the Arab world. *Journal of International Financial Markets Institutions and Money, 17*, 102–123.

Gurr, T. R., Jaggers, K., & Moore, W. H. (1989). *Polity II Codebook*. Unpublished codebook. Boulder: University of Colorado.

Hansen, B. E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. *Journal of Econometrics, 93*, 345–368.

Hassan, M. K., Maroney, N. C., El-Sady, H. M., & Telfah, A. (2003). Country risk and stock market volatility, predictability, and diversification in the Middle East and Africa. *Economic Systems, 27*, 63–82.

Heston, A., Summers, R., & Aten, B. (2006). Penn world table version 6.2. Center for International Comparisons at the University of Pennsylvania.

Hoti, S., & McAleer, M. (2004). An empirical assessment of country risk ratings and associated models. *Journal of Economic Surveys, 18*, 539–588.

IMF (2007). *World economic outlook*. Washington, DC: International Monetary Fund.

IMF (2008). *Global financial stability report-containing systemic risks and restoring financial soundness.* Washington, DC: International Monetary Fund.

Jayasuriya, S. (2005). Stock market liberalization and volatility in the presence of favorable market characteristics and institutions. *Emerging Markets Review, 6*, 170–191.

Karras, G., & Song, F. (1996). Sources of business-cycle volatility: An exploratory study on a sample of OECD countries. *Journal of Macroeconomics, 18*, 621–637.

Kim, H. E., & Singal, V. (2000). Stock market openings: Experience of emerging economies. *The Journal of Business, 73*, 25–66.

Klein, M. W. (2003). Capital account openness and the varieties of growth experience. (*NBER Working Paper 9500*). Cambridge, MA: National Bureau of Economic Research.

Kose, M. A., Prasad, E., & Terrones, M. (2003). Financial integration and macroeconomic volatility. *IMF Staff Papers, 50*, 119–142.

Kose, M. A., Prasad, E., & Terrones, M. (2005). How do trade and financial integration affect the relationship between growth and volatility? (*IMF Working Paper 05/19*). Washington, DC: International Monetary Fund.

Kremer, S., Nautz, D., & Bick, A. (2008). *Inflation and growth: New evidence from a panel threshold analysis*. Working Paper, Goethe University.

Krueger, A. (2002). Crisis prevention and resolution: Lessons from argentina. In *The Argentina crisis. National bureau of economic research conference*. Speech retrieved on 18 May 2009 from http://imf.org/external/np/speeches/2002/071702.htm.

Lane, P. R., & Milesi-Ferretti, G. M. (2007). The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970–2004. *Journal of International Economics, 73*, 223–250.

Leamer, E. E. (1983). Let's take the con out of econometrics. *American Economic Review, 73*, 31–43.

Levine, R., & Renelt, D. (1992). A sensitivity analysis of cross-country growth regressions. *American Economic Review, 82*, 942–963.

Ramey, G., & Ramey, V. A. (1995). Cross-country evidence on the link between volatility and growth. *American Economic Review, 85*, 1138–1151.

Ranciere, R., Tornell, A., & Westermann, F. (2006). Decomposing the effects of financial liberalization: Crises vs. growth. *Journal of Banking and Finance, 30*, 3331–3348.

Razin, A., & Rose, A. (1992). Business cycle volatility and openness: An exploratory cross-section analysis. (*NBER Working Paper 4208*). Cambridge, MA: National Bureau of Economic Research.

Rogoff, K., Kose, M. A., Prasad, E., & Wei, S.-J. (2009). Financial globalization: A reappraisal. *Panoeconomicus, 56*, 143–197.

Spatafora, N., & Sommer, M. (2007). The changing dynamics of the global business cycle. In *World economic outlook: globalization and inequality*, Chapter 5, (pp. 67–94). Washington, DC: International Monetary Fund.

Stiglitz, J. E. (2000). Capital market liberalization, economic growth, and instability. *World Development, 28*, 1075–1086.

Summers, P. M. (2005). What caused the Great Moderation? Some cross-country evidence. *Economic Review, 90*, 5–32.

WDI (2007). *World development indicators*. Washington, BC: The World Bank.

Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. Cambridge, MA: The MIT Press.

Yang, B. (2008). Does democracy lower growth volatility? A dynamic panel analysis. *Journal of Macroeconomics, 30*, 562–574.